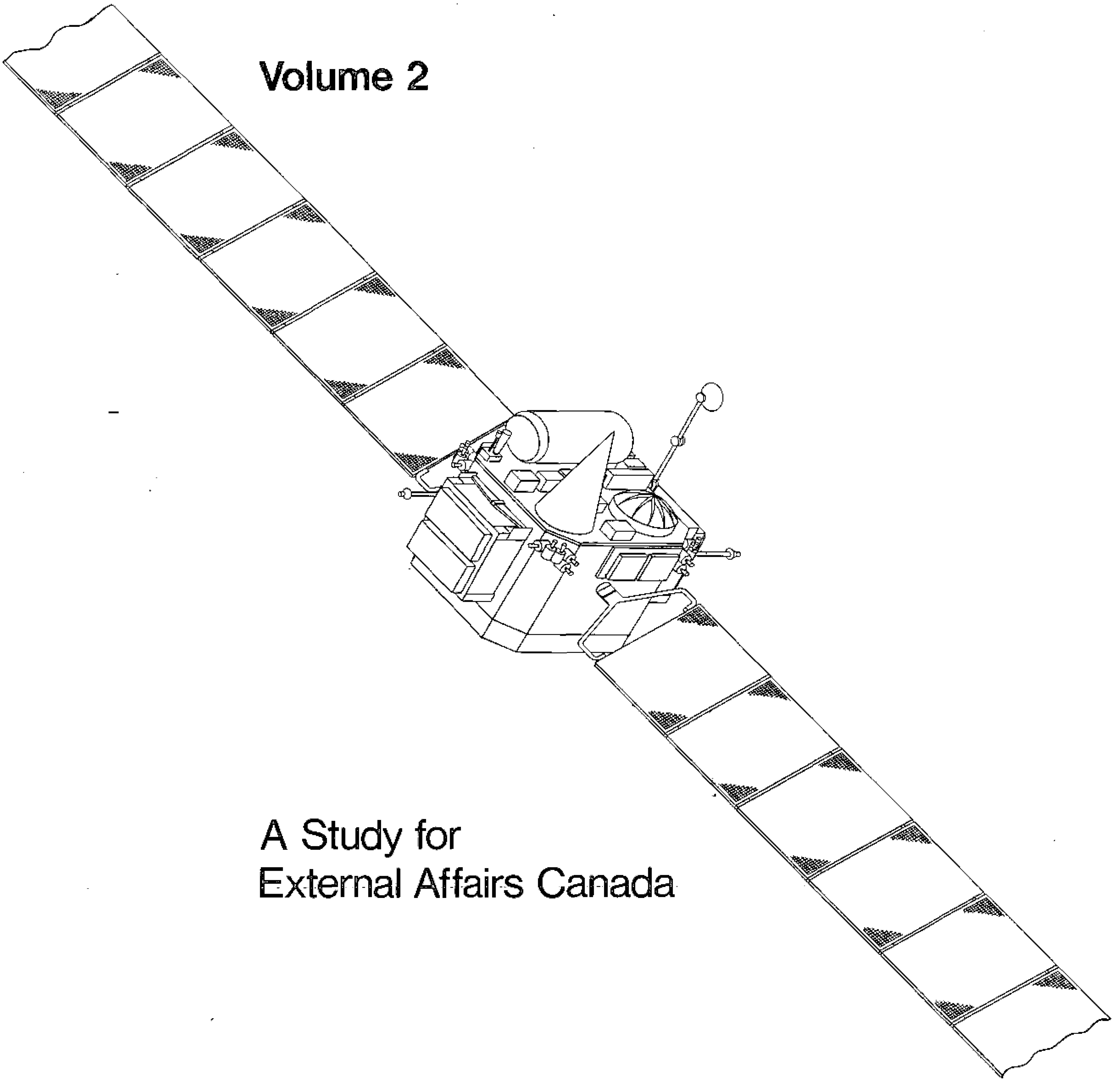
PAXSAT 'A'

Space Based Remote Sensing: Space-to-Space



Volume 2

A Study for
External Affairs Canada

Spar Aerospace Limited

SPAR

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PAXSAT 'A'

SPACE-BASED REMOTE SENSING

SPACE-TO-SPACE

VOLUME II APPENDIX

REPORT NO.

JANUARY 1985 RML-009-85-08

PREPARED FOR: EXTERNAL AFFAIRS CANADA
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FOREWORD

This constitutes the final report under Contract No. 21ST-08011-4-2297, Serial OST84-00133, titled "Paxsat Concept for Arms Control and Disarmament Verification in Outer Space".

The contract was carried out by the Satellite and Aerospace Systems Division of Spar Aerospace Limited, with a major subcontract to Philip A. Lapp Limited who in turn were supported by the Canadian Center for Arms Control and Disarmament.

The report is presented in two volumes. Volume I is the main body of the report compromising of sections 1 through 10.0. Volume 2 is the appendix of the report and contains Appendices A through D.

The material on Space Assets and Weapons Analysis presented in Volume 1, section 2.0 and, on the operational aspects of the Paxsat concept presented in section 4.0 of this report, are the effort of Philip A. Lapp Limited. Additionally, the resources of Philip A. Lapp Limited generated the material on the ground based and space based optics capabilities presented in section 6.0. Section 3.0, the Political/ Legal context for a Paxsat type mission is the effort of the Canadian Center for Arms Control and Disarmament. Remaining sections of the report including the Artificial Satellite Log of Appendix A were generated by the Satellite and Aerospace Division of Spar Aerospace Limited.

The contract was monitored for External Affairs Canada by Mr. Ron ClemInson and for Supply and Services Canada by Mr. Louis Cloutier. The monthly reviews and reports were made to an ad-hoc committee of DND, DEA, EM&R and DOC personnel chaired by Mr. J. Ray Marchand of the Interdepartmental Committee on Space.

LIST OF APPENDICES

SPAR

APPENDIX A

SATELLITE LAUNCH SUMMARY 1980-1983 AD

KEY FOR THE SATELLITE LAUNCH SUMMARY 1980-1983 AD

SATELLITE NAME	:	THE IDENTIFIER BY WHICH A GIVEN SATELLITE IS KNOWN.
INTERNATIONAL DESIGNATION	:	THE INTERNATIONAL TELECOMMUNICATIONS UNION IDENTIFIER NUMBER ASSIGNED TO ALL SPACECRAFT THAT ARE LAUNCHED. THE NUMBERS RUN SERIALLY EACH YEAR ACCORDING TO THE TIME OF LAUNCH. MULTIPLE LAUNCHES ARE INDICATED BY A LETTER B,C,D, etc.
COUNTRY	:	THE SPECIFIC COUNTRY OR INTERNATIONAL AGENCY WHO OWNS THE SATELLITE.
PROJECT DIRECTORATE	:	THE NATIONAL OR INTERNATIONAL AGENCY WHO WAS RESPONSIBLE FOR THE PROCUREMENT OF THE SATELLITE.
MISSION CIVIL / MILITARY DESIGNATION	:	A DESIGNATOR WHICH DEFINES WHETHER THE SATELLITE IS USED FOR NON-MILITARY OR MILITARY PURPOSES. A SATELLITE HAS BEEN DEFINED TO BE MILITARY FOR SHARED PAYLOAD SPACECRAFT. CAUTION SHOULD BE EXERCISED FOR SOVIET SPACECRAFT DESIGNATORS DUE TO A LACK OF DETAILS.
MISSION PURPOSE	:	A FIVE LETTER CODE DEFINED BY AUTHOR DESIGNATING THE FUNCTION OF A SPACECRAFT DEDUCED FROM REFERENCES CONSULTED. CAUTION NEEDS TO BE EXERCISED WITH MILITARY SPACECRAFT AND IN PARTICULAR ELINT,RECON,RADAR SPACECRAFT CLASSIFICATIONS.
LAUNCH DATE	:	LAUNCHED DATE OF THE SATELLITE AS ACCEPTED BY THE ITU.
LAUNCH SITE	:	A THREE LETTER CODE DEFINING THE LAUNCH SITE EMPLOYED TO LAUNCH THE SATELLITE. AKY - AKTUBINSK-KAPUSTIN YAR (USSR) CSG - CENTRE SPATIAL GUYANAIS (FRENCH GUIANA) BAI - BAIKONUR (USSR) KSC - KAGOSHIMA SPACE CENTRE (JAPAN) PLE - PLESETSK (USSR) TSC - TANEGASHIMA SPACE CENTRE (JAPAN) ETR - EASTERN TEST RANGE (USA) SSC - SRIHARIKOTA SPACE CENTRE (INDIA) WTR - WESTERN TEST RANGE (USA) JQN - JUIQUAN (CHINA)
LAUNCH VEHICLE	:	THE LAUNCH VEHICLE USED TO LAUNCH THE SATELLITE.
ORBITAL PERIOD	:	THE LENGTH OF TIME EXPESSED IN MINUTES FOR A SATELLITE TO COMPLETE ONE ORBIT ABOUT THE EARTH.
PERIGEE HEIGHT OF AN ORBIT	:	THE HEIGHT MEASURED IN KILOMETERS AT CLOSET APPROACH OF THE SATELLITE TO THE SURFACE OF THE EARTH.
APOGEE HEIGHT OF AN ORBIT	:	THE HEIGHT MEASURED IN KILOMETERS AT FARTHEST EXCURSION OF THE SATELLITE FROM THE SURFACE OF THE EARTH.
ORBITAL INCLINATION	:	THE ANGLE MEASURED IN DEGREES THAT THE PLANE OF AN ORBIT SUBTENDS WITH RESPECT TO THE EQUATORIAL PLANE OF THE EARTH.
SEMI-MAJOR AXIS OF AN ORBIT	:	ONE-HALVE OF THE LONG AXIS OF THE ELLIPTICAL ORBIT.
ECCENTRICITY	:	DISTANCE FROM THE CENTER OF AN ELLIPSE TO ITS FOCUS DIVIDED BY THE SEMI-MAJOR AXIS.
RIGHT ASCENSION RATE	:	THE RATE OF PRECESSION OF THE RIGHT ASCENSION OF AN ORBIT CAUSED BY THE NON-SPHERICAL SHAPE OF THE EARTH. A VALUE OF APPROXIMATELY +1.0 DEGREES PER DAY IS INDICATIVE OF A SUN-SYNCHRONOUS ORBIT.
GEOSYNCHRONOUS ORBITAL POSITION	:	THE LONGITUDE OF THE SPACECRAFT MEASURED EASTWARDS FROM GREENWICH MODULUS 360 DEGREES. A VALUE OF 361 INDICATES THAT THE POSITION IS UNKNOWN TO THE AUTHOUR.
MISSION STATUS	:	A THREE LETTER CODE DEFINING THE STATUS OF THE SPACECRAFT IN ITS ORBIT. DEC - DECAYED. RE-ENTERED THE EARTH's ATMOSPHERE. REC - RECOVERED. RETREIVED BY AGENCY WHO LAUNCHED THE SATELLITE. DEO - DE-ORBITED. PLACED INTO ALTERNATIVE ORBIT FOR INTENTIONAL RE-ENTRY. IOF - IN-ORBIT FAILURE. FATAL MECHANISM FAILURE ON SPACECRAFT OR UPPER STAGE. LVF - LAUNCH VEHICLE FAILURE.
MISSION STATUS DATE	:	THE DATE FOR WHICH THE STATUS OF THE SPACECRAFT IS GIVEN.
REMARKS	:	COMMENTS. QUESTION MARKS INDICATE DATA UNCERTAIN.
WARNING	:	SINCE SOME ASSUMPTIONS WERE MADE IN CORRELATING THIS INFORMATION, ACCURACY OF DATA CANNOT BE ASSURED.

IDENTIFICATION				MISSION		LAUNCH DATA			ORBITAL DATA								MISSION STATUS		
SATELLITE NAME	INT'L DESIG.	COUNTRY	PROJ. DIR.	C/M DESIG.	PURPOSE	DATE	SITE	VEHICLE	PERIOD (MIN)	PERIGEE HEIGHT (KM)	APOGEE HEIGHT (KM)	INCL. (DEG)	SEMI-MAJOR AXIS (KM)	ECCEN. (ND)	RIGHT ASCENSION RATE (DEG/DAY)	GEOSYNC ORBITAL POSITION (DEG. EAST)	STATUS	DATE	REMARKS
COSMOS-1149	1980-1-A	USSR		MIL	RECON	09-Jan-80	PLE	A-2	90.4	208.0	414.0	70.3	6689.2	0.015398	-2.84455E+00		REC	23-Jan-80	
46TH MOLNIYA-1	1980-2-A	USSR		MIL	COMMU	11-Jan-80	PLE	A-2-e	737.0	478.0	40830.0	62.8	27032.2	0.746371	-1.48118E-01				
COSMOS-1150	1980-3-A	USSR		MIL	NAVIG	14-Jan-80	PLE	C-1	105.0	989.0	1028.0	83.0	7386.7	0.002640	-7.26420E-01				
FLTSATCOM-3	1980-4-A	USA	USN	MIL	COMMU	18-Jan-80	ETR	ATLAS CENTAUR	1436.1	35745.0	35829.0	2.6	42165.2	0.000996	-1.33989E-02	337.0			UHF COMMUNICATIONS
COSMOS-1151	1980-5-A	USSR		MIL	ORSAT	23-Jan-80	PLE	F-2	97.8	650.0	678.0	82.5	7042.2	0.001988	-9.19573E-01				EORSAT? ELINT OCEAN RECONNAISSANCE
COSMOS-1152	1980-6-A	USSR		MIL	RECON	24-Jan-80	PLE	A-2	89.7	181.0	370.0	67.1	6653.7	0.014203	-3.34508E+00		REC	06-Feb-80	
COSMOS-1153	1980-7-A	USSR		MIL	NAVIG	25-Jan-80	PLE	C-1	105.0	983.0	1031.0	83.0	7385.2	0.003250	-7.26942E-01				
COSMOS-1154	1980-8-A	USSR		MIL	ELINT	30-Jan-80	PLE	A-1	97.3	634.0	671.0	81.3	7030.7	0.002631	-1.07177E+00				
COSMOS-1155	1980-9-A	USSR		MIL	RECON	07-Feb-80	PLE	A-2	90.4	206.0	422.0	72.9	6692.2	0.016138	-2.47746E+00		REC	21-Feb-80	
KH-11-3	1980-10-A	USA	USAF	MIL	RECON	07-Feb-80	WTR	TITAN IIID	91.7	220.0	498.0	97.0	6737.2	0.020632	1.00335E+00		DEC	10-Oct-82	STRATEGIC RECONNAISSANCE
NAVSTAR-5	1980-11-A	USA	USAF	MIL	NAVIG	09-Feb-80	WTR	ATLAS F	715.9	20095.0	20165.0	63.7	26508.2	0.001320	-3.01648E-02				GLOBAL POSITIONING SYSTEM
COSMOS-1156	1980-12-A	USSR		MIL	COMMU	12-Feb-80	PLE	C-1	115.4	1450.0	1528.0	74.0	7867.2	0.004957	-1.31781E+00				TACTICAL COMMUNICATIONS
COSMOS-1157	1980-12-B	USSR		MIL	COMMU	12-Feb-80	PLE	C-1	115.4	1450.0	1528.0	74.0	7867.2	0.004957	-1.31781E+00				TACTICAL COMMUNICATIONS
COSMOS-1158	1980-12-C	USSR		MIL	COMMU	12-Feb-80	PLE	C-1	115.4	1450.0	1528.0	74.0	7867.2	0.004957	-1.31781E+00				TACTICAL COMMUNICATIONS
COSMOS-1159	1980-12-D	USSR		MIL	COMMU	12-Feb-80	PLE	C-1	115.4	1450.0	1528.0	74.0	7867.2	0.004957	-1.31781E+00				TACTICAL COMMUNICATIONS
COSMOS-1160	1980-12-E	USSR		MIL	COMMU	12-Feb-80	PLE	C-1	115.4	1450.0	1528.0	74.0	7867.2	0.004957	-1.31781E+00				TACTICAL COMMUNICATIONS
COSMOS-1161	1980-12-F	USSR		MIL	COMMU	12-Feb-80	PLE	C-1	115.4	1450.0	1528.0	74.0	7867.2	0.004957	-1.31781E+00				TACTICAL COMMUNICATIONS
COSMOS-1162	1980-12-G	USSR		MIL	COMMU	12-Feb-80	PLE	C-1	115.4	1450.0	1528.0	74.0	7867.2	0.004957	-1.31781E+00				TACTICAL COMMUNICATIONS
COSMOS-1163	1980-12-H	USSR		MIL	COMMU	12-Feb-80	PLE	C-1	115.4	1450.0	1528.0	74.0	7867.2	0.004957	-1.31781E+00				TACTICAL COMMUNICATIONS
COSMOS-1164	1980-13-A	USSR		MIL	EARLY	12-Feb-80	PLE	A-2-e	92.9	220.0	640.0	62.8	6808.2	0.030845	-3.63152E+00		DEC	12-Jan-81	FAILED EARLY WARNING SATELLITE
SMM	1980-14-A	USA	NASA	CIV	SCIEN	14-Feb-80	ETR	DELTA	96.1	571.5	573.5	28.5	6950.7	0.000144	-6.48132E+00				SOLAR MAXIMUM MISSION
TANSEI-4	1980-15-A	JAPAN	ISAS	CIV	SCIEN	17-Feb-80	KSC	Mu 3S	96.5	517.0	672.0	38.7	6972.7	0.011115	-5.69381E+00		DEC	12-May-83	
RADUGA-5	1980-16-A	USSR		MIL	COMMU	20-Feb-80	BAI	D-1-e	1478.0	36610.0	36610.0	0.4	42988.2	.000000	-1.25349E-02	361.0			TV & MULTICHANNEL RADIOCOMM.
COSMOS-1165	1980-17-A	USSR		MIL	RECON	21-Feb-80	PLE	A-2	89.8	182.0	379.0	72.9	6658.7	0.014793	-2.52115E+00		REC	05-Mar-80	
AYAME-2	1980-18-A	JAPAN	NASDA	CIV	COMMU	22-Feb-80	TSC	Nu	625.8	206.9	35512.0	24.6	24237.6	0.728313	-3.84090E-01		IOF	22-Feb-80	EXPERIMENTAL COMMUNICATIONS
WHITECLOUD	1980-19-A	USA	USN	MIL	ORSAT	03-Mar-80	WTR	ATLAS F	107.1	1053.0	1151.0	63.5	7480.2	0.006551	-2.54526E+00				NOSS-1:NAVY OCEAN SURVEILLANCE 1
WHITECLOUD	1980-19-B	USA	USN	MIL	ORSAT	03-Mar-80	WTR	ATLAS F	107.1	1053.0	1151.0	63.5	7480.2	0.006551	-2.54526E+00				NOSS-1:NAVY OCEAN SURVEILLANCE 1
WHITECLOUD	1980-19-C	USA	USN	MIL	ORSAT	03-Mar-80	WTR	ATLAS F	107.1	1053.0	1151.0	63.5	7480.2	0.006551	-2.54526E+00				NOSS-1:NAVY OCEAN SURVEILLANCE 1
COSMOS-1166	1980-20-A	USSR		MIL	RECON	04-Mar-80	PLE	A-2	90.3	208.0	406.0	72.9	6685.2	0.014809	-2.48635E+00		REC	18-Mar-80	
COSMOS-1167	1980-21-A	USSR		MIL	ORSAT	14-Mar-80	BAI	F-1-m	93.3	438.0	457.0	65.0	6825.7	0.001392	-3.32124E+00		DEC	01-Oct-81	EORSAT;ELINT OCEAN RECONNAISSANCE
COSMOS-1168	1980-22-A	USSR		MIL	NAVIG	17-Mar-80	PLE	C-1	104.9	981.0	1026.0	82.9	7381.7	0.003048	-7.38496E-01				
COSMOS-1169	1980-23-A	USSR		MIL	ASATT	27-Mar-80	PLE	C-1	94.5	478.0	521.0	65.8	6877.7	0.003126	-3.13707E+00		DEC	03-Mar-83	INTERCEPTION TEST RADAR CALIBRATION
PROGRESS-8	1980-24-A	USSR		CIV	MAN'D	27-Mar-80	BAI	A-2	88.8	192.0	266.0	51.6	6607.2	0.005600	-5.47049E+00		DEC	26-Apr-80	EXPENDABLE SUPPLY CRAFT
COSMOS-1170	1980-25-A	USSR		MIL	RECON	01-Apr-80	BAI	A-2	89.9	181.0	386.0	70.4	6661.7	0.015387	-2.87179E+00		REC	13-Apr-80	
COSMOS-1171	1980-26-A	USSR		MIL	ASATT	03-Apr-80	PLE	C-1	105.0	976.0	1017.0	65.8	7374.7	0.002780	-2.45735E+00				TARGET VEHICLE FOR COSMOS-1174
SOYUZ-35	1980-27-A	USSR		CIV	MAN'D	09-Apr-80	BAI	A-2	90.3	276.0	315.0	51.6	6673.7	0.002922	-5.28183E+00		RET	03-Jun-80	
COSMOS-1172	1980-28-A	USSR		MIL	EARLY	12-Apr-80	PLE	A-2-e	726.0	637.0	40160.0	62.8	26776.7	0.738012	-1.44894E-01				
COSMOS-1173	1980-29-A	USSR		MIL	RECON	17-Apr-80	BAI	A-2	89.9	180.0	379.0	70.3	6657.7	0.014945	-2.89186E+00		REC	28-Apr-80	SIMILAR TO COSMOS-1170
COSMOS-1174	1980-30-A	USSR		MIL	ASATT	18-Apr-80	BAI	F-1-m	98.6	387.0	1035.0	65.8	7089.2	0.045704	-2.83330E+00		EXP	20-Apr-80	INTERCEPTOR FOR COSMOS-1171
COSMOS-1175	1980-31-A	USSR		MIL	EARLY	18-Apr-80	PLE	A-2-e	92.3	317.0	485.0	62.5	6779.2	0.012391	-3.71774E+00		DEC	28-May-80	FAILED EARLY WARNING SATELLITE
NAVSTAR-6	1980-32-A	USA	USAF	MIL	NAVIG	26-Apr-80	WTR	ATLAS F	707.6	19622.0	20231.0	62.9	26304.7	0.011576	-3.18704E-02				GLOBAL POSITIONING SYSTEM
PROGRESS-9	1980-33-A	USSR		CIV	MAN'D	27-Apr-80	BAI	A-2	88.9	192.0	275.0	51.6	6611.7	0.006277	-5.45756E+00		DEC	22-May-80	EXPENDABLE SUPPLY CRAFT
COSMOS-1176	1980-34-A	USSR		MIL	ORSAT	29-Apr-80	BAI	F-1-m	89.6	260.0	265.0	65.0	6640.7	0.000376	-3.65650E+00				A-PWRD RDR; SIMILAR TO COSMOS-954
COSMOS-1177	1980-35-A	USSR		MIL	RECON	29-Apr-80	PLE	A-2	89.7	181.0	365.0	67.2	6651.2	0.013832	-3.33557E+00		REC	12-Jun-80	
COSMOS-1178	1980-36-A	USSR		MIL	RECON	07-May-80	PLE	A-2	90.4	207.0	417.0	72.9	6690.2	0.015695	-2.47999E+00		REC	22-May-80	
COSMOS-1179	1980-37-A	USSR		MIL	NAVIG	14-May-80	PLE	C-1	103.5	310.0	1570.0	83.0	7318.2	0.086087	-7.61737E-01				IN ORBIT FAILURE
COSMOS-1180	1980-38-A	USSR		CIV	SCIEN	15-May-80	PLE	A-2	89.8	240.0	296.0	62.8	6646.2	0.004213	-3.94351E+00		REC	25-May-80	GEOPHYSICAL OBSERVATIONS
COSMOS-1181	1980-39-A	USSR		MIL	NAVIG	20-May-80	PLE	C-1	105.0	992.0	1020.0	82.0	7384.2	0.001896	-8.30540E-01				
COSMOS-1182	1980-40-A	USSR		MIL	RECON	23-May-80	PLE	F-2	89.2	221.0	278.0	82.3	6627.7	0.004300	-1.16727E+00		REC	05-Jun-80	
SOYUZ-38	1980-41-A	USSR		CIV	MAN'D	26-May-80	BAI	A-2	88.0	198.0	216.0	51.6	6585.2	0.001367	-5.53440E+00		RET	31-Jul-80	

SATELLITE NAME	INT'L DESIG.	COUNTRY	PROJ. DIR.	C/M DESIG.	PURPOSE	DATE	SITE	VEHICLE	PERIOD (MIN)	PERIGEE HEIGHT (KM)	APOGEE HEIGHT (KM)	INCL. (DEG)	SEMI-MAJOR AXIS (KM)	ECCEN. (ND)	RIGHT ASCENSION RATE (DEG/DAY)	GEOSYNC ORBITAL POSITION (DEG. EAST)	STATUS	DATE	REMARKS
IDENTIFICATION				MISSION		LAUNCH DATA			ORBITAL DATA								MISSION STATUS		
COSMOS-1183	1980-42-A	USSR		MIL	RECON	28-May-80	PLE	A-2	90.4	208.0	414.0	72.9	6689.2	0.015398	-2.48124E+00		REC	11-Jun-80	
NOAA-B(7)	1980-43-A	USA		CIV	METEO	29-May-80	WTR	ATLAS F	102.2	273.0	1453.0	92.3	7241.2	0.081479	2.59897E-01		DEC	03-May-81	INOPERABLE DUE TO LV FAILURE
COSMOS-1184	1980-44-A	USSR		MIL	ELINT	04-Jun-80	PLE	A-1	97.4	621.0	662.0	81.2	7019.7	0.002920	-1.08995E+00				
SOYUZ-T2	1980-45-A	USSR		CIV	MAN'D	05-Jun-80	BAI	A-2	90.3	267.0	316.0	51.6	6669.7	0.003673	-5.29297E+00		RET	09-Jun-80	
COSMOS-1185	1980-46-A	USSR		MIL	RECON	06-Jun-80	PLE	F-2	89.5	226.0	308.0	82.3	6645.2	0.006170	-7.53290E-02		REC	20-Jun-80	
COSMOS-1186	1980-47-A	USSR		MIL	RADAR	06-Jun-80	PLE	C-1	94.5	473.0	519.0	74.0	6874.2	0.003346	-2.11317E+00		DEC	01-Jan-82	
COSMOS-1187	1980-48-A	USSR		MIL	RECON	12-Jun-80	PLE	A-2	89.6	210.0	332.0	72.9	6649.2	0.009174	-6.01422E-02		REC	26-Jun-80	
GORIZONT-4	1980-49-A	USSR		MIL	COMMU	14-Jun-80	BAI	D-1-e	1473.0	36515.0	36515.0	0.8	42893.2	.000000	-1.26315E-02	361.0			TV,TELEGRAPH,TELEPHONE
COSMOS-1188	1980-50-A	USSR		MIL	EARLY	14-Jun-80	PLE	A-2-e	726.0	628.0	40165.0	62.8	26774.7	0.738329	-1.45229E-01				
30TH METEOR-1	1980-51-A	USSR		CIV	METEO	18-Jun-80	BAI	A-1	97.3	589.0	678.0	98.0	7011.7	0.006347	9.95573E-01				COMBINED METEO & ERSAT MISSION
BIG BIRD 15	1980-52-A	USA	USAF	MIL	RECON	18-Jun-80	WTR	TITAN IIID	88.5	165.0	254.0	96.5	6587.7	0.006755	1.00738E+00		DEC	06-Mar-81	BROAD COVERAGE PHOTO. RECON.
NO NAME	1980-52-C	USA	USAF	MIL	ELINT	18-Jun-80	WTR	TITAN IIID	112.2	1325.0	1329.0	96.6	7705.2	0.000260	5.90990E-01				PIGGY BACK ON BIG BIRD LAUNCHES
47TH MOLNIYA-1	1980-53-A	USSR		MIL	COMMU	21-Jun-80	PLE	A-2-e	738.0	658.0	40707.0	62.5	27060.7	0.739986	-1.42886E-01				
COSMOS-1189	1980-54-A	USSR		MIL	RECON	26-Jun-80	PLE	A-2	89.5	209.0	330.0	72.9	6647.7	0.009101	-2.53509E+00		REC	10-Jul-80	
PROGRESS-10	1980-55-A	USSR		CIV	MAN'D	29-Jun-80	BAI	A-2	88.9	191.0	281.0	51.6	6614.2	0.006804	-5.45042E+00		DEC	19-Jul-80	EXPENDABLE SUPPLY CRAFT
COSMOS-1190	1980-56-A	USSR		MIL	COMMU	01-Jul-80	PLE	C-1	100.8	792.0	829.0	74.0	7188.7	0.002574	-1.80689E+00				STORE & DUMP
COSMOS-1191	1980-57-A	USSR		MIL	EARLY	02-Jul-80	PLE	A-2-e	646.0	726.0	40165.0	62.8	26823.7	0.735153	-1.41379E-01				
COSMOS-1192	1980-58-A	USSR		MIL	COMMU	09-Jul-80	PLE	C-1	115.3	1451.0	1522.0	74.0	7864.7	0.004514	-1.31926E+00				TACTICAL COMMUNICATIONS
COSMOS-1193	1980-58-B	USSR		MIL	COMMU	09-Jul-80	PLE	C-1	115.3	1451.0	1522.0	74.0	7864.7	0.004514	-1.31926E+00				TACTICAL COMMUNICATIONS
COSMOS-1194	1980-58-C	USSR		MIL	COMMU	09-Jul-80	PLE	C-1	115.3	1451.0	1522.0	74.0	7864.7	0.004514	-1.31926E+00				TACTICAL COMMUNICATIONS
COSMOS-1195	1980-58-D	USSR		MIL	COMMU	09-Jul-80	PLE	C-1	115.3	1451.0	1522.0	74.0	7864.7	0.004514	-1.31926E+00				TACTICAL COMMUNICATIONS
COSMOS-1196	1980-58-E	USSR		MIL	COMMU	09-Jul-80	PLE	C-1	115.3	1451.0	1522.0	74.0	7864.7	0.004514	-1.31926E+00				TACTICAL COMMUNICATIONS
COSMOS-1197	1980-58-F	USSR		MIL	COMMU	09-Jul-80	PLE	C-1	115.3	1451.0	1522.0	74.0	7864.7	0.004514	-1.31926E+00				TACTICAL COMMUNICATIONS
COSMOS-1198	1980-58-G	USSR		MIL	COMMU	09-Jul-80	PLE	C-1	115.3	1451.0	1522.0	74.0	7864.7	0.004514	-1.31926E+00				TACTICAL COMMUNICATIONS
COSMOS-1199	1980-58-H	USSR		MIL	COMMU	09-Jul-80	PLE	C-1	115.3	1451.0	1522.0	74.0	7864.7	0.004514	-1.31926E+00				TACTICAL COMMUNICATIONS
COSMOS-1200	1980-59-A	USSR		MIL	RECON	09-Jul-80	PLE	A-2	89.5	209.0	332.0	72.9	6648.7	0.009250	-2.53377E+00		REC	23-Jul-80	
EKRAN-5	1980-60-A	USSR		CIV	COMMU	14-Jul-80	BAI	D-1-e	1420.0	34474.0	34474.0	0.4	40852.2	.000000	-1.49827E-02	361.0			TV RELAY
COSMOS-1201	1980-61-A	USSR		CIV	ERSAT	15-Jul-80	PLE	A-2	89.1	220.0	274.0	82.3	6625.2	0.004075	-1.16881E+00		REC	28-Jul-80	
ROHINI-1	1980-62-A	INDIA		CIV	EXPTL	18-Jul-80	SSC	SLV-3	95.0	295.0	745.0	44.7	6898.2	0.032617	-5.39462E+00		DEC	20-May-81	
13TH MOLNIYA-3	1980-63-A	USSR		MIL	COMMU	18-Jul-80	PLE	A-2-e	736.0	467.0	40815.0	62.8	27019.2	0.746656	-1.48653E-01				
SOYUZ-37	1980-64-A	USSR		CIV	MAN'D	23-Jul-80	BAI	A-2	90.0	263.0	312.0	51.6	6665.7	0.003676	-5.30410E+00		RET	11-Oct-80	
COSMOS-1202	1980-65-A	USSR		MIL	RECON	25-Jul-80	PLE	A-2	89.6	209.0	333.0	72.9	6649.2	0.009325	-2.53311E+00		REC	07-Aug-80	
COSMOS-1203	1980-66-A	USSR		CIV	ERSAT	31-Jul-80	PLE	F-2	89.5	227.0	303.0	82.3	6643.2	0.005720	-1.15780E+00		REC	14-Aug-80	
COSMOS-1204	1980-67-A	USSR		MIL	RADAR	31-Jul-80	AKY	C-1	93.3	346.0	546.0	50.7	6824.2	0.014654	-4.98351E+00		DEC	23-Feb-81	
COSMOS-1205	1980-68-A	USSR		MIL	RECON	12-Aug-80	PLE	A-2	89.6	208.0	332.0	72.8	6648.2	0.009326	-2.54882E+00		REC	26-Aug-80	
COSMOS-1206	1980-69-A	USSR		MIL	ELINT	15-Aug-80	PLE	A-1	97.4	630.0	659.0	81.2	7022.7	0.002065	-1.08832E+00				
COSMOS-1207	1980-70-A	USSR		CIV	ERSAT	22-Aug-80	PLE	F-2	89.2	218.0	282.0	82.3	6628.2	0.004828	-1.16697E+00		REC	04-Sep-80	
COSMOS-1208	1980-71-A	USSR		MIL	RECON	26-Aug-80	PLE	A-2	89.6	181.0	362.0	67.1	6649.7	0.013610	-3.35202E+00		REC	24-Sep-80	
COSMOS-1209	1980-72-A	USSR		CIV	ERSAT	03-Sep-80	PLE	A-2	89.4	222.0	306.0	82.3	6642.2	0.006323	-1.15843E+00		REC	17-Sep-80	
6TH METEOR-2	1980-73-A	USSR		MIL	METEO	09-Sep-80	PLE	A-1	102.4	868.0	906.0	81.2	7265.2	0.002615	-9.66395E-01				
GEOS-4	1980-74-A	USA		CIV	METEO	09-Sep-80	ETR	DELTA	1767.0	34264.0	49830.0	0.3	48425.2	0.160722	-8.70625E-03	265.0			
SOYUZ-38	1980-75-A	USSR		CIV	MAN'D	18-Sep-80	BAI	A-2	88.9	199.0	273.0	51.6	6614.2	0.005594	-5.45025E+00		RET	26-Sep-80	
COSMOS-1210	1980-76-A	USSR		MIL	RECON	19-Sep-80	PLE	F-2	88.8	195.0	268.0	82.3	6609.7	0.005522	-1.17846E+00		REC	30-Sep-80	
COSMOS-1211	1980-77-A	USSR		MIL	RECON	23-Sep-80	PLE	F-2	89.1	215.0	261.0	82.4	6616.2	0.003476	-1.15921E+00		REC	04-Oct-80	
COSMOS-1212	1980-78-A	USSR		CIV	ERSAT	26-Sep-80	PLE	F-2	89.1	216.0	275.0	82.3	6623.7	0.004454	-1.16974E+00		REC	09-Oct-80	
PROGRESS-11	1980-79-A	USSR		CIV	MAN'D	28-Sep-80	BAI	A-2	88.8	193.0	270.0	51.6	6609.7	0.005825	-5.46328E+00		DEC	11-Dec-80	EXPENDABLE SUPPLY CRAFT
COSMOS-1213	1980-80-A	USSR		MIL	RECON	03-Oct-80	PLE	A-2	89.6	207.0	343.0	72.8	6653.2	0.010221	-2.54221E+00		REC	17-Oct-80	
RADUGA-6	1980-81-A	USSR		MIL	COMMU	06-Oct-80	BAI	D-1-e	1444.0	36000.0	36000.0	0.4	42378.2	.000000	-1.31779E-02	361.0			TV & MULTICHANNEL RADIOCOMM.
COSMOS-1214	1980-82-A	USSR		MIL	RECON	10-Oct-80	PLE	A-2	89.7	181.0	368.0	67.2	6652.7	0.014055	-3.33298E+00		REC	23-Oct-80	
COSMOS-1215	1980-83-A	USSR		MIL	ELINT	14-Oct-80	PLE	C-1	95.1	499.0	553.0	74.0	6904.2	0.003911	-2.08123E+00		DEC	12-May-83	

IDENTIFICATION				MISSION		LAUNCH DATA			ORBITAL DATA								MISSION STATUS		
SATELLITE NAME	INT'L DESIG.	COUNTRY	PROJ. DIR.	C/M DESIG.	PURPOSE	DATE	SITE	VEHICLE	PERIOD (MIN)	PERIGEE HEIGHT (KM)	APOGEE HEIGHT (KM)	INCL. (DEG)	SEMI-MAJOR AXIS (KM)	ECCEN. (ND)	RIGHT ASCENSION RATE (DEG/DAY)	GEOSYNC ORBITAL POSITION (DEG. EAST)	STATUS	DATE	REMARKS
COSMOS-1216	1980-84-A	USSR		MIL	RECON	16-Oct-80	PLE	A-2	90.3	209.0	404.0	72.9	6684.7	0.014586	-2.48697E+00		REC	30-Oct-80	
COSMOS-1217	1980-85-A	USSR		MIL	EARLY	24-Oct-80	PLE	A-2-e	726.0	642.0	40165.0	62.8	26781.7	0.737875	-1.44670E-01				
COSMOS-1218	1980-86-A	USSR		MIL	RECON	30-Oct-80	BAI	A-2	89.7	178.0	374.0	64.9	6654.2	0.014728	-3.64576E+00		REC	12-Dec-80	
FLTSATCOM-4	1980-87-A	USA	USN	MIL	COMMU	31-Oct-80	ETR	ATLAS CENTAUR	1428.4	35033.0	36237.0	2.5	42013.2	0.014329	-1.35759E-02	172.0			UHF COMMUNICATIONS
COSMOS-1219	1980-88-A	USSR		MIL	RECON	31-Oct-80	PLE	A-2	89.7	205.0	353.0	72.9	6657.2	0.011116	-2.52266E+00		REC	13-Nov-80	
COSMOS-1220	1980-89-A	USSR		MIL	ORSAT	04-Nov-80	BAI	F-1-m	93.3	432.0	454.0	65.0	6821.2	0.001613	-3.32891E+00				EORSAT;ELINT OCEAN RECONNAISSANCE
COSMOS-1221	1980-90-A	USSR		MIL	RECON	12-Nov-80	PLE	A-2	90.5	207.0	424.0	72.9	6693.7	0.016209	-2.47553E+00		REC	26-Nov-80	
SBS-1	1980-91-A	USA	SBS	CIV	COMMU	15-Nov-80	ETR	DELTA	1436.1	35785.0	35789.0	0.0	42165.2	0.000047	-1.34127E-02	254.0			FIXED SATELLITE SERVICE
48TH MOLNIYA-1	1980-92-A	USSR		MIL	COMMU	16-Nov-80	PLE	A-2-e	736.0	640.0	40651.0	62.3	27023.7	0.740296	-1.44828E-01				
COSMOS-1222	1980-93-A	USSR		MIL	ELINT	21-Nov-80	PLE	A-1	97.4	624.0	659.0	81.2	7019.7	0.002493	-1.08995E+00				
SOYUZ-T3	1980-94-A	USSR		CIV	MAN'D	27-Nov-80	BAI	A-2	89.6	253.0	271.5	51.6	6640.4	0.001393	-5.37490E+00		RET	10-Dec-80	
COSMOS-1223	1980-95-A	USSR		MIL	EARLY	27-Nov-80	PLE	A-2-e	726.0	614.0	40165.0	62.8	26767.7	0.738784	-1.45792E-01				
COSMOS-1224	1980-96-A	USSR		MIL	RECON	01-Dec-80	PLE	A-2	90.3	209.0	403.0	72.9	6684.2	0.014512	-2.48761E+00		REC	15-Dec-80	
COSMOS-1225	1980-97-A	USSR		MIL	NAVIG	05-Dec-80	PLE	C-1	105.0	967.0	1041.0	82.9	7382.2	0.005012	-7.38345E-01				
INTELSAT-V F2	1980-98-A	INT'L	INTELSAT	CIV	COMMU	06-Dec-80	ETR	ATLAS CENTAUR	1436.1	35774.0	35800.0	0.1	42165.2	0.000308	-1.34127E-02	335.5			
COSMOS-1226	1980-99-A	USSR		MIL	NAVIG	10-Dec-80	PLE	C-1	105.0	982.0	1025.0	83.0	7381.7	0.002913	-7.28146E-01				
SDS-6	1980-100-A	USA	USAF	MIL	COMMU	13-Dec-80	WTR	TITAN IIIB	698.1	250.0	39127.0	63.8	26066.7	0.745723	-1.61781E-01				SATELLITE DATA SYSTEM
COSMOS-1227	1980-101-A	USSR		MIL	RECON	16-Dec-80	PLE	A-2	89.5	209.0	325.0	72.9	6645.2	0.008728	-2.53840E+00		REC	28-Dec-80	
COSMOS-1228	1980-102-A	USSR		MIL	COMMU	24-Dec-80	PLE	C-1	114.6	1415.0	1491.0	74.0	7831.2	0.004852	-1.33913E+00				TACTICAL COMMUNICATIONS
COSMOS-1229	1980-102-B	USSR		MIL	COMMU	24-Dec-80	PLE	C-1	114.6	1415.0	1491.0	74.0	7831.2	0.004852	-1.33913E+00				TACTICAL COMMUNICATIONS
COSMOS-1230	1980-102-C	USSR		MIL	COMMU	24-Dec-80	PLE	C-1	114.6	1415.0	1491.0	74.0	7831.2	0.004852	-1.33913E+00				TACTICAL COMMUNICATIONS
COSMOS-1231	1980-102-D	USSR		MIL	COMMU	24-Dec-80	PLE	C-1	114.6	1415.0	1491.0	74.0	7831.2	0.004852	-1.33913E+00				TACTICAL COMMUNICATIONS
COSMOS-1232	1980-102-E	USSR		MIL	COMMU	24-Dec-80	PLE	C-1	114.6	1415.0	1491.0	74.0	7831.2	0.004852	-1.33913E+00				TACTICAL COMMUNICATIONS
COSMOS-1233	1980-102-F	USSR		MIL	COMMU	24-Dec-80	PLE	C-1	114.6	1415.0	1491.0	74.0	7831.2	0.004852	-1.33913E+00				TACTICAL COMMUNICATIONS
COSMOS-1234	1980-102-G	USSR		MIL	COMMU	24-Dec-80	PLE	C-1	114.6	1415.0	1491.0	74.0	7831.2	0.004852	-1.33913E+00				TACTICAL COMMUNICATIONS
COSMOS-1235	1980-102-H	USSR		MIL	COMMU	24-Dec-80	PLE	C-1	114.6	1415.0	1491.0	74.0	7831.2	0.004852	-1.33913E+00				TACTICAL COMMUNICATIONS
PROGNOZ-8	1980-103-A	USSR		CIV	SCIEN	25-Dec-80	BAI	A-2-e	5723.0	550.0	199000.0	65.0	106153.2	0.934734	-1.40419E-02				MAGNETOSPHERE STUDY
EKRAN-6	1980-104-A	USSR		CIV	COMMU	26-Dec-80	BAI	D-1-e	1424.0	35554.0	35554.0	0.4	41932.2	.000000	-1.36750E-02	361.0			TV RELAY
COSMOS-1236	1980-105-A	USSR		MIL	RECON	26-Dec-80	PLE	A-2	89.8	180.0	388.0	67.1	6662.2	0.015611	-3.33045E+00		REC	21-Jan-81	
COSMOS-1237	1981-1-A	USSR		MIL	RECON	06-Jan-81	PLE	A-2	90.4	207.0	410.0	72.9	6686.7	0.015179	-2.48445E+00		REC	20-Jan-81	
14TH MOLNIYA-3	1981-2-A	USSR		MIL	COMMU	09-Jan-81	PLE	A-2-e	736.0	485.0	40784.0	62.5	27012.7	0.745928	-1.49558E-01				REPLACED 10TH MOLNIYA-3
COSMOS-1238	1981-3-A	USSR		MIL	ELINT	16-Jan-81	PLE	C-1	109.1	411.0	1976.0	83.0	7571.7	0.103346	-6.80625E-01				PAIRED WITH COSMOS-1263
COSMOS-1239	1981-4-A	USSR		MIL	RECON	16-Jan-81	PLE	A-2	89.0	222.0	265.0	82.3	6621.7	0.003247	-1.17096E+00		REC	28-Jan-81	
COSMOS-1240	1981-5-A	USSR		MIL	RECON	20-Jan-81	BAI	A-2	89.8	178.0	377.0	64.9	6655.7	0.014950	-3.64293E+00		REC	17-Feb-81	HI RESOLUTION PHOTOGRAPHIC
COSMOS-1241	1981-6-A	USSR		MIL	ASATT	21-Jan-81	PLE	C-1	105.0	1000.0	1000.0	65.8	7378.2	0.000000	-2.45324E+00				TARGET VEHICLE FOR C-1243&-1258
PROGRESS-12	1981-7-A	USSR		CIV	MAN'D	24-Jan-81	BAI	A-2	89.1	188.0	299.0	51.6	6621.7	0.008382	-5.42910E+00		DEC	20-Mar-81	EXPENDABLE SUPPLY CRAFT
COSMOS-1242	1981-8-A	USSR		MIL	ELINT	27-Jan-81	PLE	A-1	97.6	635.0	684.0	81.2	7037.7	0.003481	-1.08024E+00				
49TH MOLNIYA-1	1981-9-A	USSR		MIL	COMMU	30-Jan-81	PLE	A-2-e	736.0	464.0	40801.0	62.8	27010.7	0.746687	-1.48849E-01				REPLACED 41ST MOLNIYA-1
COSMOS-1243	1981-10-A	USSR		MIL	ASATT	02-Feb-81	BAI	F-1-m	98.0	316.0	1026.0	66.0	7049.2	0.050361	-2.87008E+00		DEC	02-Feb-81	INTERCEPTOR FOR COSMOS-1241
INTERCOSMOS-21	1981-11-A	USSR		CIV	SCIEN	06-Feb-81	PLE	C-1	94.5	475.0	520.0	74.0	6875.7	0.003272	-2.11156E+00		DEC	07-Jul-82	OCEAN & EARTH DATA COLLECTION
ETS-4(KIKU-3)	1981-12-A	JAPAN	NASDA	CIV	EXPTL	11-Feb-81	TSC	N-2	636.0	223.0	35824.0	28.6	24401.7	0.729479	-3.64872E-01				
COSMOS-1244	1981-13-A	USSR		MIL	NAVIG	12-Feb-81	PLE	C-1	105.0	975.0	1024.0	82.9	7377.7	0.003321	-7.39901E-01				REPLACED COSMOS-1104
COSMOS-1245	1981-14-A	USSR		MIL	RECON	13-Feb-81	PLE	A-2	90.3	208.0	403.0	72.9	6683.7	0.014588	-2.48827E+00		REC	27-Feb-81	MED. RESOLUTION PHOTOGRAPHIC
COSMOS-1246	1981-15-A	USSR		MIL	RECON	18-Feb-81	BAI	A-2	89.2	202.0	292.0	64.9	6625.2	0.006792	-3.70066E+00		REC	13-Mar-81	MED. RESOLUTION PHOTOGRAPHIC
COSMOS-1247	1981-16-A	USSR		MIL	EARLY	19-Feb-81	PLE	A-2-e	709.0	613.0	39540.0	62.8	26454.7	0.735731	-1.48953E-01				
ASTRO-1	1981-17-A	JAPAN	ISAS	CIV	SCIEN	21-Feb-81	KSC	Mu-3	96.9	578.0	645.0	31.4	6989.7	0.004793	-6.17318E+00				SOLAR ASTRONOMICAL OBSERVATIONS
COMSTAR-4	1981-18-A	USA	COMSAT	CIV	COMMU	21-Feb-81	ETR	ATLAS CENTAUR	1436.2	35782.0	35794.0	0.1	42166.2	0.000142	-1.34116E-02	273.0			FIXED SATELLITE SERVICE
BIG BIRD 16	1981-19-A	USA	USAF	MIL	RECON	28-Feb-81	WTR	TITAN IIID	88.7	129.0	309.0	96.4	6597.2	0.013642	9.87238E-01		DEC	20-Jun-81	BROAD COVERAGE PHOTO. RECON.
COSMOS-1248	1981-20-A	USSR		MIL	RECON	05-Mar-81	PLE	A-2	89.7	180.0	371.0	67.1	6653.7	0.014353	-3.34511E+00		REC	04-Apr-81	HI RESOLUTION PHOTOGRAPHIC
COSMOS-1249	1981-21-A	USSR		MIL	ORSAT	05-Mar-81	BAI	F-1-m	89.6	258.0	282.0	65.0	6648.2	0.001805	-3.64210E+00				A-PWRD RDR: PAIRED WITH COSMOS-1266

IDENTIFICATION				MISSION		LAUNCH DATA			ORBITAL DATA								MISSION STATUS		
SATELLITE NAME	INT'L DESIG.	COUNTRY	PROJ. DIR.	C/M DESIG.	PURPOSE	DATE	SITE	VEHICLE	PERIOD (MIN)	PERIGEE HEIGHT (KM)	APOGEE HEIGHT (KM)	INCL. (DEG)	SEMI-MAJOR AXIS (KM)	ECCEN. (ND)	RIGHT ASCENSION RATE (DEG/DAY)	GEOSYNC ORBITAL POSITION (DEG. EAST)	STATUS	DATE	REMARKS
COSMOS-1250	1981-22-A	USSR		MIL	COMMU	06-Mar-81	PLE	C-1	115.0	1450.0	1500.0	74.0	7853.2	0.003183	-1.32601E+00				TACTICAL COMMUNICATIONS
COSMOS-1251	1981-22-B	USSR		MIL	COMMU	06-Mar-81	PLE	C-1	115.0	1450.0	1500.0	74.0	7853.2	0.003183	-1.32601E+00				TACTICAL COMMUNICATIONS
COSMOS-1252	1981-22-C	USSR		MIL	COMMU	06-Mar-81	PLE	C-1	115.0	1450.0	1500.0	74.0	7853.2	0.003183	-1.32601E+00				TACTICAL COMMUNICATIONS
COSMOS-1253	1981-22-D	USSR		MIL	COMMU	06-Mar-81	PLE	C-1	115.0	1450.0	1500.0	74.0	7853.2	0.003183	-1.32601E+00				TACTICAL COMMUNICATIONS
COSMOS-1254	1981-22-E	USSR		MIL	COMMU	06-Mar-81	PLE	C-1	115.0	1450.0	1500.0	74.0	7853.2	0.003183	-1.32601E+00				TACTICAL COMMUNICATIONS
COSMOS-1255	1981-22-F	USSR		MIL	COMMU	06-Mar-81	PLE	C-1	115.0	1450.0	1500.0	74.0	7853.2	0.003183	-1.32601E+00				TACTICAL COMMUNICATIONS
COSMOS-1256	1981-22-G	USSR		MIL	COMMU	06-Mar-81	PLE	C-1	115.0	1450.0	1500.0	74.0	7853.2	0.003183	-1.32601E+00				TACTICAL COMMUNICATIONS
COSMOS-1257	1981-22-H	USSR		MIL	COMMU	06-Mar-81	PLE	C-1	115.0	1450.0	1500.0	74.0	7853.2	0.003183	-1.32601E+00				TACTICAL COMMUNICATIONS
SOYUZ-T4	1981-23-A	USSR		CIV	MAN'D	12-Mar-81	BAI	A-2	90.1	250.0	331.0	51.6	6668.7	0.006073	-5.29600E+00		RET	26-May-81	
COSMOS-1258	1981-24-A	USSR		MIL	ASATT	14-Mar-81	BAI	F-1-m	98.0	322.0	1032.0	65.8	7055.2	0.050318	-2.88394E+00		DEC	15-Mar-81	INTERCEPTOR FOR COSMOS-1241
DSP-11	1981-25-A	USA	USAF	MIL	EARLY	16-Mar-81	ETR	TITAN IIIC	1436.3	35750.0	35828.0	1.9	42167.2	0.000925	-1.34031E-02	226.0			DEFENSE SUPPORT PROGRAM
COSMOS-1259	1981-26-A	USSR		MIL	RECON	17-Mar-81	BAI	A-2	90.4	215.0	405.0	70.4	6688.2	0.014204	-2.83196E+00		REC	31-Mar-81	
RADUGA-7	1981-27-A	USSR		MIL	COMMU	18-Mar-81	BAI	F-1-m	1477.0	36590.0	36590.0	0.4	42968.2	.000000	-1.25554E-02	361.0			TV & MULTICHANNEL RADIOCOMM.
COSMOS-1260	1981-28-A	USSR		MIL	ORSAI	20-Mar-81	BAI	F-1-m	93.3	435.2	458.7	65.0	6825.1	0.001722	-3.32218E+00		DEC	22-May-81	EORSAT;PAIRED WITH C-12206-1286
SOYUZ-39	1981-29-A	USSR		CIV	MAN'D	22-Mar-81	BAI	A-2	90.3	271.0	321.0	51.6	6674.2	0.003746	-5.28050E+00		RET	30-Mar-81	
15TH MOLNIYA-3	1981-30-A	USSR		MIL	COMMU	24-Mar-81	PLE	A-2-e	736.0	641.0	40655.0	62.8	27026.2	0.740283	-1.42357E-01				REPLACED 11TH MOLNIYA-3
COSMOS-1261	1981-31-A	USSR		MIL	EARLY	31-Mar-81	PLE	A-2-e	710.0	615.0	40170.0	62.8	26770.7	0.738775	-1.45728E-01				
COSMOS-1262	1981-32-A	USSR		MIL	RECON	07-Apr-81	PLE	A-2	90.4	207.0	418.0	72.9	6690.7	0.015768	-2.47935E+00		REC	21-Apr-81	
COSMOS-1263	1981-33-A	USSR		MIL	ELINT	09-Apr-81	PLE	C-1	109.1	403.0	1988.0	83.0	7573.7	0.104639	-6.80366E-01				PAIRED WITH COSMOS-1238
STS-1	1981-34-A	USA	NASA	CIV	MAN'D	12-Apr-81	ETR	STS-1	89.4	238.0	250.0	40.4	6622.2	0.000906	-6.65349E+00		RET	14-Apr-81	1ST TEST FLIGHT OF COLUMBIA
COSMOS-1264	1981-35-A	USSR		MIL	RECON	15-Apr-81	BAI	A-2	89.4	210.0	411.0	70.4	6688.7	0.015025	-2.83136E+00		REC	29-Apr-81	
COSMOS-1265	1981-36-A	USSR		MIL	RECON	16-Apr-81	PLE	A-2	89.4	210.0	317.0	72.9	6641.7	0.008055	-2.54303E+00		REC	28-Apr-81	
COSMOS-1266	1981-37-A	USSR		MIL	ORSAT	21-Apr-81	BAI	F-1-m	89.7	259.0	278.0	65.0	6646.7	0.001429	-3.64497E+00		IOF	29-Apr-81	A-PWRD RDR: PAIRED WITH COSMOS-1249
SDS-7	1981-38-A	USA	USAF	MIL	COMMU	24-Apr-81	WTR	TITAN IIIB	93.0	190.0	709.0	62.7	6827.7	0.038007	-3.61111E+00				FAILED PERIGEE BOOST?
COSMOS-1267	1981-39-A	USSR		CIV	MAN'D	25-Apr-81	BAI	D-1	89.0	200.0	278.0	51.6	6617.2	0.005894	-5.44165E+00		DEC	29-Jul-82	SPACE STATION MODULE
COSMOS-1268	1981-40-A	USSR		MIL	RECON	28-Apr-81	BAI	A-2	90.3	217.0	391.0	70.4	6682.2	0.013020	-2.84069E+00		REC	12-May-81	MED. RESOLUTION PHOTOGRAPHIC
COSMOS-1269	1981-41-A	USSR		MIL	COMMU	07-May-81	PLE	C-1	100.9	797.0	833.0	74.0	7193.2	0.002502	-1.80294E+00				STORE & DUMP
SOYUZ-40	1981-42-A	USSR		CIV	MAN'D	14-May-81	BAI	A-2	90.1	260.0	307.0	51.6	6661.7	0.003528	-5.31524E+00		RET	22-May-81	
7TH METEOR-2	1981-43-A	USSR		MIL	METEO	15-May-81	PLE	A-1	102.5	868.0	904.0	81.3	7264.2	0.002478	-9.55958E-01				
NOVA-1	1981-44-A	USA	USN	MIL	NAVIG	15-May-81	WTR	SCOUT	109.0	1170.0	1187.0	90.7	7556.7	0.001125	6.72461E-02				ADVANCED VERSION OF TRANSIT
COSMOS-1270	1981-45-A	USSR		MIL	RECON	18-May-81	BAI	A-2	89.7	180.0	370.0	64.9	6653.2	0.014279	-3.64758E+00		REC	17-Jun-81	
COSMOS-1271	1981-46-A	USSR		MIL	ELINT	19-May-81	PLE	A-1	97.5	628.0	670.0	81.2	7027.2	0.002988	-1.08589E+00				REPLACED COSMOS-1077
COSMOS-1272	1981-47-A	USSR		MIL	RECON	21-May-81	BAI	A-2	90.4	217.0	403.0	70.4	6688.2	0.013905	-2.83192E+00		REC	04-Jun-81	
COSMOS-1273	1981-48-A	USSR		CIV	ERSAT	22-May-81	PLE	F-2	89.2	221.0	277.0	82.3	6627.2	0.004225	-1.16758E+00		REC	04-Jun-81	
GEOS-5	1981-49-A	USA	NOAA	CIV	METEO	22-May-81	ETR	DELTA	1436.2	35783.0	35792.0	0.1	42165.7	0.000107	-1.34121E-02	275.0			
INTELSAT-V F1	1981-50-A	INT'L	INTELSAT	CIV	COMMU	23-May-81	ETR	ATLAS CENTAUR	1436.2	35773.0	35803.0	0.1	42166.2	0.000356	-1.34116E-02	24.5			FIXED SATELLITE SERVICE
ROHINI-2	1981-51-A	INDIA		CIV	ERSAT	31-May-81	SSC	SLV-3	90.6	187.0	418.0	46.3	6680.7	0.017289	-5.85669E+00		DEC	08-Jun-81	
COSMOS-1274	1981-52-A	USSR		MIL	RECON	03-Jun-81	PLE	A-2	89.8	183.0	380.0	67.2	6659.7	0.014791	-3.32088E+00		REC	03-Jul-81	HI RESOLUTION PHOTOGRAPHIC
COSMOS-1275	1981-53-A	USSR		MIL	NAVIG	04-Jun-81	PLE	C-1	104.9	983.0	1026.0	83.0	7382.7	0.002912	-7.27801E-01				REPLACED COSMOS-1141
16TH MOLNIYA-3	1981-54-A	USSR		MIL	COMMU	09-Jun-81	PLE	A-2-e	736.0	471.0	40837.0	62.8	27032.2	0.746629	-1.48377E-01				REPLACED 14TH MOLNIYA-3
COSMOS-1276	1981-55-A	USSR		CIV	ERSAT	16-Jun-81	PLE	A-2	89.1	224.0	265.0	82.3	6622.7	0.003095	-1.17034E+00		REC	29-Jun-81	
COSMOS-1277	1981-56-A	USSR		MIL	RECON	17-Jun-81	BAI	A-2	90.3	216.0	393.0	70.4	6682.7	0.013243	-2.83998E+00		REC	01-Jul-81	MED. RESOLUTION PHOTOGRAPHIC
METEOSAT-2	1981-57-A	EUROPE	ESA	CIV	METEO	19-Jun-81	CSG	ARIANE	1441.1	35669.0	36100.0	1.2	42262.7	0.005099	-1.33025E-02	0.0			
APPLE	1981-57-B	INDIA	IRSO	CIV	COMMU	19-Jun-81	CSG	ARIANE	1436.3	35783.0	35797.0	0.7	42168.2	0.000166	-1.34084E-02	102.0			EXPERIMENTAL COMMUNICATIONS
CAT-3	1981-57-C	EUROPE	ESA	CIV	EXPTL	19-Jun-81	CSG	ARIANE	635.6	224.0	35992.0	10.4	24486.2	0.730372	-4.06096E-01				LAUNCH VEHICLE TEST PACKAGE
COSMOS-1278	1981-58-A	USSR		MIL	EARLY	19-Jun-81	PLE	A-2-e	726.0	614.0	40165.0	62.8	26767.7	0.738784	-1.45792E-01				
NOAA-7	1981-59-A	USA	NOAA	CIV	METEO	23-Jun-81	WTR	ATLAS F	101.9	843.5	861.5	98.9	7230.7	0.001245	9.93697E-01				
50TH MOLNIYA-1	1981-60-A	USSR		MIL	COMMU	24-Jun-81	PLE	A-2-e	736.0	645.0	40640.0	62.8	27020.7	0.740082	-1.42271E-01				REPLACED 42ND MOLNIYA-1
EKRAN-7	1981-61-A	USSR		CIV	COMMU	26-Jun-81	BAI	D-1-e	1426.0	35636.0	35636.0	0.4	42014.2	.000000	-1.35822E-02	361.0			TV RELAY
COSMOS-1279	1981-62-A	USSR		MIL	RECON	01-Jul-81	BAI	A-2	90.3	218.0	385.0	70.4	6679.7	0.012501	-2.84434E+00		REC	15-Jul-81	

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IDENTIFICATION				MISSION		LAUNCH DATA			ORBITAL DATA								MISSION STATUS		
SATELLITE NAME	INT'L DESIG.	COUNTRY	PROJ. DIR.	C/M DESIG.	PURPOSE	DATE	SITE	VEHICLE	PERIOD (MIN)	PERIGEE HEIGHT (KM)	APOGEE HEIGHT (KM)	INCL. (DEG)	SEMI-MAJOR AXIS (KM)	ECCEN. (ND)	RIGHT ASCENSION RATE (DEG/DAY)	GEOSYNC ORBITAL POSITION (DEG. EAST)	STATUS	DATE	REMARKS
COSMOS-1280	1981-63-A	USSR		CIV	ERSAT	02-Jul-81	PLE	A-2	89.5	222.0	312.0	82.3	6645.2	0.006772	-1.15661E+00		REC	15-Jul-81	
COSMOS-1281	1981-64-A	USSR		MIL	RECON	07-Jul-81	PLE	A-2	90.4	208.0	419.0	72.8	6691.7	0.015766	5.88352E-02		REC	21-Jul-81	
METEOR-PRIRODA	1981-65-A	USSR		CIV	METEO	10-Jul-81	PLE	A-1	97.9	611.0	688.0	97.6	7027.7	0.005478	9.38558E-01				ALSO LABELLED 31ST METEOR
ISKRA-1	1981-65-C	USSR	MAI	CIV	COMMU	10-Jul-81	PLE	A-1	97.6	611.0	688.0	97.7	7027.7	0.005478	9.50833E-01		DEC	07-Oct-81	
COSMOS-1282	1981-66-A	USSR		MIL	RECON	15-Jul-81	BAI	A-2	89.6	179.0	357.0	64.9	6646.2	-0.013391	-3.66087E+00		REC	14-Aug-81	
COSMOS-1283	1981-67-A	USSR		MIL	RECON	17-Jul-81	PLE	F-2	88.9	184.0	278.0	82.3	6609.2	0.007111	-1.17882E+00		REC	31-Jul-81	
COSMOS-1284	1981-68-A	USSR		CIV	ERSAT	29-Jul-81	PLE	F-2	88.8	195.0	270.0	82.3	6610.7	0.005673	-1.17784E+00		REC	12-Aug-81	
RADUGA-8	1981-69-A	USSR		MIL	COMMU	31-Jul-81	BAI	D-1-e	1477.0	36690.0	36690.0	0.4	43068.2	.000000	-1.24536E-02	361.0			TV & MULTICHANNEL RADIOCOMM.
DE-1	1981-70-A	USA	NASA	CIV	SCIEN	03-Aug-81	WTR	DELTA	410.8	567.6	23289.6	89.9	18306.8	0.620591	-1.14823E-03				DYNAMICS EXPLORER
DE-2	1981-70-B	USA	NASA	CIV	SCIEN	03-Aug-81	WTR	DELTA	98.0	309.0	1012.5	90.0	7038.9	0.049972	-2.41557E-18		DEC	19-Feb-83	PLASMA PHYSICS INVESTIGATION
COSMOS-1285	1981-71-A	USSR		MIL	EARLY	04-Aug-81	PLE	A-2-e	726.0	630.0	40165.0	62.8	26775.7	0.738264	-1.45149E-01				REPLACED COSMOS-1261
COSMOS-1286	1981-72-A	USSR		MIL	ORSAT	04-Aug-81	BAI	F-1-m	93.2	433.0	453.0	65.0	6821.2	0.001466	-3.32891E+00		DEC	16-Oct-82	EORSAT;PAIRED WITH C-1260&-1306
FLTSATCOM-5	1981-73-A	USA	USN	MIL	COMMU	06-Aug-81	ETR	ATLAS CENTAUR	1436.3	34777.0	36803.0	2.6	42168.2	0.024023	-1.33438E-02	287.0			UHF COMMUNICATIONS
COSMOS-1287	1981-74-A	USSR		MIL	COMMU	06-Aug-81	PLE	C-1	115.2	1446.0	1508.0	74.0	7855.2	0.003946	-1.56483E+00				TACTICAL COMMUNICATIONS
COSMOS-1288	1981-74-B	USSR		MIL	COMMU	06-Aug-81	PLE	C-1	115.2	1446.0	1508.0	74.0	7855.2	0.003946	-1.56483E+00				TACTICAL COMMUNICATIONS
COSMOS-1289	1981-74-C	USSR		MIL	COMMU	06-Aug-81	PLE	C-1	115.2	1446.0	1508.0	74.0	7855.2	0.003946	-1.56483E+00				TACTICAL COMMUNICATIONS
COSMOS-1290	1981-74-D	USSR		MIL	COMMU	06-Aug-81	PLE	C-1	115.2	1446.0	1508.0	74.0	7855.2	0.003946	-1.56483E+00				TACTICAL COMMUNICATIONS
COSMOS-1291	1981-74-E	USSR		MIL	COMMU	06-Aug-81	PLE	C-1	115.2	1446.0	1508.0	74.0	7855.2	0.003946	-1.56483E+00				TACTICAL COMMUNICATIONS
COSMOS-1292	1981-74-F	USSR		MIL	COMMU	06-Aug-81	PLE	C-1	115.2	1446.0	1508.0	74.0	7855.2	0.003946	-1.56483E+00				TACTICAL COMMUNICATIONS
COSMOS-1293	1981-74-G	USSR		MIL	COMMU	06-Aug-81	PLE	C-1	115.2	1446.0	1508.0	74.0	7855.2	0.003946	-1.56483E+00				TACTICAL COMMUNICATIONS
COSMOS-1294	1981-74-H	USSR		MIL	COMMU	06-Aug-81	PLE	C-1	115.2	1446.0	1508.0	74.0	7855.2	0.003946	-1.56483E+00				TACTICAL COMMUNICATIONS
BULGARIA-1300	1981-75-A	USSR		CIV	SCIEN	07-Aug-81	PLE	A-1	101.9	825.0	906.0	81.2	7243.7	0.005591	-9.76520E-01				BUL./USSR MAGNETO&IONOSPHERE STUDY
GMS-2	1981-76-A	JAPAN	JMA	CIV	METEO	11-Aug-81	TSC	N-2	1438.1	35606.0	36047.0	1.0	42204.7	0.005225	-1.33675E-02	140.0			(HIMAWARI-2)
COSMOS-1295	1981-77-A	USSR		MIL	NAVIG	12-Aug-81	PLE	C-1	104.8	966.0	1026.0	82.9	7374.2	0.004068	-7.41139E-01				REPLACED COSMOS-1181
COSMOS-1296	1981-78-A	USSR		MIL	RECON	13-Aug-81	PLE	A-2	89.8	181.0	377.0	67.2	6657.2	0.014721	-3.32523E+00		REC	13-Sep-81	
COSMOS-1297	1981-79-A	USSR		MIL	RECON	18-Aug-81	PLE	A-2	90.2	209.0	389.0	72.9	6677.2	0.013479	-2.49660E+00		REC	28-Aug-81	MED. RESOLUTION PHOTOGRAPHIC
COSMOS-1298	1981-80-A	USSR		MIL	RECON	21-Aug-81	BAI	A-2	89.5	179.0	351.0	64.9	6643.2	0.012946	-3.66657E+00		REC	02-Oct-81	
COSMOS-1299	1981-81-A	USSR		MIL	ORSAT	24-Aug-81	BAI	F-1-m	89.7	250.0	281.0	65.0	6643.7	0.002333	-3.65076E+00		IOF	05-Sep-81	A-PWRD RDR;PAIRED WITH C-1260&-1286
COSMOS-1300	1981-82-A	USSR		MIL	ORSAT	24-Aug-81	PLE	F-2	97.7	648.0	675.0	82.5	7039.7	0.001918	-9.20716E-01				EORSAT? PHASED WITH C-1378&-1328
COSMOS-1301	1981-83-A	USSR		CIV	ERSAT	27-Aug-81	PLE	F-2	89.4	224.0	300.0	82.3	6640.2	0.005723	-1.15963E+00		REC	10-Sep-81	
COSMOS-1302	1981-84-A	USSR		MIL	COMMU	28-Aug-81	PLE	C-1	100.8	783.0	824.0	74.0	7181.7	0.002854	-1.81307E+00				STORE & DUMP : REPLACED C-1269
KH-11-4	1981-85-A	USA	USAF	MIL	RECON	03-Sep-81	WTR	TITAN IIID	92.5	273.0	517.0	97.0	6773.2	0.018012	9.84606E-01				STATEGIC RECONNAISSANCE
COSMOS-1303	1981-86-A	USSR		MIL	RECON	04-Sep-81	BAI	A-2	90.4	216.0	398.0	70.4	6685.2	0.013612	-2.83632E+00		REC	18-Sep-81	
COSMOS-1304	1981-87-A	USSR		MIL	NAVIG	04-Sep-81	PLE	C-1	104.0	917.0	984.0	83.0	7328.7	0.004571	-7.46762E-01				REPLACED COSMOS-926
COSMOS-1305	1981-88-A	USSR		MIL	COMMU	11-Sep-81	PLE	A-2-e	264.0	648.0	13870.0	63.0	13637.2	0.484779	-5.40825E-01				FAILED MOLNIYA SATELLITE?
COSMOS-1306	1981-89-A	USSR		MIL	ORSAT	14-Sep-81	BAI	F-1-m	93.2	406.0	459.0	65.0	6810.7	0.003891	-3.34700E+00		DEC	16-Jul-82	EORSAT;PAIRED WITH COSMOS-1286
COSMOS-1307	1981-90-A	USSR		MIL	RECON	15-Sep-81	PLE	A-2	90.4	209.0	419.0	72.9	6692.2	0.015690	-2.47739E+00		REC	28-Sep-81	MED. RESOLUTION PHOTOGRAPHIC
COSMOS-1308	1981-91-A	USSR		MIL	NAVIG	18-Sep-81	PLE	C-1	104.9	978.0	1017.0	82.9	7375.7	0.002644	-7.40598E-01				REPLACED COSMOS-1275
COSMOS-1309	1981-92-A	USSR		MIL	RECON	18-Sep-81	PLE	F-2	89.2	225.0	282.0	82.3	6631.7	0.004298	-1.16481E+00		REC	01-Oct-81	MED. RESOLUTION PHOTOGRAPHIC
CHINA-9	1981-93-A	CHINA		CIV	SCIEN	19-Sep-81	JQN	CSL-2	103.3	231.0	920.0	59.4	6953.7	0.049542	-3.76701E+00		DEC	26-Sep-81	SPACE PHYSICS EXPERIMENTS
CHINA-9	1981-93-B	CHINA		CIV	SCIEN	19-Sep-81	JQN	CSL-2	103.3	231.0	920.0	59.4	6953.7	0.049542	-3.76701E+00		DEC	17-Aug-82	SPACE PHYSICS EXPERIMENTS
CHINA-9	1981-93-D	CHINA		CIV	SCIEN	19-Sep-81	JQN	CSL-2	103.3	231.0	920.0	59.4	6953.7	0.049542	-3.76701E+00		DEC	06-Oct-82	SPACE PHYSICS EXPERIMENTS
OREOL-3	1981-94-A	FRANCE		CIV	SCIEN	21-Sep-81	PLE	A-2	108.2	380.0	1920.0	82.6	7528.2	0.102283	-7.33636E-01				FR./USSR MAGNETO&IONOSPHERE STUDY
COSMOS-1310	1981-95-A	USSR		MIL	ASATT	23-Sep-81	PLE	C-1	94.6	478.0	524.0	65.9	6879.2	0.003343	-3.12251E+00				INTERCEPTION TEST RADAR CALIBRATION
SBS-2	1981-96-A	USA	SBS	CIV	COMMU	24-Sep-81	ETR	THOR DELTA	1436.1	35783.0	35791.0	0.1	42165.2	0.000095	-1.34127E-02	263.0			FIXED SATELLITE SERVICE
COSMOS-1311	1981-97-A	USSR		MIL	RADAR	28-Sep-81	PLE	C-1	94.5	470.0	521.0	83.0	6873.7	0.003710	-9.34554E-01		DEC	28-Aug-83	
COSMOS-1312	1981-98-A	USSR		MIL	SCIEN	30-Sep-81	PLE	F-2	116.0	1490.0	1531.0	82.6	7888.7	0.002599	-6.09890E-01				GEODETIC: PHASED WITH COSMOS-1410
COSMOS-1313	1981-99-A	USSR		MIL	RECON	01-Oct-81	BAI	A-2	89.5	214.0	314.0	70.4	6642.2	0.007528	-2.90036E+00		REC	15-Oct-81	
SME	1981-100-A	USA	NASA	CIV	SCIEN	06-Oct-81	WTR	THOR DELTA	95.3	533.0	535.0	97.5	6912.2	0.000145	9.81534E-01				SOLAR MESOSPHERE EXPLORER
UOSAT	1981-100-B	UK	UOS	CIV	COMMU	06-Oct-81	WTR	THOR DELTA	95.4	536.0	561.0	97.5	6926.7	0.001805	9.74368E-01				USA/UK AMATEUR RADIO

SPAR

IDENTIFICATION: SATELLITE NAME	INT'L DESIG.	COUNTRY	PROJ. DIR.	MISSION: C/M DESIG.	PURPOSE	LAUNCH DATA: DATE	SITE	VEHICLE	ORBITAL DATA: PERIOD (MIN)	PERIGEE HEIGHT (KM)	APOGEE HEIGHT (KM)	INCL. (DEG)	SEMI-MAJOR AXIS (KM)	ECCEN. (ND)	RIGHT ASCENSION RATE (DEG/DAY)	GEOSYNC ORBITAL POSITION (DEG. EAST)	MISSION STATUS: STATUS	DATE	REMARKS
COSMOS-1314	1981-101-A	USSR		MIL	RECON	09-Oct-81	PLE	F-2	89.0	220.0	263.0	82.3	6619.7	0.003248	-1.17220E+00		REC	22-Oct-81	MED. RESOLUTION PHOTOGRAPHIC
RADUGA-9	1981-102-A	USSR		MIL	COMMU	09-Oct-81	BAI	D-1-e	1442.0	35900.0	35900.0	0.4	42278.2	.000000	-1.32873E-02	361.0			TV & MULTICHANNEL RADIOCOMM.
COSMOS-1315	1981-103-A	USSR		MIL	ELINT	14-Oct-81	PLE	A-1	97.7	628.0	685.0	81.2	7034.7	0.004051	-1.08186E+00				REPLACED COSMOS-1154
COSMOS-1316	1981-104-A	USSR		MIL	RECON	15-Oct-81	BAI	A-2	90.5	215.0	407.0	70.3	6689.2	0.014352	-2.84438E+00		REC	29-Oct-81	
17TH MOLNIYA-3	1981-105-A	USSR		MIL	COMMU	17-Oct-81	PLE	A-2-e	736.0	649.0	40644.0	63.0	27024.7	0.739973	-1.41129E-01				REPLACED 12TH MOLNIYA-3
VENERA-13	1981-106-A	USSR		CIV	INTER	30-Oct-81	BAI	D-1-e											AUTOMATIC INTERPLANETARY STATION
NO NAME	1981-107-A	USA	USAF	MIL	UNK'N	31-Oct-81	ETR	TITAN IIIC											*CURRENT ELEMENTS NOT MAINTAINED*
COSMOS-1317	1981-108-A	USSR		MIL	EARLY	31-Oct-81	PLE	A-2-e	726.0	636.0	40165.0	62.9	26778.7	0.738069	-1.44417E-01				
COSMOS-1318	1981-109-A	USSR		MIL	RECON	03-Nov-81	PLE	A-2	89.8	183.0	379.0	67.2	6659.2	0.014717	-3.32174E+00		REC	04-Dec-81	
VENERA-14	1981-110-A	USSR		CIV	INTER	04-Nov-81	BAI	D-1-e											AUTOMATIC INTERPLANETARY STATION
STS-2	1981-111-A	USA	NASA	CIV	MAN'D	12-Nov-81	ETR	STS-2	89.0	219.0	229.0	38.0	6602.2	0.000757	-6.95805E+00		RET	14-Nov-81	COLUMBIA:OSTA-1 PAYLOAD & RMS TESTS
COSMOS-1319	1981-112-A	USSR		MIL	RECON	13-Nov-81	BAI	A-2	90.4	216.0	400.0	70.4	6686.2	0.013760	-2.83486E+00		REC	27-Nov-81	
51ST MOLNIYA-1	1981-113-A	USSR		MIL	COMMU	17-Nov-81	PLE	A-2-e	702.0	472.0	39117.0	62.8	26172.7	0.738271	-1.57201E-01				REPLACED 39TH MOLNIYA-1
SATCOM-3R	1981-114-A	USA	RCA	CIV	COMMU	20-Nov-81	ETR	DELTA	1436.1	35779.0	35794.0	0.1	42164.7	0.000178	-1.34132E-02	228.0			FIXED SATELLITE SERVICE
BHASKARA-2	1981-115-A	INDIA	ISRO	CIV	ERSAT	20-Nov-81	AKY	C-1	95.2	514.0	557.0	50.7	6913.7	0.003110	-4.75939E+00				
COSMOS-1320	1981-116-A	USSR		MIL	COMMU	28-Nov-81	PLE	C-1	117.0	1507.0	1632.0	74.0	7947.7	0.007864	-1.27177E+00				TACTICAL COMMUNICATIONS
COSMOS-1321	1981-116-B	USSR		MIL	COMMU	28-Nov-81	PLE	C-1	117.0	1507.0	1632.0	74.0	7947.7	0.007864	-1.27177E+00				TACTICAL COMMUNICATIONS
COSMOS-1322	1981-116-C	USSR		MIL	COMMU	28-Nov-81	PLE	C-1	117.0	1507.0	1632.0	74.0	7947.7	0.007864	-1.27177E+00				TACTICAL COMMUNICATIONS
COSMOS-1323	1981-116-D	USSR		MIL	COMMU	28-Nov-81	PLE	C-1	117.0	1507.0	1632.0	74.0	7947.7	0.007864	-1.27177E+00				TACTICAL COMMUNICATIONS
COSMOS-1324	1981-116-E	USSR		MIL	COMMU	28-Nov-81	PLE	C-1	117.0	1507.0	1632.0	74.0	7947.7	0.007864	-1.27177E+00				TACTICAL COMMUNICATIONS
COSMOS-1325	1981-116-F	USSR		MIL	COMMU	28-Nov-81	PLE	C-1	117.0	1507.0	1632.0	74.0	7947.7	0.007864	-1.27177E+00				TACTICAL COMMUNICATIONS
COSMOS-1326	1981-116-G	USSR		MIL	COMMU	28-Nov-81	PLE	C-1	117.0	1507.0	1632.0	74.0	7947.7	0.007864	-1.27177E+00				TACTICAL COMMUNICATIONS
COSMOS-1327	1981-116-H	USSR		MIL	COMMU	28-Nov-81	PLE	C-1	117.0	1507.0	1632.0	74.0	7947.7	0.007864	-1.27177E+00				TACTICAL COMMUNICATIONS
COSMOS-1328	1981-117-A	USSR		MIL	ORSAT	03-Dec-81	PLE	F-2	97.8	647.0	677.0	82.5	7040.2	0.002131	-9.20489E-01				EORSAT? PHASED WITH C-1300&-1378
COSMOS-1329	1981-118-A	USSR		MIL	RECON	04-Dec-81	BAI	A-2	89.5	237.0	283.0	65.0	6638.2	0.003465	-3.66140E+00		REC	18-Dec-81	
INTELSAT-V F3	1981-119-A	INT'L	INTELSAT	CIV	COMMU	15-Dec-81	ETR	ATLAS-CENTAUR	1439.1	35690.0	36001.0	0.3	42223.7	0.003683	-1.33479E-02	15.0			
RADIO-3	1981-120-A	USSR	DOSAAF	CIV	COMMU	17-Dec-81	PLE	C-1	120.9	1685.0	1794.0	83.0	8117.7	0.006714	-5.22133E-01				AMATEUR RADIO
RADIO-4	1981-120-B	USSR	DOSAAF	CIV	COMMU	17-Dec-81	PLE	C-1	120.9	1685.0	1794.0	83.0	8117.7	0.006714	-5.22133E-01				AMATEUR RADIO
RADIO-5	1981-120-C	USSR	DOSAAF	CIV	COMMU	17-Dec-81	PLE	C-1	120.9	1685.0	1794.0	83.0	8117.7	0.006714	-5.22133E-01				AMATEUR RADIO
RADIO-6	1981-120-D	USSR	DOSAAF	CIV	COMMU	17-Dec-81	PLE	C-1	120.9	1685.0	1794.0	83.0	8117.7	0.006714	-5.22133E-01				AMATEUR RADIO
RADIO-7	1981-120-E	USSR	DOSAAF	CIV	COMMU	17-Dec-81	PLE	C-1	120.9	1685.0	1794.0	83.0	8117.7	0.006714	-5.22133E-01				AMATEUR RADIO
RADIO-8	1981-120-F	USSR	DOSAAF	CIV	COMMU	17-Dec-81	PLE	C-1	120.9	1685.0	1794.0	83.0	8117.7	0.006714	-5.22133E-01				AMATEUR RADIO
COSMOS-1330	1981-121-A	USSR		MIL	RECON	19-Dec-81	BAI	A-2	90.0	177.0	403.0	70.4	6668.2	0.016946	-2.86229E+00		REC	19-Jan-82	
MARECS 1	1981-122-A	EUROPE	ESA	CIV	COMMU	20-Dec-81	CSG	ARIANE	1430.8	35620.0	35743.0	2.3	42059.7	0.001462	-1.35200E-02	361.0			MARINE MOBILE SATELLITE SERVICE
CAT-4	1981-122-B	EUROPE	ESA	CIV	EXPTL	20-Dec-81	CSG	ARIANE	636.1	218.0	35795.0	10.5	24384.7	0.729496	-4.09661E-01				LAUNCH VEHICLE TEST PACKAGE
52ND MOLNIYA-1	1981-123-A	USSR		MIL	COMMU	23-Dec-81	PLE	A-2-E	699.0	485.0	38990.0	63.0	26115.7	0.737202	-1.56243E-01				REPLACED 45TH MOLNIYA-1
COSMOS-1331	1982-1-A	USSR		MIL	COMMU	07-Jan-82	PLE	C-1	100.7	776.0	819.0	74.0	7175.7	0.002996	-1.81838E+00				STORE & DUMP : REPLACED C-1302
COSMOS-1332	1982-2-A	USSR		MIL	RECON	13-Jan-82	PLE	A-2	89.1	218.0	275.0	82.3	6624.7	0.004302	-1.16912E+00		REC	25-Jan-82	MED. RESOLUTION PHOTOGRAPHIC
COSMOS-1333	1982-3-A	USSR		MIL	NAVIG	14-Jan-82	PLE	C-1	105.0	989.0	1029.0	82.9	7387.2	0.002707	-7.36571E-01				REPLACED COSMOS-1150
SATCOM-4	1982-4-A	USA	RCA	CIV	COMMU	16-Jan-82	ETR	DELTA	1436.2	35781.0	35794.0	0.1	42165.7	0.000154	-1.34121E-02	277.0			FIXED SATELLITE SERVICE
COSMOS-1334	1982-5-A	USSR		MIL	RECON	20-Jan-82	PLE	A-2	89.4	206.0	315.0	72.9	6638.7	0.008210	-9.07097E-02		REC	03-Feb-82	
KH-9	1982-6-A	USA	USAF	MIL	RECON	21-Jan-82	WTR	TITAN IIIB	91.2	137.0	527.0	97.3	6710.2	0.029060	1.06182E+00		DEC	23-May-82	HI-RESOL. FILM RECON.
COSMOS-1335	1982-7-A	USSR		MIL	RADAR	29-Jan-82	PLE	C-1	94.7	487.0	535.0	74.0	6889.2	0.003484	6.23408E-01				REPLACED COSMOS-1186
COSMOS-1336	1982-8-A	USSR		MIL	RECON	29-Jan-82	BAI	A-2	89.8	179.0	379.0	70.4	6657.2	0.015021	-2.87853E+00		REC	26-Feb-82	HI RESOLUTION PHOTOGRAPHIC
EKRAN-8	1982-9-A	USSR		CIV	COMMU	05-Feb-82	BAI	D-1-e	1429.0	35658.0	35658.0	0.4	42036.2	.000000	-1.35570E-02	99.0			TV RELAY
COSMOS-1337	1982-10-A	USSR		MIL	ORSAT	11-Feb-82	BAI	F-1-m	93.3	436.0	456.0	65.0	6824.2	0.001465	-3.32379E+00		DEC	25-Jul-82	EORSAT;PAIRED WITH COSMOS-1306
COSMOS-1338	1982-11-A	USSR		MIL	RECON	16-Feb-82	PLE	A-2	90.2	208.0	393.0	72.8	6678.7	0.013850	-2.62176E+00		REC	02-Mar-82	MED. RESOLUTION PHOTOGRAPHIC
COSMOS-1339	1982-12-A	USSR		MIL	NAVIG	17-Feb-82	PLE	C-1	104.8	975.0	1029.0	82.9	7380.2	0.003658	-7.39028E-01				REPLACED COSMOS-1092
COSMOS-1340	1982-13-A	USSR		MIL	ELINT	19-Feb-82	PLE	A-1	97.6	636.0	679.0	81.2	7035.7	0.003056	-1.08131E+00				REPLACED COSMOS-1206
WESTAR-4	1982-14-A	USA	WU	CIV	COMMU	26-Feb-82	ETR	DELTA 3910	1436.2	35781.0	35794.0	0.0	42165.7	0.000154	-1.34121E-02	290.0			FSS; REPLACED WESTAR 1

1160-12/77

IDENTIFICATION				MISSION		LAUNCH DATA			ORBITAL DATA								MISSION STATUS		
SATELLITE NAME	INT'L DESIG.	COUNTRY	PROJ. DIR.	C/M DESIG.	PURPOSE	DATE	SITE	VEHICLE	PERIOD (MIN)	PERIGEE HEIGHT (KM)	APOGEE HEIGHT (KM)	INCL. (DEG)	SEMI-MAJOR AXIS (KM)	ECCEN. (ND)	RIGHT ASCENSION RATE (DEG/DAY)	GEOSYNC ORBITAL POSITION (DEG. EAST)	STATUS	DATE	REMARKS
53RD MOLNIYA-1	1982-15-A	USSR		MIL	COMMU	26-Feb-82	PLE	A-2-e	735.0	490.0	40765.0	62.8	27005.7	0.745677	-1.47936E-01				REPLACED 47TH MOLNIYA-1
COSMOS-1341	1982-16-A	USSR		MIL	EARLY	03-Mar-82	PLE	A-2-e	709.0	614.0	40165.0	62.8	26767.7	0.738784	-1.45792E-01				REPLACED COSMOS-1247
INTELSAT-V F4	1982-17-A	INT'L	INTELSAT	CIV	COMMU	05-Mar-82	ETR	ATLAS CENTAUR	1444.2	35929.0	35959.0	0.1	42322.2	0.000354	-1.32393E-02	361.0			FIXED SATELLITE SERVICE
COSMOS-1342	1982-18-A	USSR		MIL	RECON	05-Mar-82	PLE	A-2	89.5	207.0	326.0	72.9	6644.7	0.008955	-2.53909E+00		REC	19-Mar-82	MED. RESOLUTION PHOTOGRAPHIC
DSP-12	1982-19-A	USA	USAF	MIL	EARLY	06-Mar-82	ETR	TITAN IIIC	1424.7	35524.0	35606.0	2.0	41943.2	0.000978	-1.36545E-02	290.0			DEFENSE SUPPORT PROGRAM
GORIZONT-5	1982-20-A	USSR		MIL	COMMU	15-Mar-82	BAI	D-1-e	1463.0	36320.0	36320.0	0.7	42698.2	.000000	-1.28348E-02	53.0			TV,TELEGRAPH,TELEPHONE
COSMOS-1343	1982-21-A	USSR		MIL	RECON	17-Mar-82	PLE	A-2	89.4	208.0	314.0	72.9	6639.2	0.007983	-2.54637E+00		REC	31-Mar-82	
STS-3	1982-22-A	USA	NASA	CIV	MAN'D	22-Mar-82	ETR	STS-3	89.0	240.0	240.0	38.0	6618.2	0.000000	-6.89934E+00		RET	30-Mar-82	3RD TEST FLT OF COLUMBIA
18TH MOLNIYA-3	1982-23-A	USSR		MIL	COMMU	24-Mar-82	PLE	A-2-e	736.0	656.0	40615.0	62.9	27013.7	0.739608	-1.41476E-01				REPLACED 15TH MOLNIYA-3
COSMOS-1344	1982-24-A	USSR		MIL	NAVIG	24-Mar-82	PLE	C-1	105.0	987.0	1023.0	82.9	7383.2	0.002438	-7.37967E-01				REPLACED COSMOS-1244
8TH-METEOR-2	1982-25-A	USSR		MIL	METEO	25-Mar-82	PLE	F-2	104.2	954.0	976.0	82.5	7343.2	0.001498	-7.94264E-01				1ST METEOR-2 IN THIS ORBIT REGIME
COSMOS-1345	1982-26-A	USSR		MIL	ELINT	31-Mar-82	PLE	C-1	95.2	507.0	550.0	74.0	6906.7	0.003113	-2.07857E+00				
COSMOS-1346	1982-27-A	USSR		MIL	ELINT	31-Mar-82	PLE	A-1	97.6	623.0	675.0	81.0	7027.2	0.003700	-1.11038E+00				REPLACED COSMOS-1222
COSMOS-1347	1982-28-A	USSR		MIL	RECON	02-Apr-82	BAI	A-2	89.7	181.0	364.0	70.4	6650.7	0.013758	-2.88018E+00		REC	22-May-82	HI RESOLUTION PHOTOGRAPHIC
COSMOS-1348	1982-29-A	USSR		MIL	EARLY	07-Apr-82	PLE	A-2-e	709.0	613.0	39342.0	62.8	26355.7	0.734738	-1.49964E-01				REPLACED COSMOS-1172
COSMOS-1349	1982-30-A	USSR		MIL	NAVIG	08-Apr-82	PLE	C-1	105.0	984.0	1025.0	84.0	7382.7	0.002777	-6.24241E-01				REPLACED COSMOS-1153
INSAT-1A	1982-31-A	INDIA		CIV	COMMU	10-Apr-82	ETR	THOR DELTA	1435.9	34395.0	37167.0	0.5	42159.2	0.032875	-1.34479E-02	361.0	IOF	22-Apr-82	FSS & METEORLOGICAL
COSMOS-1350	1982-32-A	USSR		MIL	RECON	15-Apr-82	PLE	A-2	89.8	181.0	380.0	67.2	6658.7	0.014943	-3.32266E+00		REC	16-May-82	HI RESOLUTION PHOTOGRAPHIC
SALYUT-7	1982-33-A	USSR		CIV	MAN'D	19-Apr-82	BAI	D-1-h	89.2	219.0	278.0	51.6	6626.7	0.004452	-5.41423E+00				SPACE STATION; REPLACES SALYUT-6
ISKRA-2	1982-33-C	USSR	MAI	CIV	COMMU	17-May-82	BAI	N/A	92.3	342.0	357.0	51.6	6727.7	0.001115	-5.13485E+00		DEC	09-Jul-82	AMATEUR RADIO;LNCHD FROM SALYUT-7
COSMOS-1351	1982-34-A	USSR		MIL	RADAR	21-Apr-82	AKY	C-1	93.5	349.0	555.0	50.7	6830.2	0.015080	-4.96833E+00		DEC	14-Mar-83	
COSMOS-1352	1982-35-A	USSR		MIL	RECON	21-Apr-82	BAI	A-2	90.2	216.0	383.0	70.4	6677.7	0.012504	-2.84732E+00		REC	05-May-82	MED. RESOLUTION PHOTOGRAPHIC
COSMOS-1353	1982-36-A	USSR		MIL	RECON	23-Apr-82	PLE	A-2	89.1	218.0	269.0	82.3	6621.7	0.003851	-1.17097E+00		REC	06-May-82	MED. RESOLUTION PHOTOGRAPHIC
COSMOS-1354	1982-37-A	USSR		MIL	COMMU	28-Apr-82	PLE	C-1	101.0	795.0	829.0	74.0	7190.2	0.002364	-1.80557E+00				STORE & DUMP : REPLACED C-1190
COSMOS-1355	1982-38-A	USSR		MIL	ORSAT	29-Apr-82	BAI	F-1-m	93.3	438.0	459.0	65.1	6826.7	0.001538	-3.30711E+00		DEC	27-Aug-83	EORSAT;PAIRED WITH COSMOS-1405
COSMOS-1356	1982-39-A	USSR		MIL	ELINT	05-May-82	PLE	A-1	97.6	632.0	684.0	81.2	7036.2	0.003695	-1.08105E+00				REPLACED COSMOS-1184
COSMOS-1357	1982-40-A	USSR		MIL	COMMU	06-May-82	PLE	C-1	115.4	1449.0	1520.0	74.0	7862.7	0.004515	-1.32044E+00				TACTICAL COMMUNICATIONS
COSMOS-1358	1982-40-B	USSR		MIL	COMMU	06-May-82	PLE	C-1	115.4	1449.0	1520.0	74.0	7862.7	0.004515	-1.32044E+00				TACTICAL COMMUNICATIONS
COSMOS-1359	1982-40-C	USSR		MIL	COMMU	06-May-82	PLE	C-1	115.4	1449.0	1520.0	74.0	7862.7	0.004515	-1.32044E+00				TACTICAL COMMUNICATIONS
COSMOS-1360	1982-40-D	USSR		MIL	COMMU	06-May-82	PLE	C-1	115.4	1449.0	1520.0	74.0	7862.7	0.004515	-1.32044E+00				TACTICAL COMMUNICATIONS
COSMOS-1361	1982-40-E	USSR		MIL	COMMU	06-May-82	PLE	C-1	115.4	1449.0	1520.0	74.0	7862.7	0.004515	-1.32044E+00				TACTICAL COMMUNICATIONS
COSMOS-1362	1982-40-F	USSR		MIL	COMMU	06-May-82	PLE	C-1	115.4	1449.0	1520.0	74.0	7862.7	0.004515	-1.32044E+00				TACTICAL COMMUNICATIONS
COSMOS-1363	1982-40-G	USSR		MIL	COMMU	06-May-82	PLE	C-1	115.4	1449.0	1520.0	74.0	7862.7	0.004515	-1.32044E+00				TACTICAL COMMUNICATIONS
COSMOS-1364	1982-40-H	USSR		MIL	COMMU	06-May-82	PLE	C-1	115.4	1449.0	1520.0	74.0	7862.7	0.004515	-1.32044E+00				TACTICAL COMMUNICATIONS
BIG BIRD 17	1982-41-A	USA	USAF	MIL	RECON	11-May-82	WTR	TITAN IIID	88.5	168.0	257.0	96.4	6590.7	0.006752	9.90372E-01		DEC	05-Dec-82	BROAD COVERAGE PHOTO. RECON.
NO NAME	1982-41-C	USA	USAF	MIL	ELINT	11-May-82	WTR	TITAN IIID	98.7	699.0	701.0	96.0	7078.2	0.000141	7.23384E-01				PIGGY BACK ON BIG BIRD LAUNCHES
SOYUZ-T5	1982-42-A	USSR		CIV	MAN'D	13-May-82	BAI	A-2	90.4	271.0	329.0	51.6	6678.2	0.004343	-5.26949E+00		RET	27-Aug-82	
COSMOS-1365	1982-43-A	USSR		MIL	ORSAT	14-May-82	BAI	F-1-m	89.6	259.0	276.0	65.0	6645.7	0.001279	-3.64689E+00				A-PWRD RDR; PAIRED WITH COSMOS-1372
COSMOS-1366	1982-44-A	USSR		MIL	COMMU	17-May-82	BAI	D-1-e	1437.0	35820.0	35820.0	1.5	42198.2	.000000	-1.33714E-02	80.0			MILITARY COMMUNICATIONS @ SHF
COSMOS-1367	1982-45-A	USSR		MIL	EARLY	20-May-82	PLE	A-2-e	709.0	612.0	39530.0	62.8	26449.2	0.735714	-1.49045E-01				
COSMOS-1368	1982-46-A	USSR		MIL	RECON	21-May-82	BAI	A-2	90.0	218.0	365.0	70.4	6669.7	0.011020	-2.85909E+00		REC	03-Jun-82	MED. RESOLUTION PHOTOGRAPHIC
PROGRESS-13	1982-47-A	USSR		CIV	MAN'D	23-May-82	BAI	A-2	88.9	191.0	278.0	51.6	6612.7	0.006578	-5.45471E+00		DEO	06-Jun-82	EXPENDABLE SUPPLY CRAFT
COSMOS-1369	1982-48-A	USSR		MIL	RECON	25-May-82	PLE	A-2	89.4	229.0	296.0	82.3	6640.7	0.005045	-1.15931E+00		REC	08-Jun-82	
COSMOS-1370	1982-49-A	USSR		MIL	RECON	28-May-82	BAI	A-2	89.2	203.0	290.0	64.9	6624.7	0.006566	-3.70161E+00		REC	11-Jul-82	MED. RESOLUTION PHOTOGRAPHIC
54TH MOLNYA-1	1982-50-A	USSR		MIL	COMMU	29-May-82	PLE	A-2-e	736.0	653.0	40633.0	62.8	27021.2	0.739791	-1.41991E-01				REPLACED 44TH MOLNIYA-1
COSMOS-1371	1982-51-A	USSR		MIL	COMMU	01-Jun-82	PLE	C-1	101.0	793.0	833.0	74.1	7191.2	0.002781	-1.79371E+00				STORE & DUMP : REPLACED C-1140
COSMOS-1372	1982-52-A	USSR		MIL	ORSAT	01-Jun-82	BAI	F-1-m	89.6	258.0	277.0	65.0	6645.7	0.001430	-3.64689E+00				A-PWRD RDR; PAIRED WITH COSMOS-1365
COSMOS-1373	1982-53-A	USSR		MIL	RECON	02-Jun-82	BAI	A-2	90.1	217.0	368.0	70.4	6670.7	0.011318	-2.85763E+00		REC	16-Jun-82	MED. RESOLUTION PHOTOGRAPHIC
COSMOS-1374	1982-54-A	USSR		CIV	EXPTL	03-Jun-82	AKY	C-1	88.9	225.0	225.0	50.7	6603.2	0.000000	-5.58971E+00		REC	03-Jun-82	WINGED RE-USABLE SHUTTLE MODEL TEST
COSMOS-1375	1982-55-A	USSR		MIL	ASATT	06-Jun-82	PLE	C-1	105.0	990.0	1021.0	65.9	7383.7	0.002099	-2.43736E+00				TARGET VEHICLE FOR COSMOS-1379

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IDENTIFICATION				MISSION		LAUNCH DATA			ORBITAL DATA								MISSION STATUS		
SATELLITE NAME	INT'L DESIG.	COUNTRY	PROJ. DIR.	C/M DESIG.	PURPOSE	DATE	SITE	VEHICLE	PERIOD (MIN)	PERIGEE HEIGHT (KM)	APOGEE HEIGHT (KM)	INCL. (DEG)	SEMI-MAJOR AXIS (KM)	ECCEN. (ND)	RIGHT ASCENSION RATE (DEG/DAY)	GEOSYNC ORBITAL POSITION (DEG. EAST)	STATUS	DATE	REMARKS
COSMOS-1376	1982-56-A	USSR		CIV	ERSAT	08-Jun-82	PLE	A-2	89.2	227.0	274.0	82.3	6628.7	0.003545	-1.16664E+00		REC	22-Jun-82	NATURAL RESOURCES MONITORING
COSMOS-1377	1982-57-A	USSR		MIL	RECON	08-Jun-82	BAI	A-2	89.7	179.0	362.0	64.9	6648.7	0.013762	-3.65613E+00		REC	22-Jul-82	HI RESOLUTION PHOTOGRAPHIC
WESTAR-5	1982-58-A	USA	WU	CIV	COMMU	09-Jun-82	ETR	DELTA 3910	1436.2	35780.0	35796.0	0.0	42166.2	0.000190	-1.34116E-02	237.0			FIXED SATELLITE SERVICES
COSMOS-1378	1982-59-A	USSR		MIL	ORSAT	10-Jun-82	PLE	F-2	97.8	648.0	682.0	82.5	7043.2	0.002414	-9.19120E-01				EORSAT? PHASED WITH C-1300&-1328
COSMOS-1379	1982-60-A	USSR		MIL	ASATT	18-Jun-82	BAI	F-1-m	100.3	552.0	1027.0	65.8	7167.7	0.033135	-2.72077E+00		DEO	18-Jun-82	INTERCEPTOR FOR COSMOS-1375
COSMOS-1380	1982-61-A	USSR		MIL	NAVIG	18-Jun-82	PLE	C-1	93.1	156.0	732.0	82.9	6822.2	0.042215	-9.76568E-01		DEC	27-Jun-82	INTENDED TO REPLACE COSMOS-1225
COSMOS-1381	1982-62-A	USSR		MIL	RECON	18-Jun-82	BAI	A-2	90.3	216.0	395.0	70.4	6683.7	0.013391	-2.83852E+00		REC	01-Jul-82	MED. RESOLUTION PHOTOGRAPHIC
SOYUZ-T6	1982-63-A	USSR		CIV	MAN'D	24-Jun-82	BAI	A-2	89.6	248.0	277.0	51.6	6640.7	0.002184	-5.37422E+00		RET	02-Jul-82	
COSMOS-1382	1982-64-A	USSR		MIL	EARLY	25-Jun-82	PLE	A-2-e	709.0	614.0	39540.0	62.8	26455.2	0.735698	-1.48911E-01				REPLACED COSMOS-1223
STS-4	1982-65-A	USA	NASA	CIV	MAN'D	27-Jun-82	ETR	STS-4	90.5	296.7	304.8	28.5	6678.9	0.000606	-7.45221E+00		RET	04-Jul-82	4TH TEST FLT OF COLUMBIA
COSMOS-1383	1982-66-A	USSR		MIL	NAVIG	29-Jun-82	PLE	C-1	105.4	1004.0	1041.0	83.0	7400.7	0.002500	-7.21621E-01				KOSPAS-SARSAT
COSMOS-1384	1982-67-A	USSR		MIL	RECON	30-Jun-82	PLE	A-2	89.8	181.0	381.0	67.1	6659.2	0.015017	-3.33558E+00		REC	30-Jul-82	HI RESOLUTION PHOTOGRAPHIC
COSMOS-1385	1982-68-A	USSR		MIL	RECON	06-Jul-82	PLE	A-2	88.7	197.0	264.0	82.3	6608.7	0.005069	-1.17908E+00		REC	20-Jul-82	
COSMOS-1386	1982-69-A	USSR		MIL	NAVIG	07-Jul-82	PLE	C-1	104.6	965.0	1010.0	83.0	7365.7	0.003055	-7.33698E-01				REPLACED COSMOS-1225
PROGRESS-14	1982-70-A	USSR		CIV	MAN'D	10-Jul-82	BAI	A-2	88.7	192.0	258.0	51.6	6603.2	0.004998	-5.48203E+00		DEC	13-Aug-82	EXPENDABLE SUPPLY CRAFT
COSMOS-1387	1982-71-A	USSR		CIV	ERSAT	13-Jul-82	PLE	A-2	89.1	219.0	271.0	82.3	6623.2	0.003926	-1.17004E+00		REC	26-Jul-82	NATURAL RESOURCES MONITORING
LANDSAT-4	1982-72-A	USA	NASA	CIV	ERSAT	16-Jul-82	WTR	THOR DELTA	98.5	678.0	696.0	98.3	7065.2	0.001274	1.00546E+00				NATURAL RESOURCES MONITORING
COSMOS-1388	1982-73-A	USSR		MIL	COMMU	21-Jul-82	PLE	C-1	115.3	1448.0	1515.0	74.0	7859.7	0.004262	-1.32220E+00				TACTICAL COMMUNICATIONS
COSMOS-1389	1982-73-B	USSR		MIL	COMMU	21-Jul-82	PLE	C-1	115.3	1448.0	1515.0	74.0	7859.7	0.004262	-1.32220E+00				TACTICAL COMMUNICATIONS
COSMOS-1390	1982-73-C	USSR		MIL	COMMU	21-Jul-82	PLE	C-1	115.3	1448.0	1515.0	74.0	7859.7	0.004262	-1.32220E+00				TACTICAL COMMUNICATIONS
COSMOS-1391	1982-73-D	USSR		MIL	COMMU	21-Jul-82	PLE	C-1	115.3	1448.0	1515.0	74.0	7859.7	0.004262	-1.32220E+00				TACTICAL COMMUNICATIONS
COSMOS-1392	1982-73-E	USSR		MIL	COMMU	21-Jul-82	PLE	C-1	115.3	1448.0	1515.0	74.0	7859.7	0.004262	-1.32220E+00				TACTICAL COMMUNICATIONS
COSMOS-1393	1982-73-F	USSR		MIL	COMMU	21-Jul-82	PLE	C-1	115.3	1448.0	1515.0	74.0	7859.7	0.004262	-1.32220E+00				TACTICAL COMMUNICATIONS
COSMOS-1394	1982-73-G	USSR		MIL	COMMU	21-Jul-82	PLE	C-1	115.3	1448.0	1515.0	74.0	7859.7	0.004262	-1.32220E+00				TACTICAL COMMUNICATIONS
COSMOS-1395	1982-73-H	USSR		MIL	COMMU	21-Jul-82	PLE	C-1	115.3	1448.0	1515.0	74.0	7859.7	0.004262	-1.32220E+00				TACTICAL COMMUNICATIONS
55TH MOLNYA-1	1982-74-A	USSR		MIL	COMMU	21-Jul-82	PLE	A-2-e	701.0	650.0	38900.0	63.0	26153.2	0.731269	-1.49694E-01				REPLACED 46TH MOLNIYA-1
COSMOS-1396	1982-75-A	USSR		MIL	RECON	27-Jul-82	PLE	A-2	89.5	208.0	323.0	72.9	6643.7	0.008655	-2.54040E+00		REC	10-Aug-82	
COSMOS-1397	1982-76-A	USSR		MIL	RADAR	29-Jul-82	AKY	C-1	93.4	346.0	549.0	50.7	6825.7	0.014870	-4.97974E+00		DEC	18-May-83	
COSMOS-1398	1982-77-A	USSR		MIL	RECON	03-Aug-82	PLE	A-2	89.0	225.0	262.0	82.3	6621.7	0.002794	-1.17095E+00		REC	13-Aug-82	
COSMOS-1399	1982-78-A	USSR		MIL	RECON	04-Aug-82	BAI	A-2	89.7	179.0	371.0	64.9	6653.2	0.014429	-3.64762E+00		REC	16-Sep-82	HI RESOLUTION PHOTOGRAPHIC
COSMOS-1400	1982-79-A	USSR		MIL	ELINT	05-Aug-82	PLE	A-1	97.6	631.0	675.0	81.2	7031.2	0.003129	-1.08373E+00				REPLACED COSMOS-1315
SOYUZ-T7	1982-80-A	USSR		CIV	MAN'D	19-Aug-82	BAI	A-2	89.5	228.0	280.0	51.6	6632.2	0.003920	-5.39848E+00		RET	10-Dec-82	
COSMOS-1401	1982-81-A	USSR		CIV	ERSAT	20-Aug-82	PLE	A-2	89.3	226.0	282.0	82.3	6632.2	0.004222	-1.16450E+00		REC	03-Sep-82	NATURAL RESOURCES MONITORING
ANIK-D1	1982-82-A	CANADA	TELESAT	CIV	COMMU	26-Aug-82	ETR	DELTA 3920	1436.1	35781.0	35793.0	0.0	42165.2	0.000142	-1.34127E-02	256.0			FIXED SATELLITE SERVICE
19TH MOLNIYA-3	1982-83-A	USSR		MIL	COMMU	27-Aug-82	PLE	A-2-e	736.0	494.0	40814.0	62.8	27032.2	0.745779	-1.47529E-01				REPLACED 13TH MOLNIYA-3
COSMOS-1402	1982-84-A	USSR		MIL	ORSAT	30-Aug-82	BAI	F-1-m	89.6	254.0	279.0	65.0	6644.7	0.001881	-3.64882E+00		DEC	23-Jan-83	A-PWRD RDR;PAIRED WITH C-1365&-1412
COSMOS-1403	1982-85-A	USSR		MIL	RECON	01-Sep-82	BAI	A-2	90.2	216.0	380.0	70.4	6676.2	0.012283	-2.84953E+00		REC	15-Sep-82	
COSMOS-1404	1982-86-A	USSR		MIL	RECON	01-Sep-82	PLE	A-2	90.2	211.0	394.0	72.9	6680.7	0.013696	-2.49206E+00		REC	15-Sep-82	
ETS-3(KIKI-4)	1982-87-A	JAPAN	NASDA	CIV	EXPTL	03-Sep-82	TSC	N-I	107.0	964.0	1234.0	45.0	7477.2	0.018055	-4.04153E+00				ENGINEERING TEST SATELLITE
COSMOS-1405	1982-88-A	USSR		MIL	ORSAT	04-Sep-82	BAI	F-1-m	93.3	438.0	456.0	65.0	6825.2	0.001319	-3.32209E+00				EORSAT;PAIRED WITH COSMOS-1355
COSMOS-1406	1982-89-A	USSR		CIV	ERSAT	08-Sep-82	PLE	A-2	89.0	222.0	253.0	82.3	6615.7	0.002343	-1.17467E+00		REC	21-Sep-82	NATURAL RESOURCES MONITORING
CHINA-12	1982-90-A	CHINA		MIL	EXPTL	09-Sep-82	JQN	CSL-2	90.2	172.0	393.0	63.0	6660.7	0.016590	-3.88894E+00		REC	21-Sep-82	RECONNAISSANCE SATELLITE TEST
COSMOS-1407	1982-91-A	USSR		MIL	RECON	15-Sep-82	PLE	A-2	89.7	181.0	364.0	67.2	6650.7	0.013758	-3.33644E+00		REC	16-Oct-82	HI RESOLUTION PHOTOGRAPHIC
COSMOS-1408	1982-92-A	USSR		MIL	ORSAT	16-Sep-82	PLE	F-2	97.8	645.0	679.0	82.5	7040.2	0.002415	-9.20492E-01				EORSAT? REPLACED COSMOS-1378?
EKRAN-9	1982-93-A	USSR		CIV	COMMU	16-Sep-82	BAI	D-1-e	1426.0	35580.0	35580.0	0.3	41958.2	.000000	-1.36455E-02	99.0			TV RELAY
PROGRESS-15	1982-94-A	USSR		CIV	MAN'D	18-Sep-82	BAI	A-2	88.7	195.0	258.0	51.6	6604.7	0.004769	-5.47765E+00		DEO	16-Oct-82	EXPENDABLE SUPPLY CRAFT
COSMOS-1409	1982-95-A	USSR		MIL	EARLY	22-Sep-82	PLE	A-2-e	709.0	613.0	39340.0	62.8	26354.7	0.734728	-1.49974E-01				REPLACED COSMOS-1217
COSMOS-1410	1982-96-A	USSR		MIL	SCIEN	24-Sep-82	PLE	F-2	116.0	1500.0	1522.0	82.6	7889.2	0.001394	-6.09748E-01				GEODETIC: PHASED WITH COSMOS-1312
INTELSAT-V F5	1982-97-A	INT'L	INTELSAT	CIV	COMMU	28-Sep-82	ETR	ATLAS CENTAUR	1435.8	35767.0	35795.0	1.5	42159.2	0.000332	-1.34148E-02	361.0			FIXED SATELLITE SERVICE
COSMOS-1411	1982-98-A	USSR		MIL	RECON	30-Sep-82	PLE	A-2	90.1	208.0	384.0	72.9	6674.2	0.013185	-2.50049E+00		REC	14-Oct-82	MED. RESOLUTION PHOTOGRAPHIC

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IDENTIFICATION				MISSION		LAUNCH DATA			ORBITAL DATA								MISSION STATUS		
SATELLITE NAME	INT'L. DESIG.	COUNTRY	PROJ. DIR.	C/M DESIG.	PURPOSE	DATE	SITE	VEHICLE	PERIOD (MIN)	PERIGEE HEIGHT (KM)	APOGEE HEIGHT (KM)	INCL. (DEG)	SEMI-MAJOR AXIS (KM)	ECCEN. (ND)	RIGHT ASCENSION RATE (DEG/DAY)	GEOSYNC ORBITAL POSITION (DEG. EAST)	STATUS	DATE	REMARKS
COSMOS-1412	1982-99-A	USSR		MIL	ORSAT	02-Oct-82	BAI	F-1-m	89.6	255.0	280.0	65.0	6645.7	0.001881	-3.64690E+00				A-PWRD ROR; PAIRED WITH COSMOS-1402
COSMOS-1413	1982-100-A	USSR		MIL	NAVIG	12-Oct-82	BAI	D-1-e	673.0	19100.0	19100.0	64.8	25478.2	.000000	-3.33005E-02				GLONASS
COSMOS-1414	1982-100-D	USSR		MIL	NAVIG	12-Oct-82	BAI	D-1-e	673.0	19100.0	19100.0	64.8	25478.2	.000000	-3.33005E-02				GLONASS
COSMOS-1415	1982-100-E	USSR		MIL	NAVIG	12-Oct-82	BAI	D-1-e	673.0	19100.0	19100.0	64.8	25478.2	.000000	-3.33005E-02				GLONASS
COSMOS-1416	1982-101-A	USSR		MIL	RECON	14-Oct-82	BAI	A-2	90.2	217.0	380.0	70.4	6676.7	0.012207	-2.84877E+00		REC	28-Oct-82	MED. RESOLUTION PHOTOGRAPHIC
COSMOS-1417	1982-102-A	USSR		MIL	NAVIG	19-Oct-82	PLE	C-1	104.9	978.0	1023.0	83.0	7378.7	0.003049	-7.29184E-01				REPLACED COSMOS-1308
GORIZONT-6	1982-103-A	USSR		MIL	COMMU	20-Oct-82	BAI	D-1-e	1437.0	35800.0	35800.0	0.8	42178.2	.000000	-1.33969E-02	90.0			TV,TELEGRAPH,TELEPHONE
COSMOS-1418	1982-104-A	USSR		MIL	RADAR	21-Oct-82	AKY	C-1	92.2	362.0	417.0	50.7	6767.7	0.004063	-5.12862E+00		DEC	30-Sep-83	
SATCOM-5	1982-105-A	USA	RCA	CIV	COMMU	28-Oct-82	ETR	DELTA	1436.1	35764.0	35810.0	0.1	42165.2	0.000545	-1.34127E-02	232.0			FIXED SATELLITE SERVICE
DSCS-15	1982-106-A	USA	DOD	MIL	COMMU	30-Oct-82	ETR	TITAN IIID	1432.2	35644.0	35776.0	2.4	42088.2	0.001568	-1.34870E-02	346.0			DSCS PHASE III
DSCS-16	1982-106-B	USA	DOD	MIL	COMMU	30-Oct-82	ETR	TITAN IIID	1432.2	35644.0	35776.0	2.0	42088.2	0.001568	-1.34870E-02	225.0			DSCS PHASE II
PROGRESS-16	1982-107-A	USSR		CIV	MAN'D	31-Oct-82	BAI	A-2	88.7	193.0	263.0	51.6	6606.2	0.005298	-5.47335E+00		DEC	14-Dec-82	EXPENDABLE SUPPLY CRAFT
COSMOS-1419	1982-108-A	USSR		MIL	RECON	02-Nov-82	BAI	A-2	89.3	216.0	290.0	70.4	6631.2	0.005580	-2.91709E+00		REC	16-Nov-82	MED. RESOLUTION PHOTOGRAPHIC
COSMOS-1420	1982-109-A	USSR		MIL	COMMU	11-Nov-82	PLE	C-1	100.8	782.0	820.0	74.0	7179.2	0.002647	-1.81527E+00				STORE & DUMP : REPLACED C-1331
STS-5	1982-110-A	USA	NASA	CIV	MAN'D	11-Nov-82	ETR	STS-5	90.3	296.0	302.0	28.5	6677.2	0.000449	-7.45905E+00		RET	16-Nov-82	1ST OPERATIONAL FLT OF COLUMBIA
SBS-3	1982-110-B	USA	SBS	CIV	COMMU	11-Nov-82	ETR	STS-5	1436.2	35786.0	35790.0	0.0	42166.2	0.000047	-1.34116E-02	266.0			FIXED SATELLITE SERVICE
ANIK-C3	1982-110-C	CANADA	TELESAT	CIV	COMMU	12-Nov-82	ETR	STS-5	1436.1	35778.0	35796.0	0.0	42165.2	0.000213	-1.34127E-02	242.5			FIXED SATELLITE SERVICE
KH-11-5	1982-111-A	USA	USAF	MIL	RECON	17-Nov-82	WTR	TITAN IIID	92.0	268.0	474.0	97.0	6749.2	0.015261	9.96733E-01				STRATEGIC RECONNAISSANCE
COSMOS-1421	1982-112-A	USSR		MIL	RECON	18-Nov-82	BAI	A-2	89.2	216.0	286.0	70.4	6629.2	0.005280	-2.92015E+00		REC	02-Dec-82	
ISKRA-3	1982-33-AD	USSR	MAI	CIV	COMMU	18-Nov-82	BAI	N/A	91.5	350.0	365.0	51.6	6735.7	0.001113	-5.11354E+00		DEC	16-Dec-82	AMATEUR RADIO; LNCHD FROM SALYUT-7
RADUGA-10	1982-113-A	USSR		MIL	COMMU	26-Nov-82	BAI	D-1-e	1480.0	36640.0	36640.0	1.3	43018.2	.000000	-1.25015E-02	35.0			TV & MULTICHANNEL RADIOCOMM.
COSMOS-1422	1982-114-A	USSR		MIL	RECON	03-Dec-82	PLE	A-2	89.0	208.0	314.0	73.0	6639.2	0.007983	-2.53192E+00		REC	17-Dec-82	
COSMOS-1423	1982-115-A	USSR		CIV	COMMU	08-Dec-82	BAI	A-2-e	94.3	401.0	575.0	62.8	6866.2	0.012671	-3.51970E+00				FAILED REPLACEMENT FOR MOLNIYA 1-48
9TH METEOR-2	1982-116-A	USSR		MIL	METEO	14-Dec-82	PLE	A-1	102.0	836.0	904.0	81.3	7248.2	0.004691	-9.63395E-01				REPLACEMENT FOR 6TH METEOR-2?
COSMOS-1424	1982-117-A	USSR		MIL	RECON	16-Dec-82	BAI	A-2	89.7	179.4	371.0	64.9	6653.4	0.014399	-3.64723E+00		DEC	28-Jan-83	HI RESOLUTION PHOTOGRAPHIC
DMSP-5	1982-118-A	USA	USAF	MIL	METEO	21-Dec-82	WTR	ATLAS F	101.2	811.0	823.0	98.7	7195.2	0.000834	9.88420E-01				1ST BLOCK 5D2 S/C BUS
COSMOS-1425	1982-119-A	USSR		MIL	RECON	23-Dec-82	BAI	A-2	90.3	237.0	374.0	70.0	6683.7	0.010249	-2.89367E+00		DEC	06-Jan-83	
COSMOS-1426	1982-120-A	USSR		MIL	RECON	28-Dec-82	BAI	A-2	90.0	209.0	377.0	50.6	6671.2	0.012592	-5.40603E+00		DEC	05-Mar-83	PHOTO-RECONNAISSANCE WITH SALYUT-7
COSMOS-1427	1982-121-A	USSR		MIL	ASATT	29-Dec-82	PLE	C-1	94.0	460.0	494.0	65.8	6855.2	0.002480	-3.17323E+00				INTERCEPTION TEST RADAR CALIBRATION
COSMOS-1428	1983-1-A	USSR		MIL	NAVIG	12-Jan-83	PLE	C-1	104.7	972.0	1017.0	82.9	7372.7	0.003052	-7.41657E-01				REPLACED COSMOS-1333
COSMOS-1429	1983-2-A	USSR		MIL	COMMU	19-Jan-83	PLE	C-1	115.3	1449.0	1513.0	74.0	7859.2	0.004072	-1.32249E+00				TACTICAL COMMUNICATIONS
COSMOS-1430	1983-2-B	USSR		MIL	COMMU	19-Jan-83	PLE	C-1	115.3	1449.0	1513.0	74.0	7859.2	0.004072	-1.32249E+00				TACTICAL COMMUNICATIONS
COSMOS-1431	1983-2-C	USSR		MIL	COMMU	19-Jan-83	PLE	C-1	115.3	1449.0	1513.0	74.0	7859.2	0.004072	-1.32249E+00				TACTICAL COMMUNICATIONS
COSMOS-1432	1983-2-D	USSR		MIL	COMMU	19-Jan-83	PLE	C-1	115.3	1449.0	1513.0	74.0	7859.2	0.004072	-1.32249E+00				TACTICAL COMMUNICATIONS
COSMOS-1433	1983-2-E	USSR		MIL	COMMU	19-Jan-83	PLE	C-1	115.3	1449.0	1513.0	74.0	7859.2	0.004072	-1.32249E+00				TACTICAL COMMUNICATIONS
COSMOS-1434	1983-2-F	USSR		MIL	COMMU	19-Jan-83	PLE	C-1	115.3	1449.0	1513.0	74.0	7859.2	0.004072	-1.32249E+00				TACTICAL COMMUNICATIONS
COSMOS-1435	1983-2-G	USSR		MIL	COMMU	19-Jan-83	PLE	C-1	115.3	1449.0	1513.0	74.0	7859.2	0.004072	-1.32249E+00				TACTICAL COMMUNICATIONS
COSMOS-1436	1983-2-H	USSR		MIL	COMMU	19-Jan-83	PLE	C-1	115.3	1449.0	1513.0	74.0	7859.2	0.004072	-1.32249E+00				TACTICAL COMMUNICATIONS
COSMOS-1437	1983-3-A	USSR		MIL	ELINT	20-Jan-83	PLE	A-1	97.6	629.0	678.0	81.2	7031.7	0.003484	-1.08347E+00				
IRAS-1	1983-4-A	USA		CIV	SCIEN	25-Jan-83	WTR	DELTA	102.4	856.6	883.6	100.1	7248.3	0.001863	1.11683E+00				HOLLAND/USA/UK IR ASTRONOMICAL
COSMOS-1438	1983-5-A	USSR		MIL	RECON	27-Jan-83	BAI	A-2	88.9	213.0	254.0	70.4	6611.7	0.003101	-2.94719E+00		REC	07-Feb-83	LOW RESOLUTION PHOTOGRAPHIC
CS-2A(SAKURA)	1983-6-A	JAPAN	NASDA	CIV	COMMU	04-Feb-83	TSC	N-2	1436.2	35752.0	35822.0	0.1	42165.2	0.000830	-1.34127E-02	132.0			FIXED SATELLITE SERVICE
COSMOS-1439	1983-7-A	USSR		MIL	RECON	06-Feb-83	BAI	A-2	89.7	180.0	371.0	70.4	6653.7	0.014353	-2.88372E+00		REC	22-Feb-83	
WHITECLOUD	1983-8-A	USA	USN	MIL	ORSAT	09-Feb-83	WTR	ATLAS F	107.4	1059.0	1156.0	63.4	7485.7	0.006479	-2.54760E+00				NOSS-1:NAVY OCEAN SURVEILLANCE 1
WHITECLOUD	1983-8-E	USA	USN	MIL	ORSAT	09-Feb-83	WTR	ATLAS F	107.4	1059.0	1156.0	63.4	7485.7	0.006479	-2.54760E+00				NOSS-1:NAVY OCEAN SURVEILLANCE 1
WHITECLOUD	1983-8-F	USA	USN	MIL	ORSAT	09-Feb-83	WTR	ATLAS F	107.4	1059.0	1156.0	63.4	7485.7	0.006479	-2.54760E+00				NOSS-1:NAVY OCEAN SURVEILLANCE 1
COSMOS-1440	1983-9-A	USSR		CIV	ERSAT	10-Feb-83	PLE	A-2	89.3	223.0	293.0	82.3	6636.2	0.005274	-1.16207E+00		REC	24-Feb-83	
COSMOS-1441	1983-10-A	USSR		MIL	ELINT	16-Feb-83	PLE	A-1	97.5	632.0	667.0	81.0	7027.7	0.002490	-1.11008E+00				
ASTRO-B(TENMA)	1983-11-A	JAPAN	ISAS	CIV	SCIEN	20-Feb-83	KSC	Mu 35	95.2	490.0	570.0	31.8	6908.2	0.005790	-6.40443E+00				X-RAY ASTRONOMY
COSMOS-1442	1983-12-A	USSR		MIL	RECON	25-Feb-83	PLE	A-2	89.6	180.0	364.0	67.2	6650.2	0.013834	-3.33733E+00		REC	11-Apr-83	

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IDENIFICATION				MISSION		LAUNCH DATA			ORBITAL DATA								MISSION STATUS		
SATELLITE NAME	INT'L DESIG.	COUNTRY	PROJ. DIR.	C/M DESIG.	PURPOSE	DATE	SITE	VEHICLE	PERIOD (MIN)	PERIGEE HEIGHT (KM)	APOGEE HEIGHT (KM)	INCL. (DEG)	SEMI-MAJOR AXIS (KM)	ECCEN. (ND)	RIGHT ASCENSION RATE (DEG/DAY)	GEOSYNC ORBITAL POSITION (DEG. EAST)	STATUS	DATE	REMARKS
COSMOS-1443	1983-13-A	USSR		CIV	MAN'D	02-Mar-83	BAI	D-1-h	88.9	199.0	269.0	51.6	6612.2	0.005293	-5.45599E+00		DEC	19-Sep-83	EXPENDIBLE SUPPLY CRAFT
COSMOS-1444	1983-14-A	USSR		MIL	RECON	02-Mar-83	PLE	A-2	90.3	203.0	413.0	72.9	6686.2	0.015704	-2.48518E+00		REC	16-Mar-83	
20TH MOLNIYA-3	1983-15-A	USSR		MIL	COMMU	11-Mar-83	PLE	A-2-e	736.0	474.0	40773.0	62.8	27001.7	0.746232	-1.48566E-01				REPLACED 17TH MOLNIYA-3
EKRAN-10	1983-16-A	USSR		CIV	COMMU	12-Mar-83	BAI	D-1-e	1428.0	35619.0	35619.0	0.1	41997.2	.000000	-1.36014E-02	99.0			TV RELAY
COSMOS-1445	1983-17-A	USSR		CIV	EXPTL	15-Feb-83	AKY	C-1	88.3	207.0	230.0	50.7	6596.7	0.001743	-5.60905E+00		REC	16-Mar-83	WINGED RE-USABLE SHUTTLE MODEL TEST
COSMOS-1446	1983-18-A	USSR		MIL	RECON	16-Mar-83	BAI	A-2	90.3	237.0	368.0	70.0	6680.7	0.009804	-2.89817E+00		REC	30-Mar-83	
56TH MOLNIYA-1	1983-19-A	USSR		MIL	COMMU	16-Mar-83	PLE	A-2-e	737.0	488.0	40821.0	62.8	27032.7	0.746005	-1.47745E-01				REPLACED 50TH MOLNIYA-1
ASTRON	1983-20-A	USSR		CIV	SCIEN	23-Mar-83	BAI	D-1-e	5680.0	2000.0	200000.0	51.5	107378.2	0.921975	-1.40876E-02				FR./USSR UV & X-RAY ASTRONOMY
COSMOS-1447	1983-21-A	USSR		MIL	NAVIG	24-Mar-83	PLE	C-1	104.9	975.0	1025.0	83.0	7378.2	0.003388	-7.29360E-01				KOSPAS-SARSAT REPLACED COSMOS-1226
NOAA-8	1983-22-A	USA	NOAA	CIV	METED	25-Mar-83	WTR	ATLAS F	101.2	806.0	829.0	98.8	7195.7	0.001598	9.99452E-01				ADVANCED TIROS-N & SARSAT
COSMOS-1448	1983-23-A	USSR		MIL	NAVIG	30-Mar-83	PLE	C-1	104.9	977.0	1017.0	83.0	7375.2	0.002712	-7.30393E-01				REPLACED COSMOS-1344
COSMOS-1449	1983-24-A	USSR		MIL	RECON	31-Mar-83	PLE	A-2	90.3	207.0	402.0	72.9	6682.7	0.014590	-2.48957E+00		REC	15-Apr-83	
57TH MOLNIYA-1	1983-25-A	USSR		MIL	COMMU	02-Apr-83	BAI	A-2-e	700.0	483.0	39023.0	62.9	26131.2	0.737434	-1.56688E-01				REPLACED 52ND MOLNIYA-1
STS-6	1983-26-A	USA	NASA	CIV	MAN'D	04-Apr-83	ETR	STS-6	90.3	284.0	291.0	28.5	6665.7	0.000525	-7.50419E+00		RET	09-Apr-83	1ST FLT OF CHALLENGER
TDRS-1	1983-26-B	USA	NASA	CIV	COMMU	02-Apr-83	ETR	STS-6	1086.1	21857.0	35388.0	2.4	35000.7	0.193296	-2.77512E-02	361.0	IOF		TRACKING & DATA RELAY
COSMOS-1450	1983-27-A	USSR		MIL	ASATT	06-Apr-83	PLE	C-1	94.7	474.0	515.0	65.9	6872.7	0.002983	-3.13284E+00				INTERCEPTION TEST RADAR CALIBRATION
RADUGA-11	1983-28-A	USSR		MIL	COMMU	08-Apr-83	BAI	D-1-e	1440.0	35870.0	35870.0	1.3	42248.2	.000000	-1.33173E-02	84.0			TV & MULTICHANNEL RADIOCOMM.
COSMOS-1451	1983-29-A	USSR		MIL	RECON	08-Apr-83	PLE	A-2	88.7	194.0	264.0	82.3	6607.2	0.005297	-1.18002E+00		REC	22-Apr-83	HI RESOLUTION PHOTOGRAPHIC
SATCOM-6	1983-30-A	USA	RCA	CIV	COMMU	11-Apr-83	ETR	DELTA 3924	1436.2	35780.0	35794.0	0.0	42165.2	0.000166	-1.34127E-02	221.0			FIXED SATELLITE SERVICE
COSMOS-1452	1983-31-A	USSR		MIL	COMMU	12-Apr-83	PLE	C-1	100.3	786.0	826.0	74.0	7184.2	0.002784	-1.81086E+00				STORE & DUMP : REPLACED C-1371
KH-9	1983-32-A	USA	USAF	MIL	RECON	15-Apr-83	WTR	TITAN III8	87.9	135.0	208.0	96.5	6549.7	0.005573	1.02796E+00		REC	21-Aug-83	HI RESOLUTION PHOTOGRAPHIC
ROHINI-3	1983-33-A	INDIA	ISRO	CIV	EXPTL	17-Apr-83	SSC	SLV-3	96.9	387.0	833.0	46.6	6988.2	0.031911	-4.98291E+00				
COSMOS-1453	1983-34-A	USSR		MIL	ELINT	19-Apr-83	PLE	C-1	94.5	473.0	520.0	74.0	6874.7	0.003418	-2.11264E+00				
SOYUZ-T8	1983-35-A	USSR		CIV	MAN'D	20-Apr-83	BAI	A-2	89.5	226.0	278.0	51.6	6630.2	0.003921	-5.40419E+00		RET	22-Apr-83	MISSION CANCELLED
COSMOS-1454	1983-36-A	USSR		MIL	RECON	22-Apr-83	PLE	A-2	89.7	181.0	374.0	67.2	6655.7	0.014499	-3.32781E+00		REC	22-May-83	
COSMOS-1455	1983-37-A	USSR		MIL	ELINT	23-Apr-83	PLE	F-2	97.8	648.0	676.0	82.5	7040.2	0.001989	9.57084E-01				ELINT? PHASED WITH COSMOS-1470
COSMOS-1456	1983-38-A	USSR		MIL	EARLY	25-Apr-83	PLE	A-2-e	709.0	613.0	39343.0	62.8	26356.2	0.734743	-1.49959E-01				REPLACED COSMOS-1191
COSMOS-1457	1983-39-A	USSR		MIL	RECON	26-Apr-83	BAI	A-2	89.8	180.0	376.0	70.4	6656.2	0.014723	-2.87999E+00		REC	08-Jun-83	
COSMOS-1458	1983-40-A	USSR		CIV	ERSAT	28-Apr-83	PLE	A-2	89.1	220.0	275.0	82.3	6625.7	0.004151	-1.16850E+00		REC	11-May-83	
GEOS-6	1983-41-A	USA	NOAA	CIV	METED	28-Apr-83	ETR	DELTA 3914	1707.4	33483.0	48400.0	0.5	47319.7	0.157620	-9.41984E-03	225.0			VISIBLE & IR SPECTRA
COSMOS-1459	1983-42-A	USSR		MIL	NAVIG	06-May-83	PLE	C-1	104.8	960.0	1028.0	83.0	7372.2	0.004612	-7.31454E-01				REPLACED COSMOS-1349
COSMOS-1460	1983-43-A	USSR		MIL	RECON	06-May-83	BAI	A-2	90.1	218.0	369.0	70.3	6671.7	0.011317	-2.87013E+00		REC	20-May-83	
COSMOS-1461	1983-44-A	USSR		MIL	ORSAT	07-May-83	BAI	F-1-m	93.3	438.0	457.0	65.0	6825.7	0.001392	-3.32124E+00				EORSAT;PAIRED WITH COSMOS-1507
COSMOS-1462	1983-45-A	USSR		CIV	ERSAT	17-May-83	PLE	A-2	89.5	224.0	318.0	82.3	6649.2	0.007069	-1.15419E+00		REC	31-May-83	
COSMOS-1463	1983-46-A	USSR		MIL	SCIEN	19-May-83	PLE	C-1	103.5	307.0	1570.0	82.9	7316.7	0.086310	-7.73177E-01				IONOSPHERIC RESEARCH?
INTELSAT-V F6	1983-47-A	INT'L	INTELSAT	CIV	COMMU	19-May-83	ETR	ATLAS CENTAUR	1442.1	35859.0	35950.0	0.2	42282.7	0.001076	-1.32826E-02	361.0			FSS & MSS
COSMOS-1464	1983-48-A	USSR		MIL	NAVIG	24-May-83	PLE	C-1	104.9	985.0	1022.0	82.9	7381.7	0.002506	-7.38492E-01				REPLACED COSMOS-1295
COSMOS-1465	1983-49-A	USSR		MIL	RADAR	26-May-83	AKY	C-1	93.4	349.0	551.0	50.7	6828.2	0.014792	-4.97334E+00				
COSMOS-1466	1983-50-A	USSR		MIL	RECON	26-May-83	BAI	A-2	89.7	180.0	367.0	64.9	6651.7	0.014057	-3.65042E+00		REC	06-Jul-83	HI RESOLUTION PHOTOGRAPHIC
EXOSAT	1983-51-A	EUROPE	ESA	CIV	SCIEN	26-May-83	WTR	DELTA 3914	5435.4	347.0	191709.0	72.5	102406.2	0.934329	-1.11955E-02				X-RAY ASTRONOMY
COSMOS-1467	1983-52-A	USSR		MIL	RECON	31-May-83	PLE	A-2	90.0	209.0	389.0	72.9	6677.2	0.013479	-2.49660E+00		REC	12-Jun-83	
VENERA-15	1983-53-A	USSR		CIV	INTER	02-Jun-83	BAI	D-1-e											AUTOMATIC INTERPLANETARY STATION
VENERA-16	1983-54-A	USSR		CIV	INTER	07-Jun-83	BAI	D-1-e											AUTOMATIC INTERPLANETARY STATION
COSMOS-1468	1983-55-A	USSR		CIV	ERSAT	07-Jun-83	PLE	A-2	89.3	227.0	283.0	82.3	6633.2	0.004221	-1.16388E+00		REC	21-Jun-83	
WHITECLOUD	1983-56-A	USA	USN	MIL	ORSAT	09-Jun-83	WTR	ATLAS F	107.7	1062.0	1182.0	63.4	7500.2	0.008000	-2.53052E+00				NOSS-1:NAVY OCEAN SURVEILLANCE 1
WHITECLOUD	1983-56-C	USA	USN	MIL	ORSAT	09-Jun-83	WTR	ATLAS F	107.4	1049.0	1167.0	63.4	7486.2	0.007881	-2.54711E+00				NOSS-1:NAVY OCEAN SURVEILLANCE 1
WHITECLOUD	1983-56-D	USA	USN	MIL	ORSAT	09-Jun-83	WTR	ATLAS F	107.4	1049.0	1168.0	63.4	7486.7	0.007947	-2.54652E+00				NOSS-1:NAVY OCEAN SURVEILLANCE 1
COSMOS-1469	1983-57-A	USSR		MIL	RECON	14-Jun-83	PLE	A-2	90.0	211.0	377.0	72.8	6672.2	0.012440	-2.51722E+00		REC	24-Jun-83	
ECS-1	1983-58-A	EUROPE	ESA	CIV	COMMU	16-Jun-83	CSG	ARIANE	1427.7	35462.0	35782.0	0.1	42000.2	0.003810	-1.35984E-02	10.0			FIXED SATELLITE SERVICE
OSCAR-10	1983-58-B	GERMANY	AMSAT	CIV	COMMU	16-Jun-83	CSG	ARIANE	625.8	211.0	35503.0	8.5	24235.2	0.728116	-4.17430E-01				AMATEUR RADIO AMSAT PHASE III B

IDENTIFICATION				MISSION		LAUNCH DATA			ORBITAL DATA								MISSION STATUS		
SATELLITE NAME	INT'L DESIG.	COUNTRY	PROJ. DIR.	C/M DESIG.	PURPOSE	DATE	SITE	VEHICLE	PERIOD (MIN)	PERIGEE HEIGHT (KM)	APOGEE HEIGHT (KM)	INCL. (DEG)	SEMI-MAJOR AXIS (KM)	ECCEN. (ND)	RIGHT ASCENSION RATE (DEG/DAY)	GEOSYNC ORBITAL POSITION (DEG. EAST)	STATUS	DATE	REMARKS
STS-7	1983-59-A	USA	NASA	CIV	MAN'D	18-Jun-83	ETR	STS-7	90.4	291.0	296.0	28.5	6671.7	0.000375	-7.48059E+00		RET	24-Jun-83	SPACE SHUTTLE CHALLENGER
ANIK-C2	1983-59-B	CANADA	TELESAT	CIV	COMMU	18-Jun-83	ETR	STS-7	1436.1	35776.0	35798.0	0.0	42165.2	0.000261	-1.34127E-02	361.0			FIXED SATELLITE SERVICE
PALAPA-B1	1983-59-C	INDONESIA		CIV	COMMU	19-Jun-83	ETR	STS-7	1436.2	35780.0	35796.0	0.0	42166.2	0.000190	-1.34116E-02	361.0			FIXED SATELLITE SERVICE
SPAS-01	1983-59-F	GERMANY		CIV	EXPTL	22-Jun-83	ETR	STS-7	90.5	295.0	300.0	28.5	6675.7	0.000374	-7.46492E+00		REC	22-Jun-83	SHUTTLE PALLET SATELLITE
BIG BIRD 18	1983-60-A	USA	USAF	MIL	RECON	20-Jun-83	WTR	TITAN IIID	88.6	156.5	255.0	96.5	6583.9	0.007480	1.00942E+00				BROAD COVERAGE PHOTO. RECON.
NO NAME	1983-60-C	USA	USAF	MIL	ELINT	20-Jun-83	WTR	TITAN IIID	111.3	1284.0	1287.0	96.7	7663.7	0.000196	6.11351E-01				PIGGY BACK ON BIG BIRD LAUNCHES
COSMOS-1470	1983-61-A	USSR		MIL	ELINT	23-Jun-83	PLE	F-2	97.7	630.0	664.0	82.5	7025.2	0.002420	9.51972E-01				ELINT? PHASED WITH COSMOS-1455
SOYUZ-T9	1983-62-A	USSR		CIV	MAN'D	27-Jun-83	BAI	A-2	90.0	258.0	303.0	51.6	6658.7	0.003379	-5.32362E+00		RET	23-Nov-83	
HILAT	1983-63-A	USA	USN	MIL	SCIEN	27-Jun-83	WTR	SCOUT	100.9	767.0	834.0	82.0	7178.7	0.004667	-9.16808E-01				IONOSPHERE RESEARCH
COSMOS-1471	1983-64-A	USSR		MIL	RECON	28-Jun-83	PLE	A-2	89.7	182.0	369.0	67.2	6653.7	0.014052	-3.33123E+00		REC	28-Jul-83	
GALAXY-1	1983-65-A	USA	HUGHES	CIV	COMMU	28-Jun-83	ETR	DELTA 3920	1437.5	35256.0	36373.0	0.1	42192.7	0.013237	-1.33868E-02	225.0			FIXED SATELLITE SERVICE
GORIZONT-7	1983-66-A	USSR		MIL	COMMU	01-Jul-83	BAI	D-1-e	1479.0	36600.0	36600.0	1.3	42978.2	.000000	-1.25422E-02	346.0			TELEGRAPH,TELEPHONE,TV
PROGNOZ-9	1983-67-A	USSR		CIV	SCIEN	01-Jul-83	BAI	A-2-e	38448.0	380.0	720000.0	65.5	366568.2	0.981564	-2.15118E-03				X & GAMMA RAY OBSERVATORY
COSMOS-1472	1983-68-A	USSR		CIV	ERSAT	05-Jul-83	PLE	A-2	88.8	197.0	264.0	82.4	6608.7	0.005069	-1.16385E+00		REC	19-Jul-83	
COSMOS-1473	1983-69-A	USSR		MIL	COMMU	06-Jul-83	PLE	C-1	115.1	1448.0	1511.0	74.0	7857.7	0.004009	-1.32337E+00				TACTICAL COMMUNICATIONS
COSMOS-1474	1983-69-B	USSR		MIL	COMMU	06-Jul-83	PLE	C-1	115.1	1448.0	1511.0	74.0	7857.7	0.004009	-1.32337E+00				TACTICAL COMMUNICATIONS
COSMOS-1475	1983-69-C	USSR		MIL	COMMU	06-Jul-83	PLE	C-1	115.1	1448.0	1511.0	74.0	7857.7	0.004009	-1.32337E+00				TACTICAL COMMUNICATIONS
COSMOS-1476	1983-69-D	USSR		MIL	COMMU	06-Jul-83	PLE	C-1	115.1	1448.0	1511.0	74.0	7857.7	0.004009	-1.32337E+00				TACTICAL COMMUNICATIONS
COSMOS-1477	1983-69-E	USSR		MIL	COMMU	06-Jul-83	PLE	C-1	115.1	1448.0	1511.0	74.0	7857.7	0.004009	-1.32337E+00				TACTICAL COMMUNICATIONS
COSMOS-1478	1983-69-F	USSR		MIL	COMMU	06-Jul-83	PLE	C-1	115.1	1448.0	1511.0	74.0	7857.7	0.004009	-1.32337E+00				TACTICAL COMMUNICATIONS
COSMOS-1479	1983-69-G	USSR		MIL	COMMU	06-Jul-83	PLE	C-1	115.1	1448.0	1511.0	74.0	7857.7	0.004009	-1.32337E+00				TACTICAL COMMUNICATIONS
COSMOS-1480	1983-69-H	USSR		MIL	COMMU	06-Jul-83	PLE	C-1	115.1	1448.0	1511.0	74.0	7857.7	0.004009	-1.32337E+00				TACTICAL COMMUNICATIONS
COSMOS-1481	1983-70-A	USSR		MIL	EARLY	08-Jul-83	PLE	A-2-e	718.0	615.0	40165.0	62.8	26768.2	0.738751	-1.45752E-01				FAILED TO SYNCHRONIZE ORBIT
COSMOS-1482	1983-71-A	USSR		MIL	RECON	13-Jul-83	BAI	A-2	90.2	217.0	376.0	70.0	6674.7	0.011911	-2.90756E+00		REC	27-Jul-83	
NAVSTAR-8	1983-72-A	USA	USAF	MIL	NAVIG	14-Jul-83	WTR	ATLAS F	718.0	19921.0	20442.0	62.8	26559.7	0.009808	-3.09149E-02				#7 WAS A LVF ON 18-DEC-81
58TH MOLNIYA-1	1983-73-A	USSR		MIL	COMMU	19-Jul-83	PLE	A-2-e	700.0	480.0	39025.0	62.9	26130.7	0.737544	-1.56810E-01				REPLACED 49TH MOLNIYA-1
COSMOS-1483	1983-74-A	USSR		CIV	ERSAT	20-Jul-83	PLE	A-2	89.5	227.0	305.0	82.3	6644.2	0.005870	-1.15719E+00		REC	03-Aug-83	
COSMOS-1484	1983-75-A	USSR		CIV	METEO	24-Jul-83	BAI	A-1	97.3	595.0	673.0	98.0	7012.2	0.005562	9.95306E-01				F/O TO METEOR-PRIRODA SERIES
COSMOS-1485	1983-76-A	USSR		MIL	RECON	26-Jul-83	PLE	A-2	90.2	209.0	395.0	72.9	6680.2	0.013922	-2.49274E+00		REC	09-Aug-83	
TELSTAR-3A	1983-77-A	USA	AT&T	CIV	COMMU	28-Jul-83	ETR	DELTA 3920	1436.2	35433.0	36133.0	0.1	42161.2	0.008301	-1.34190E-02	264.0			FIXED SATELLITE SERVICE
SDS-8	1983-78-A	USA	USAF	MIL	COMMU	31-Jul-83	WTR	TITAN IIIB	718.0	500.0	39000.0	63.0	26128.2	0.736753	-1.55531E-01				SATELLITE DATA SYSTEM
COSMOS-1486	1983-79-A	USSR		MIL	COMMU	03-Aug-83	PLE	C-1	100.8	786.0	820.0	74.1	7181.2	0.002367	-1.80246E+00				STORE & DUMP : REPLACED C-1354
COSMOS-1487	1983-80-A	USSR		CIV	ERSAT	05-Aug-83	PLE	A-2	89.5	226.0	305.0	82.3	6643.7	0.005946	-1.15750E+00		REC	19-Aug-83	
CS-2B(SAKURA)	1983-81-A	JAPAN	NASDA	CIV	COMMU	05-Aug-83	TSC	N II	1450.8	35535.0	36610.0	0.3	42450.7	0.012662	-1.31036E-02	136.0			FIXED SATELLITE SERVICE
COSMOS-1488	1983-82-A	USSR		MIL	RECON	09-Aug-83	PLE	A-2	90.2	208.0	397.0	72.8	6680.7	0.014145	-2.50625E+00		REC	23-Aug-83	
COSMOS-1489	1983-83-A	USSR		MIL	RECON	10-Aug-83	BAI	A-2	89.3	182.0	323.0	64.7	6630.7	0.010632	-3.71790E+00		REC	23-Sep-83	
COSMOS-1490	1983-84-A	USSR		MIL	NAVIG	10-Aug-83	BAI	D-1-e	676.0	19154.0	19154.0	64.7	25532.2	.000000	-3.31772E-02				GLONASS
COSMOS-1491	1983-84-B	USSR		MIL	NAVIG	10-Aug-83	BAI	D-1-e	676.0	19154.0	19154.0	64.7	25532.2	.000000	-3.31772E-02				GLONASS
COSMOS-1492	1983-84-C	USSR		MIL	NAVIG	10-Aug-83	BAI	D-1-e	676.0	19154.0	19154.0	64.7	25532.2	.000000	-3.31772E-02				GLONASS
PROGRESS-17	1983-85-A	USSR		CIV	MAN'D	17-Aug-83	BAI	A-2	88.7	196.0	257.0	51.6	6604.7	0.004618	-5.47763E+00		DEC	18-Sep-83	EXPENDABLE SUPPLY CRAFT
CHINA-13	1983-86-A	CHINA		MIL	EXPTL	19-Aug-83	SCT	LONG MARCH 2	88.8	160.0	266.0	63.3	6591.2	0.008041	-3.99117E+00		REC	24-Aug-83	CHINA II:TEST DEPLOYMENT & RECOVERY
COSMOS-1493	1983-87-A	USSR		MIL	RECON	23-Aug-83	PLE	A-2	90.2	207.0	396.0	72.9	6679.7	0.014147	-2.49343E+00		REC	06-Sep-83	
RADUGA-13	1983-88-A	USSR		MIL	COMMU	26-Aug-83	BAI	D-1-e	1478.0	36617.0	36617.0	1.3	42995.2	.000000	-1.25249E-02	45.0			TV & MULTICHANNEL RADIOCOMM.
STS-8	1983-89-A	USA	NASA	CIV	MAN'D	30-Aug-83	ETR	STS-8	90.5	296.0	302.0	28.5	6677.2	0.000449	-7.45905E+00		RET	05-Sep-83	CHALLENGER
INSAT-1B	1983-89-B	INDIA		CIV	COMMU	31-Aug-83	ETR	STS-8	1436.0	35778.0	35797.0	0.0	42165.7	0.000225	-1.34121E-02	94.0			FSS & METEOROLOGICAL
21ST MOLNIYA-3	1983-90-A	USSR		MIL	COMMU	31-Aug-83	PLE	A-2-e	736.0	497.0	40815.0	62.8	27034.2	0.745686	-1.47400E-01				ESTABLISHED NEW ORBITAL PLANE
COSMOS-1494	1983-91-A	USSR		MIL	RADAR	31-Aug-83	AKY	C-1	93.5	341.0	561.0	50.7	6829.2	0.016107	-4.97120E+00				
COSMOS-1495	1983-92-A	USSR		MIL	RECON	03-Sep-83	PLE	A-2	88.9	211.0	248.0	82.3	6607.7	0.002800	-1.17966E+00		REC	16-Sep-83	
COSMOS-1496	1983-93-A	USSR		MIL	RECON	07-Sep-83	PLE	A-2	89.6	182.0	362.0	67.2	6650.2	0.013534	-3.33727E+00		REC	19-Oct-83	
SATCOM-7	1983-94-A	USA	RCA	CIV	COMMU	08-Sep-83	ETR	DELTA 3910	1436.2	35775.0	35802.0	0.0	42166.7	0.000320	-1.34110E-02	294.0			FSS REPLACES SATCOM-2

IDENTIFICATION: SATELLITE NAME	INT'L DESIG.	COUNTRY	PROJ. DIR.	MISSION: C/M DESIG.	PURPOSE	LAUNCH DATA: DATE	SITE	VEHICLE	ORBITAL DATA: PERIOD (MIN)	PERIGEE HEIGHT (KM)	APOGEE HEIGHT (KM)	INCL. (DEG)	SEMI-MAJOR AXIS (KM)	ECCEN. (ND)	RIGHT ASCENSION RATE (DEG/DAY)	GEOSYNC ORBITAL POSITION (DEG. EAST)	MISSION STATUS: STATUS	DATE	REMARKS
COSMOS-1497	1983-95-A	USSR		MIL	RECON	09-Sep-83	PLE	A-2	90.3	208.0	403.0	72.8	6683.7	0.014588	-2.50238E+00		REC	23-Sep-83	
COSMOS-1498	1983-96-A	USSR		CIV	ERSAT	14-Sep-83	PLE	A-2	89.4	222.0	305.0	82.3	6641.7	0.006248	-1.15873E+00		REC	28-Sep-83	
COSMOS-1499	1983-97-A	USSR		MIL	RECON	17-Sep-83	PLE	A-2	90.2	208.0	396.0	72.9	6680.2	0.014072	-2.49276E+00		REC	01-Oct-83	
GALAXY-2	1983-98-A	USA	HUGHES	CIV	COMMU	22-Sep-83	ETR	DELTA 3920	1436.2	35787.0	35789.0	0.0	42166.2	0.000024	-1.34116E-02	286.0			FIXED SATELLITE SERVICE
COSMOS-1500	1983-99-A	USSR		CIV	ERSAT	28-Sep-83	PLE	F-2	97.8	649.0	679.0	82.6	7042.2	0.002130	-9.07382E-01				OCEAN & EARTH RESOURCE SATELLITE
EKRAN-11	1983-100-A	USSR		CIV	COMMU	29-Sep-83	BAI	D-1-e	1428.0	36630.0	36630.0	0.4	43008.2	.000000	-1.25146E-02	99.0			TV RELAY
COSMOS-1501	1983-101-A	USSR		MIL	RADAR	30-Sep-83	PLE	C-1	94.4	470.0	516.0	82.9	6871.2	0.003347	-9.49039E-01				SIMILAR TO COSMOS-1311
COSMOS-1502	1983-102-A	USSR		MIL	ASATT	05-Oct-83	PLE	C-1	92.3	372.0	411.0	75.9	6769.7	0.002881	-1.97053E+00				RELATED TO ASAT RADAR CALIBRATION?
COSMOS-1503	1983-103-A	USSR		MIL	COMMU	12-Oct-83	PLE	C-1	100.9	791.0	827.0	74.0	7187.2	0.002504	-1.80821E+00				STORE & DUMP : REPLACED C-1486
COSMOS-1504	1983-104-A	USSR		MIL	RECON	14-Oct-83	BAI	A-2	89.3	180.0	328.0	64.9	6632.2	0.011158	-3.68758E+00		REC	06-Dec-83	
INTELSAT-V F7	1983-105-A	INT'L	INTELSAT	CIV	COMMU	19-Oct-83	ETR	ATLAS CENTAUR	1433.3	35513.0	35950.0	0.4	42109.7	0.005189	-1.34751E-02	60.0			FIXED SATELLITE SERVICE
PROGRESS-18	1983-106-A	USSR		CIV	MAN'D	20-Oct-83	BAI	A-2	88.8	193.0	269.0	51.6	6609.2	0.005750	-5.46472E+00		DEC	20-Nov-83	EXPENDABLE SUPPLY CRAFT
COSMOS-1505	1983-107-A	USSR		MIL	RECON	21-Oct-83	PLE	A-2	90.0	210.0	377.0	72.9	6671.7	0.012516	-2.50369E+00		REC	04-Nov-83	
COSMOS-1506	1983-108-A	USSR		MIL	NAVIG	26-Oct-83	PLE	C-1	104.8	969.0	1026.0	83.0	7375.7	0.003864	-7.30231E-01				REPLACED COSMOS-1304
10TH METEOR-2	1983-109-A	USSR		MIL	METEO	28-Oct-83	PLE	A-1	101.0	780.0	901.0	81.2	7218.7	0.008381	-9.88485E-01				PHASED WITH 7TH & 9TH METEOR-2
COSMOS-1507	1983-110-A	USSR		MIL	ORSAT	29-Oct-83	BAI	F-1-m	93.0	431.0	449.0	65.0	6818.2	0.001320	-3.33404E+00				EORSAT;PAIRED WITH COSMOS-1461
COSMOS-1508	1983-111-A	USSR		MIL	SCIEN	11-Nov-83	PLE	C-1	108.8	400.0	1964.0	83.0	7560.2	0.103437	-6.84282E-01				IONOSPHERIC RESEARCH?
COSMOS-1509	1983-112-A	USSR		MIL	RECON	17-Nov-83	PLE	A-2	89.3	209.0	309.0	72.9	6637.2	0.007533	-2.54903E+00		REC	01-Dec-83	
DMSP-6	1983-113-A	USA	USAF	MIL	METEO	18-Nov-83	WTR	ATLAS F	101.4	814.0	831.0	98.7	7200.7	0.001180	9.85781E-01				
59TH MOLNIYA-1	1983-114-A	USSR		MIL	COMMU	23-Nov-83	PLE	A-2-e	702.0	465.0	39150.0	62.8	26185.7	0.738668	-1.57334E-01				REPLACED 48TH MOLNYA-1
COSMOS-1510	1983-115-A	USSR		MIL	SCIEN	24-Nov-83	PLE	F-2	116.1	1497.0	1537.0	73.6	7895.2	0.002533	-1.33313E+00				GEODETIC: RELATED TO C-1410&-1312
STS-9	1983-116-A	USA	NASA	CIV	MAN'D	28-Nov-83	ETR	STS-9	89.5	242.0	254.0	57.0	6626.2	0.000906	-4.74842E+00		RET	07-Dec-83	COLUMBIA & SPACELAB 1
COSMOS-1511	1983-117-A	USSR		MIL	RECON	30-Nov-83	PLE	A-2	89.7	181.0	368.0	67.2	6652.7	0.014055	-3.33298E+00				
GORIZONT-8	1983-118-A	USSR		MIL	COMMU	30-Nov-83	BAI	D-1-e	1439.0	35850.0	35850.0	1.4	42228.2	.000000	-1.33388E-02	90.0			TELEGRAPH,TELEPHONE,TV
COSMOS-1512	1983-119-A	USSR		MIL	RECON	07-Dec-83	PLE	A-2	90.2	209.0	392.0	72.9	6678.7	0.013700	-2.49467E+00		REC	21-Dec-83	
COSMOS-1513	1983-120-A	USSR		MIL	NAVIG	08-Dec-83	PLE	C-1	105.0	977.0	1029.0	83.0	7381.2	0.003522	-7.28324E-01				REPLACED COSMOS-1417
COSMOS-1514	1983-121-A	USSR		CIV	SCIEN	14-Dec-83	PLE	A-2	89.3	226.0	288.0	82.3	6635.2	0.004672	-1.16267E+00		REC	19-Dec-83	BIOLOGICAL RESEARCH
COSMOS-1515	1983-122-A	USSR		MIL	ELINT	15-Dec-83	PLE	F-2	97.8	648.0	676.0	82.5	7040.2	0.001989	-9.20488E-01				ELINT? PHASED WITH C-1455 & C-1470
22ND MOLNIYA-3	1983-123-A	USSR		MIL	COMMU	21-Dec-83	PLE	A-2-e	736.0	645.0	40635.0	62.8	27018.2	0.740058	-1.42295E-01				REPLACED 16TH MOLNYA-3
COSMOS-1516	1983-124-A	USSR		MIL	RECON	27-Dec-83	BAI	A-2	89.2	205.0	299.0	65.0	6630.2	0.007089	-3.67717E+00				
COSMOS-1517	1983-125-A	USSR		CIV	EXPTL	27-Dec-83	AKY	C-1	88.7	208.0	228.0	50.7	6596.2	0.001516	-5.61053E+00		REC	27-Dec-83	WINGED RE-USABLE SHUTTLE MODEL TEST
COSMOS-1518	1983-126-A	USSR		MIL	EARLY	28-Dec-83	PLE	A-2-e	709.0	614.0	39345.0	62.8	26357.7	0.734720	-1.49907E-01				REPLACED COSMOS-1341
COSMOS-1519	1983-127-A	USSR		MIL	NAVIG	29-Dec-83	BAI	D-1-e	674.0	19100.0	19100.0	64.3	25478.2	.000000	-3.39168E-02				GLONASS
COSMOS-1520	1983-127-B	USSR		MIL	NAVIG	29-Dec-83	BAI	D-1-e	674.0	19100.0	19100.0	64.3	25478.2	.000000	-3.39168E-02				GLONASS
COSMOS-1521	1983-127-C	USSR		MIL	NAVIG	29-Dec-83	BAI	D-1-e	674.0	19100.0	19100.0	64.3	25478.2	.000000	-3.39168E-02				GLONASS

APPENDIX B

MISSION ANALYSIS ANNEX

B1.0 LAUNCH ON DEMAND RENDEZVOUS PROBLEM

1.0 INTRODUCTION

To determine the feasibility and costs of a satellite designed to approach other satellites for purposes of information gathering requires an exploration of the general problem of rendezvous. To launch from earth and come close to another satellite requires the same timing and manoeuvres as to rendezvous with a spacecraft. In each case the launch will be planned so as to have the satellite reach the same place at the same time and at the same speed as the target. A method of matching the position and velocity of the target satellite is therefore required.

Such a method involves two phases. The first phase uses ground station controlled manoeuvres to bring the satellite into acquisition range, and is addressed by this paper. The second uses on-board controlled transfer manoeuvres to home in on the target, and will be treated separately.

2.0 PROCEDURE FOR RENDEZVOUS

2.1 Overview

A method of matching the position and velocity of a target satellite was sought. The outline of such a method was given by NASA's Orbital Flight Handbook and forms the basis of this description. A similar method was used by Battelle in studying retrieval of satellites by the STS, and the method is also incorporated in studies funded by ESA/ESTEC on rendezvous in geostationary transfer orbits.

In establishing a procedure to attain a target orbit, an attempt was made to avoid large planar changes due to their high cost in fuel. This cost is well illustrated in Figures 2-1 and 2-2 from the Handbook which show the impulsive velocity required to rotate a satellite's orbital plane, both as a single maneuver and combined with altitude changes. As these are given in non-dimensional form, the velocity table (see Table 2-1) is included to illustrate the magnitudes involved. An impulsive velocity of ΔV = 2500 mps was taken as a reasonable maximum for orbit changes, and the inclination change attainable with this maximum is shown. At low altitudes, no more than an 18° or 19° change would be considered.

The method which reduces the problem to a nearly coplanar orbital transfer, and which does not impose restrictions upon the target orbit, is predicated upon definition of launch times and the use of an intermediate orbit. The procedure consists of launching into the plane of motion of the target at the time the launch site is in this plane, waiting in an intermediate orbit for the desired relative positions of the two vehicles and then performing a planar transfer.

The general assumptions made are that the orbits are ellipses perturbed by earth oblateness, that burns are impulsive, and that no perturbations occur due to other forces. When more detailed planning is done, these effects will have to be included, particularly that of atmospheric drag at low altitudes.

The procedure is outlined in sequential steps, working from the known to the unknown.

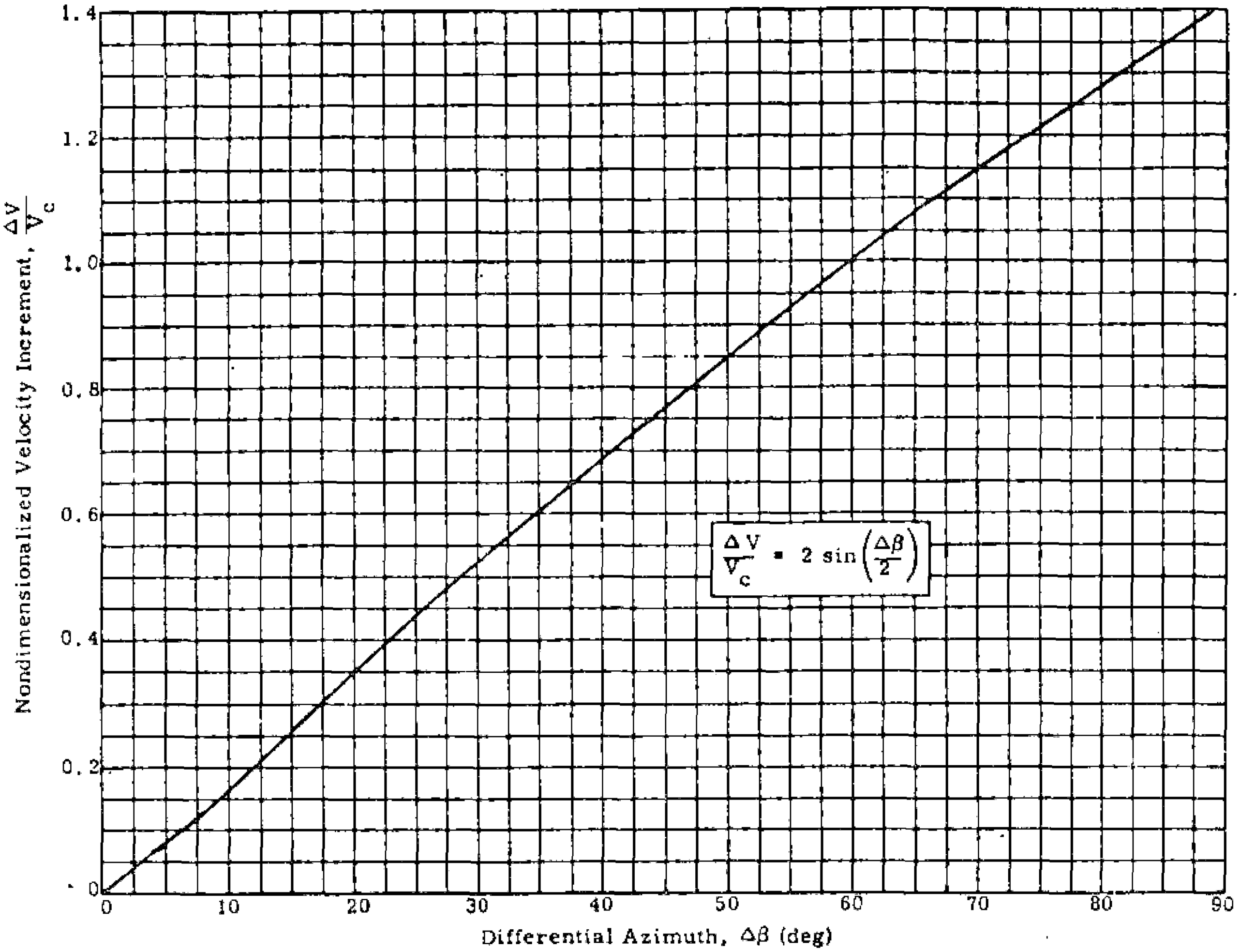


FIGURE 2-1 NONDIMENSIONALIZED IMPULSIVE VELOCITY REQUIRED TO ROTATE A SATELLITE'S ORBITAL PLANE

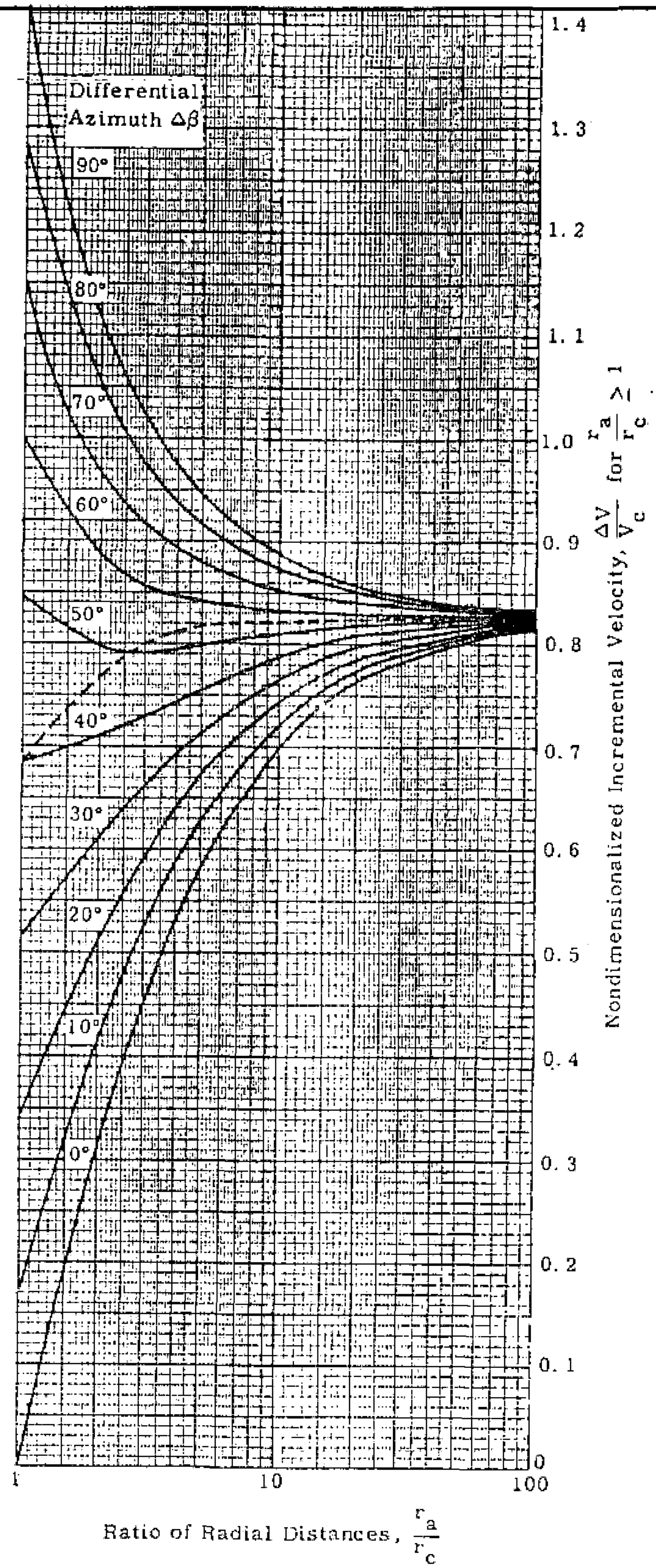


FIGURE 2-2 NONDIMENSIONALIZED IMPULSIVE VELOCITY REQUIRED TO TRANSFER TO A NEW ALTITUDE, ROTATE THE ORBITAL PLANE AND RECIRCULARIZE

TABLE 2-1 CIRCULAR ORBITAL SPEEDS AT VARIOUS ALTITUDES

ALTITUDE (km) h	CIRCULAR SPEED (m/s) $V_c = \sqrt{\mu/r}$	CHANGE IN INCLINATION WITH ΔV = 2500 m/s
300	7726	18.6
400	7668	18.8
500	7613	18.9
600	7558	19.0
700	7504	19.2
800	7452	19.3
900	7400	19.4
1000	7350	19.6
2000	6898	20.9
3000	6519	22.1
4000	6197	23.3
5000	5919	24.4
6000	5675	25.5
7000	5458	26.5
8000	5265	27.5
9000	5091	28.4
10000	4933	29.4
20000	3887	37.5
30000	3310	44.4
36000	3067	48.1
40000	2932	50.5

2.1 Overview (Continued)

(a) Determine parameters of the target orbit.

(b) Assume a rendezvous point.

(c) Predict the transfer orbit parameters

(d) Establish the position of the target satellite at the time of launch measured from perigee in the final orbit.

(e) Establish the time when the launch site crosses the orbital plane measured from the vernal equinox direction in the equatorial plane.

(f) Match the time of launch with the time the launch site crosses the orbital plane.

(g) Iterate on the altitude of the waiting orbit.

(h) Solve for the positions of each maneuver and the launch azimuth.

2.2 Determine Parameters of the Target Orbit

It is assumed that good tracking and orbit determination methods are available, and that these may be used to establish the target or final orbit parameters. These include the perigee radius (r_{pf}), the apogee radius (r_{af}), the inclination (i_f), the argument of perigee (ω_f) and the right ascension of the ascending node (Ω), with the subscript f indicating the final orbit.

2.3 Assume a Rendezvous Point

This rendezvous point will be reached via some type of transfer orbit from some chosen waiting orbit. Figure 2-3 shows a fully arbitratry transfer orbit, and will be used to identify the parameters of the three orbits leading to rendezvous. For generality, the point of injection into the final orbit is taken at the point of intersection of the transfer and final orbits. A transfer orbit may be chosen such that injection into the final orbit occurs at the apogee of the transfer orbit or at the point of tangency of the two orbits.

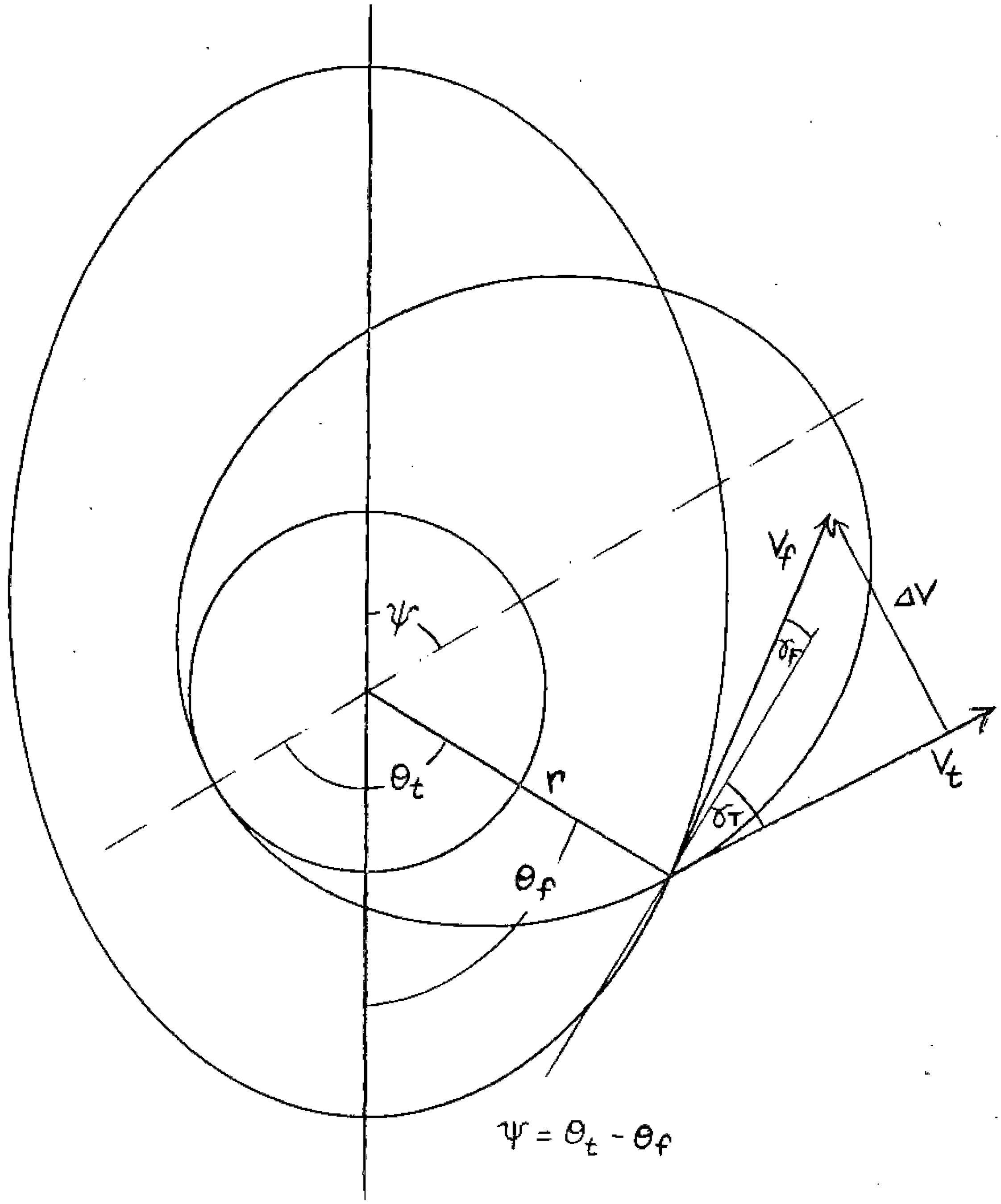


FIGURE 2-3 ARBITRARY TRANSFER FOR RENDEZVOUS

2.3 Assume a Rendezvous Point (Continued)

The angle between the lines of apsides of the transfer and final orbits is labelled ψ and must be specified for each mission. This constitutes selecting the position of the perigee of the transfer orbit, which is the point of injection into the transfer orbit. This position may be constrained for reasons of visibility of the satellite by a ground station, for ability of the control center to command the maneuver or for any other geographic restriction.

The intermediate or waiting orbit, subscripted w, is assumed to be circular. Its inclination is that of the final orbit due to launch into the plane of motion of the target satellite. The altitude of the waiting orbit is the primary trade parameter. An initial value is selected arbitrarily and is later iterated upon. Launch vehicle data is used to determine the time of ascent to this orbit (t_{ascent}) and the ground range (x) attained in ascent to the waiting orbit over a non-rotating earth. Typical trajectories for an Ariane launch are shown in Figures 2-4 and 2-5.

2.4 Predict the Transfer Orbit Parameters

The elements of the transfer orbit are predicted from the final orbit parameters. Since tracking is required to determine both orbits, it is assumed that good data is available on the target orbit and that the actual transfer orbit is very close to the predicted transfer orbit.

Transfer orbit elements are calculated from the point of intersection with the final orbit. The true anomalies, θ_t and θ_f, are set to establish the positions of the two vehicles at the radius of intersection, r. They are related by $\theta_t = \theta_f + \psi$, and θ_t may be expressed as a function of the angle ψ, which is known (chosen).

The radius of intersection is calculated by equating the orbital radii at this point.

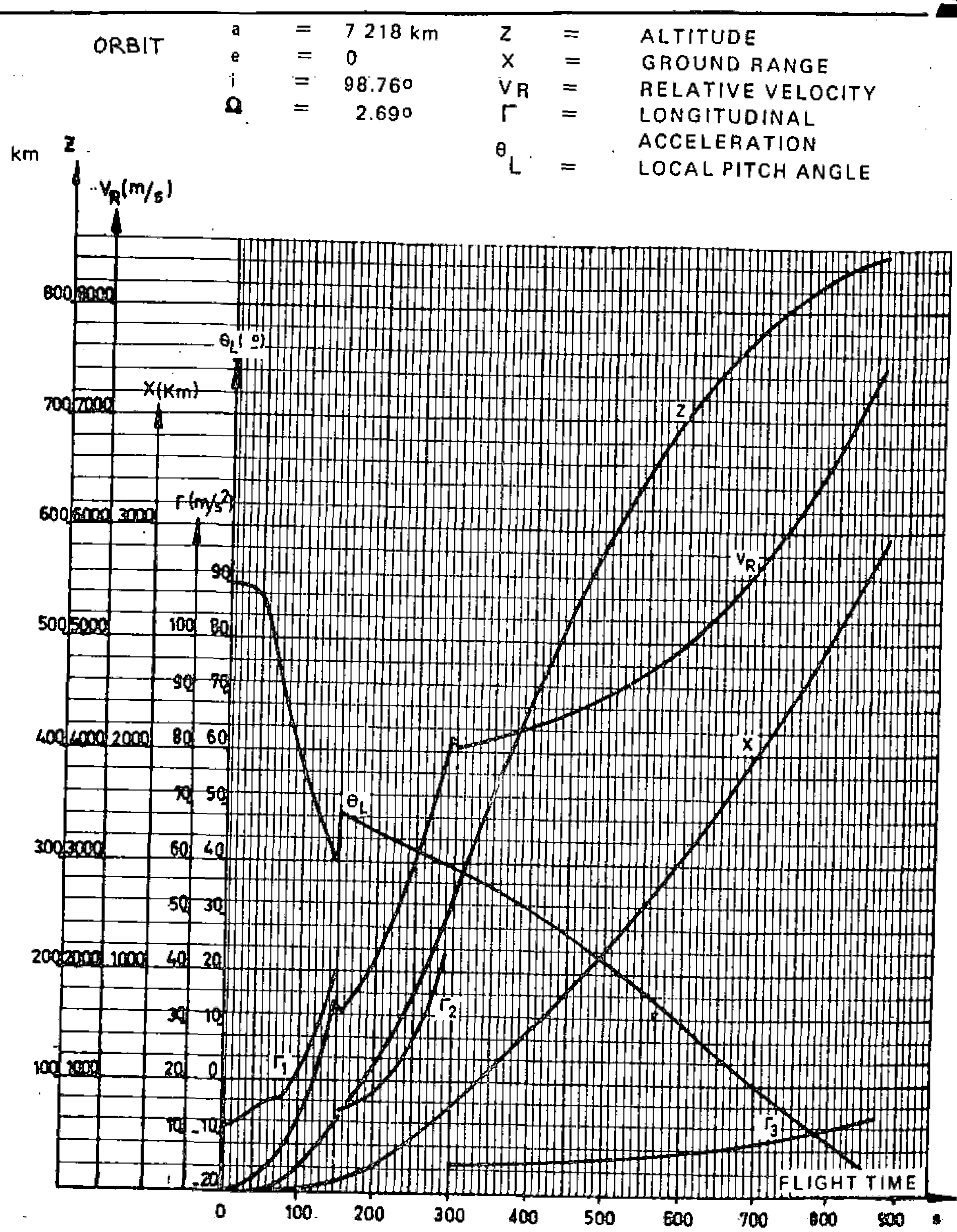


FIGURE 2-4 LAUNCH VEHICLE DATA
TYPICAL TRAJECTORY-SUNSYNCHRONOUS MISSION

ORBIT

a	=	24 371 km	Z	=	ALTITUDE
e	=	0.73	X	=	GROUND RANGE
i	=	9.65°	V_R	=	RELATIVE VELOCITY
ω	=	180°	Γ	=	LONGITUDINAL ACCELERATION
Ω	=	−144.6°	θ_L	=	LOCAL PITCH ANGLE
Z_a	=	35 786 km			
Z_p	=	200 km			

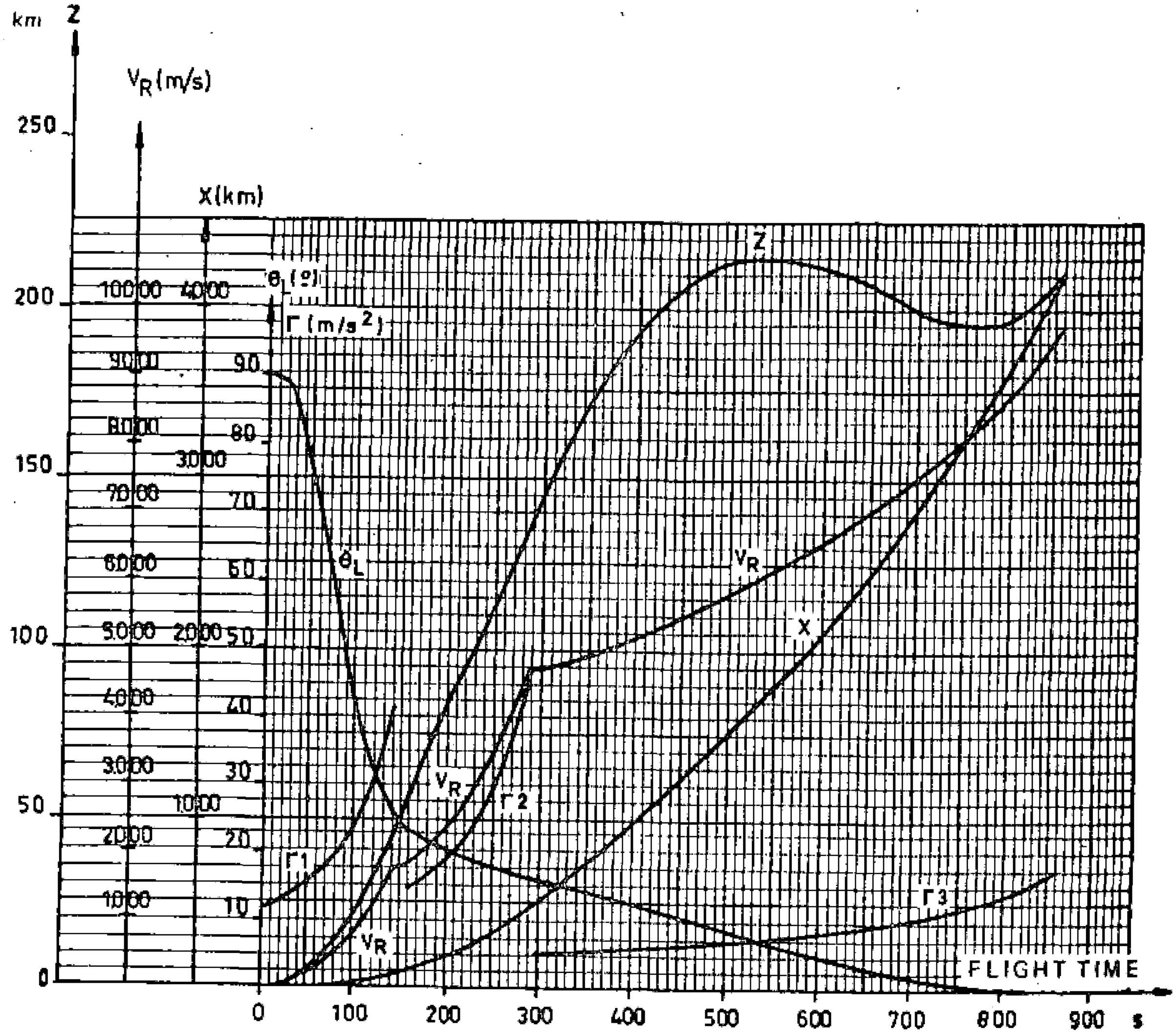


FIGURE 2-5 LAUNCH VEHICLE DATA
TYPICAL TRAJECTORY - GEOSTATIONARY MISSION

Predict the Transfer Orbit Parameters (Continued)

2.4 For any ellipse,

$$r = P/(1 + e \cos \theta)$$

$$\rho = a(1-e^2) = \frac{2r_a r_p}{r_a + r_p}$$

$$2a = r_a + r_p$$

$$e = \frac{r_a - r_p}{r_a + r_p}$$

$$\tau = 2\pi \sqrt{\frac{a^3}{\mu}}$$

Equating the radii at the point of intersection,

$$r = \frac{P_t}{1+e_t \cos \theta_t} = \frac{P_f}{1+e_f \cos \theta_f} = \frac{P_f}{1+e_f \cos(\theta_t-\Psi)}$$

$$P_f (1+e_t \cos \theta_t) = P_t [1+e_f \cos(\theta_t-\Psi)]$$

$$P_f e_t \cos \theta_t = P_t [1+e_f (\cos \theta_t \cos \Psi + \sin \theta_t \sin \Psi)] - P_f$$

$$\cos \theta_t [P_f e_t - P_t e_f \cos \Psi] - \sin \theta_t [P_t e_f \sin \Psi] = P_t - P_f$$

$$A \cos \theta_t - B \sin \theta_t - C = 0$$

$$A \cos \theta_t - C = B \sqrt{1-\cos^2 \theta_t}$$

2.4 Predict the Transfer Orbit Parameters (Continued)

$$A^2 \cos^2 \theta_t + C^2 - 2AC \cos \theta_t = B^2(1 - \cos^2 \theta_t)$$

$$(A^2 + B^2) \cos^2 \theta_t - 2AC \cos \theta_t + C^2 - B^2 = 0$$

$$\cos \theta_t = \frac{2AC \pm \sqrt{4A^2C^2 - 4(C^2 - B^2)}}{2(A^2+B^2)}$$

$$\cos \theta_t = \frac{AC \pm \sqrt{A^2C^2 - C^2 + B^2}}{A^2 + B^2} ; \quad \begin{aligned} A &= P_f e_t - P_t e_f \cos \Psi \\ B &= P_t e_f \sin \Psi \\ C &= P_t - P_f \end{aligned}$$

The elements of the final orbit are known, and the radius of perigee of the transfer orbit is set equal to the semi-major axis of the circular waiting orbit.

$$r_{pt} = a_w$$

This allows solving for the radius of apogee of the transfer orbit and the radius of intersection.

$$\frac{r_{at}\, r_{pt}}{r_{at} + r_{pt}} \left[1 + \frac{r_{af} - r_{pf}}{r_{af} + r_{pf}} \cos(\theta_t - \Psi) \right]$$

$$= \frac{r_{af}\, r_{pf}}{r_{af} + r_{pf}} \left[1 + \frac{r_{at} - r_{pt}}{r_{at} + r_{pt}} \cos(\theta_t) \right]$$

$$\frac{r_{af} + r_{pf}}{r_{af}\, r_{pf}} \left[1 + \frac{r_{af} - r_{pf}}{r_{af} + r_{pf}} \cos(\theta_t - \Psi) \right]$$

$$= \frac{r_{at} + r_{pt}}{r_{at}\, r_{pt}} \left[1 + \frac{r_{at} - r_{pt}}{r_{at} + r_{pt}} \cos(\theta_t) \right]$$

2.4 Predict the Transfer Orbit Parameters (Continued)

$$\frac{1}{r_{af}} + \frac{1}{r_{pf}} + \frac{r_{af} - r_{pf}}{r_{af}\, r_{pf}} \cos(\theta_t - \Psi)$$

$$= \frac{1}{r_{pt}} + \frac{1}{r_{at}} + \frac{r_{at} - r_{pt}}{r_{at}\, r_{pt}} \cos \theta_t$$

$$\frac{r_{af}}{r_{pf}} + 1 + \frac{r_{af} - r_{pf}}{r_{pf}} \cos(\theta_t - \Psi)$$

$$= \frac{r_{af}}{r_{pt}} + \frac{r_{af}}{r_{at}} + \frac{r_{af}(r_{at} - r_{pt})}{r_{at}\, r_{pt}} \cos \theta_t$$

$$\boxed{\left(\frac{r_{af}}{r_{pf}} + 1\right) + \left(\frac{r_{af}}{r_{pf}} - 1\right) \cos(\theta_t - \Psi) = \frac{r_{af}}{r_{at}} \left[\left(\frac{r_{at}}{r_{pt}} + 1\right) + \left(\frac{r_{at}}{r_{pt}} - 1\right) \cos \theta_t\right]}$$

Also,

$$\frac{2 r_{at}\, r_{pt}}{r_{at} + r_{pt}} = r \left[1 + \frac{r_{at} - r_{pt}}{r_{at} + r_{pt}} \cos \theta_t\right]$$

$$\frac{2 r_{at}\, r_{pt}}{r} = r_{at} + r_{pt} + (r_{at} - r_{pt}) \cos \theta_t$$

2.4 Predict the Transfer Orbit Parameters (Continued)

$$\frac{2r_{at}}{r} = \left(\frac{r_{at}}{r_{pt}} + 1\right) + \left(\frac{r_{at}}{r_{pt}} - 1\right) \cos \theta_t$$

Similarly,

$$\frac{2r_{af}\, r_{pf}}{r_{af}+r_{pf}} = r \left[1 + \frac{r_{af}-r_{pf}}{r_{af}+r_{pf}} \cos \theta_f\right]$$

$$\frac{2r_{af}}{r} = \left(\frac{r_{af}}{r_{pf}} + 1\right) + \left(\frac{r_{af}}{r_{pf}} - 1\right) \cos \theta_f$$

The solutions for the apogee radius of the transfer orbit and the radius of intersection are simplified if a transfer orbit is selected such that injection into the final orbit occurs at the point of tangency of the two orbits. At tangency, the flight path angles (γ) must be equal.

For any orbit,

$$\cos \gamma = \sqrt{\frac{r_a\, r_p}{r(r_a+r_p-r)}}$$

At tangency,

$$\frac{r_{af}\, r_{pf}}{r_{af} + r_{pf} - r_{tan}} = \frac{r_{at}\, r_{pt}}{r_{at} + r_{pt} - r_{tan}}$$

$$r_{tan} = \frac{r_{af}\left(\frac{r_{at}}{r_{pt}} + 1\right) - r_{at}\left(\frac{r_{af}}{r_{pf}} + 1\right)}{\frac{r_{af}}{r_{pt}} - \frac{r_{at}}{r_{pf}}}$$

2.5 Establish Position of Target at Time of Launch

The time of launch must be coordinated with the position of the target satellite in its orbit at the launch time. This is obtained by working backwards from the rendezvous point and equating the times for both vehicles to reach this point. These times are measured in the final orbit relative to perigee.

The time for the homing satellite to reach the rendezvous point is the sum of the time in the transfer orbit (t_t), the time in the waiting orbit (t_w) and the time of ascent to the waiting orbit (t_{ascent}).

The time for the target satellite to reach the rendezvous point is divided into the time before perigee crossing (t_{1f}) and the time following perigee crossing (t_{2f}). Since time is measured from perigee, t_{1f} has a negative value, and the target time is $t_{2f} - t_{1f}$. Equating the times of the two vehicles gives

$$t_{1f} = t_{2f} - t_t - t_w - t_{ascent} \quad \text{(Eqn. 2.5-1)}$$

Launch vehicle data gives t_{ascent} for the chosen altitude of the waiting orbit. Time in the waiting orbit,

$$t_w = n\ \tau_w \left(1 + \frac{\Delta\tau}{\tau}\right) \quad (2.5\text{-}2)$$

where

n is the integer number of revolutions in the waiting orbit, and
τ_w is the period of this orbit.
$\Delta\tau$ is the oblateness correction to the orbital period.

Roth gives this correction as

$$\Delta\tau = \frac{3\pi\ J_2 R_e^{\,2}}{a^2(1-e)^3} \sqrt{\frac{a^3}{\mu}}\ (3\ \sin^2\omega\ \sin^2 i - 1) \quad (2.5\text{-}3)$$

2.5 Establish Position of Target at Time of Launch (Continued)

Time in the transfer orbit is given by Kepler's equation,

$$M = n(t-T) = E - e \sin E \qquad (2.5\text{-}4)$$

$M \equiv$ mean anomaly

$n \equiv$ mean motion $\equiv \sqrt{\mu/a^3} = 2\pi/\tau$

$T =$ time of periapsis passage

$$\cos E = \frac{e + \cos\theta}{1 + e\cos\theta}$$

Time from periapsis passage

$$\equiv t - T = \frac{\tau}{2\pi}(E - e\sin E)$$

$$t_t = \frac{\tau_t}{2\pi}(E_t - e_t \sin E_t), \text{ with} \qquad (2.5\text{-}5)$$

$$E_t = \cos^{-1}\left[\frac{e_t + \cos\theta_t}{1 + e_t\cos\theta_t}\right]$$

Adding the correction for oblateness,

$$t_t = t_t + \Delta\tau_t\left(\frac{\theta_t}{360°}\right) \qquad (2.5\text{-}6)$$

2.5 Establish Position of Target at Time of Launch (Continued)

The time from perigee to the intercept point is obtained from

$$t_{2f} = \frac{\tau_f}{2\pi} [E_{2f} - e_f \sin E_{2f}] \qquad (2.5\text{-}7)$$

$$E_{2f} = \cos^{-1} \left[\frac{e_f + \cos \theta_{2f}}{I + e_f \cos \theta_{2f}} \right]$$

$$= 2 \tan^{-1} \left[\sqrt{\frac{r_{pf}}{r_{af}}} \tan \frac{\theta_{2f}}{2} \right] \qquad (2.5\text{-}8)$$

$$\theta_{2f} = \theta_t - \Psi$$

Adding the correction for oblateness,

$$t_{2f} = t_{2f} + \Delta \tau_f \left(\frac{\theta_f}{360°} \right) \qquad (2.5\text{-}9)$$

Substituting these values into equation 2.5-1 gives t_{1f} or the time before perigee in the final orbit at the time of launch. This time is used to obtain the initial position of the target at the time of launch, θ_{1f}.

$$\theta_{1f} = 2 \tan^{-1} \left[\sqrt{\frac{r_{af}}{r_{pf}}} \tan \frac{E_{1f}}{2} \right] \qquad (2.5\text{-}10)$$

$$E_{1f} - e_f \sin E_{1f} = M_{1f} = \frac{2\pi}{\tau_f} t_{1f} \qquad (2.5\text{-}11)$$

2.5 Establish Position of Target at Time of Launch (Continued)

This may be solved using Newtonian iteration:

$$f(E_k) = E_k - e \sin E_k - M_1 = 0$$

$$f'(E_k) = 1 - e \cos E_k$$

$$E_{k+1} = E_k - \frac{f(E_k)}{f'(E_k)} = E_k - \frac{E_k - e \sin E_k - M_1}{1 - e \cos E_k}$$

$$E_{k+1} = \frac{e \left[\sin E_k - E_k \cos E_k \right] + M_1}{1 - e \cos E_k}$$

The first estimate of E_k may be obtained by dividing Kepler's equation into two terms.

$$M = E - e \sin E \rightarrow \sin E = \frac{1}{e} (E-M)$$

The intersection of the two lines $y = \sin E$ and $y = \frac{1}{e}(E-M)$ gives a good first estimate which results in rapid convergence. (The eccentricity of the final orbit is known.) This graphical solution is given in Figure 2-6 from the Handbook.

After convergence, this value is used in Equation 2.5-10 to give the initial position of the target satellite. The position of the target, θ_{1f}, and the corresponding time of launch measured from perigee in the final orbit, t_{1f}, are thereby established.

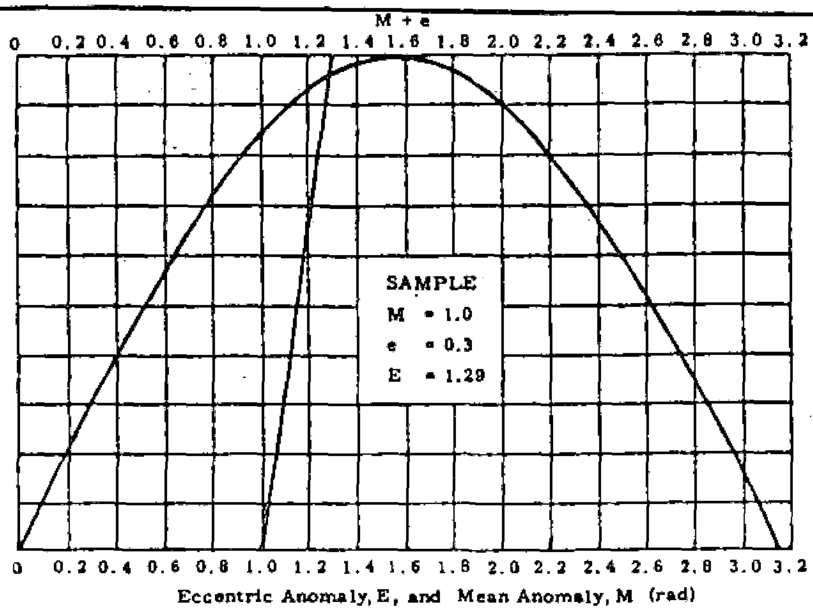
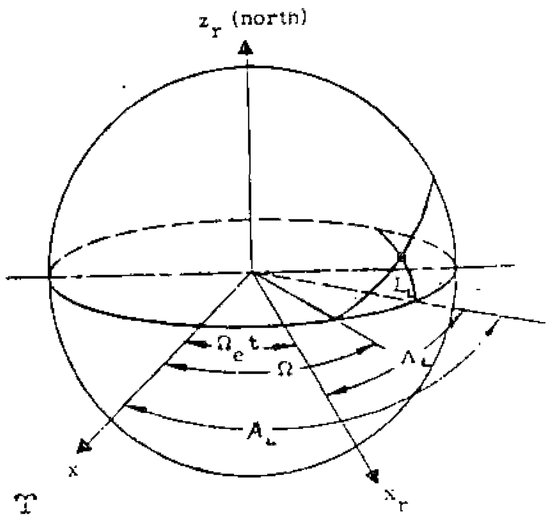


FIGURE 2.6 GRAPHICAL SOLUTION TO KEPLERS EQUATION FOR E(M,e)

2.6 Establish Time the Launch Site Crosses the Orbital Plane

It is assumed that a particular launch site and launch vehicle have been selected. Figure 2-7 illustrates the parameters to be considered in determining the time of launch relative to the reference direction in the equatorial plane. Those parameters relating only to the launch site are shown separately below.



The fixed reference (x) is the vernal equinox direction (♈) and the rotating reference (x_r) is the prime meridian through Greenwich.

L_L = geocentric latitude of the launch site.

Λ_L = longitude of the launch site relative to the prime meridian measured positive in the direction of rotation.

A_L = right ascension of the launch site, or longitude of the launch site measured counterclockwise from ♈ when viewed from the north side of the equatorial plane.

Ω_e = rotation rate of the earth = 360.9856122808°/day.

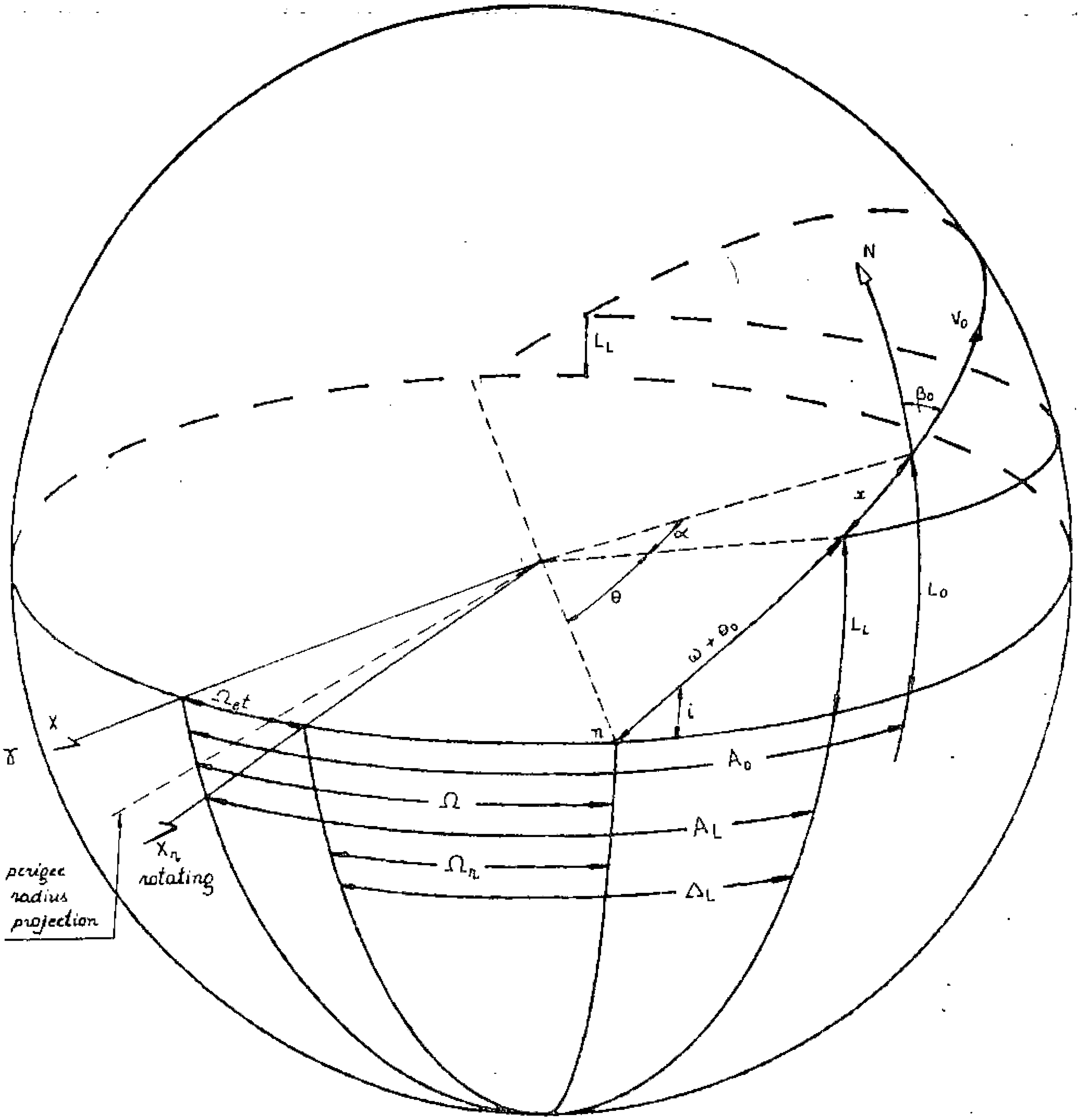


FIGURE 2-7 ORBITAL AND GEOCENTRIC PARAMETERS

2.6 Establish Time the Launch Site Crosses the Orbital Plane (Continued)

$\Omega_e t$ = longitude of the prime meridian relative to T at the time the launch site crosses the orbital plane.

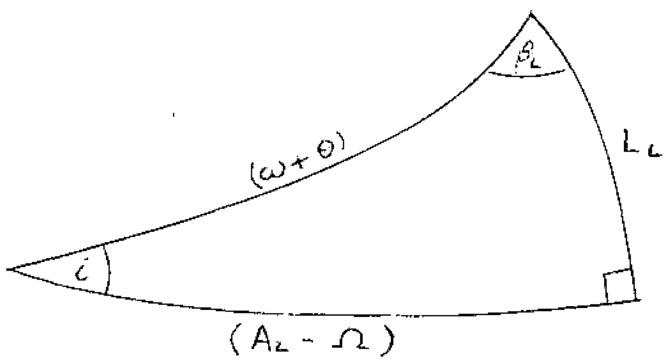
$\Omega_e t = A_L - \Lambda_L$ by inspection.

The geocentric latitude, L, may be obtained from the geodetic latitude, L', by means of

$$\tan L = (1-f)^2 \tan L' \qquad (2\text{-}6\text{-}1)$$

$$f = \frac{1}{298.24}$$

The spherical triangle of interest shows the launch site at the instant of intersection with the plane of motion.



$$\sin(A_L - \Omega) = \tan L_L \tan(90-i) \rightarrow (A_L - \Omega)$$

$$= \sin^{-1}\left(\frac{\tan L_L}{\tan i}\right)$$

(Note that the inclination must be equal to or greater than the latitude for the procedure to work.)

2.6 Establish Time the Launch Site Crosses the Orbital Plane (Continued)

$$\Omega_e \; t_L = A_L - \Lambda_L = (A_L - \Omega) + (\Omega - \Lambda_L)$$

$$t_L = \frac{1}{\Omega_e} \left[\Omega - \Lambda_L + \sin^{-1} \left(\frac{\tan L_L}{\tan i} \right) \right] \text{ for northerly launches}$$

For southward launches

$$\Omega_e \; t_L = \Omega - \Lambda_L + 180° - (A_L - \Omega)$$

and

$$t_L = \frac{1}{\Omega_e} \left[\Omega - \Lambda_L - \sin^{-1} \left(\frac{\tan L_L}{\tan i} \right) + 180° \right]$$

The perturbing influence of the earth's oblateness may be added to this geometric formulation. Secular regression rates in the various orbits are given by:

$$\dot{\Omega} = \frac{-3\pi \, J_2 \cos i}{\left(\frac{a}{R}\right)^2 (1-e^2)^2} \; \frac{\text{rad}}{\text{orbit}}$$

$$= \frac{-540° \, J_2 \cos i}{\left(\frac{a}{R}\right)^2 (1-e^2)^2} \; \frac{\text{deg}}{\text{orbit}} \; ; \; 0° < i < 180° \qquad (2\text{-}6\text{-}2)$$

2.6 Establish Time the Launch Site Crosses the Orbital Plane (Continued)

Including their impact, gives

$$t_L = \frac{1}{\Omega_e}\left[\Omega - \Lambda_L + n\dot{\Omega}_w - \left(\frac{\theta_t}{360°}\right)\dot{\Omega}_t - \left(\frac{\theta_f}{360°}\right)\dot{\Omega}_f \pm \sin^{-1}\left(\frac{\tan L_L}{\tan i}\right) + \delta\, 180°\right]$$

$$\delta = \begin{cases} 0, \text{ Launch North} \\ 1, \text{ Launch South} \end{cases}$$

$$\sin^{-1}\left(\frac{\tan L_L}{\tan i}\right) = \begin{cases} + \text{ North} \\ - \text{ South} \end{cases} \qquad (2\cdot6-3)$$

If small errors in the nodal position are accepted due to fuel available for maneuvering, then it is possible to launch at a time when the launch site is arbitrarily close to the desired plane. This launch time tolerance is given by

$$\Delta t_L = \Delta\Omega / \Omega_e$$

where $\Delta\Omega$ = allowable nodal error.

2.7 Match Launch Time with Time Launch Site Crosses Orbital Plane

The time the launch site crosses the orbital plane t_L given by Equation 2-6-3 is measured from the vernal equinox direction in the equatorial plane. The launch time t_{1f} calculated in section 2.5 gave the time the target satellite must spend in the final orbit prior to the last perigee crossing before rendezvous. To make these times correspond, it is necessary to add the time (t^*) required by the target satellite to travel from the projection of the perigee radius in the equatorial plane to the vernal equinox direction.

$$t_1 = t_{1f} + t^*$$

The times t_L and t_1 are related to a common base and may be equated:

$$t_L = t_1$$

The time t^* is determined from spherical trigonometry.

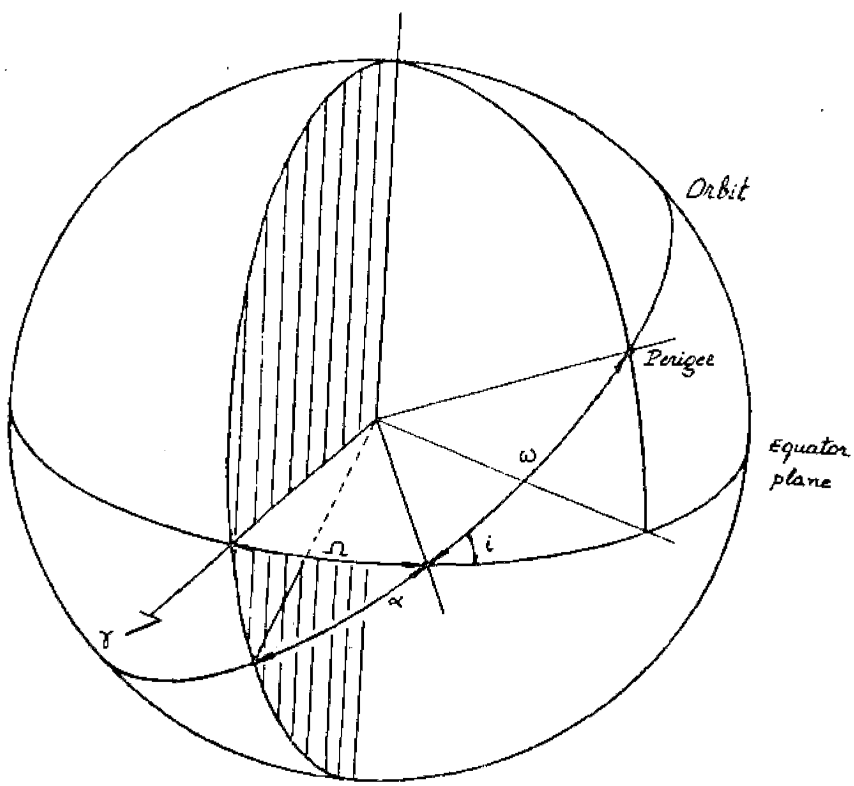


FIGURE 2-8 INTERSECTION OF ORBIT PLANE, EQUATORIAL PLANE AND PLANE OF REFERENCE (EQUINOX) DIRECTION

2.7 Match Launch Time with Time Launch Site Crosses Orbital Plane (Continued)

$$(\Omega - \Lambda_L) = -n \left\{ \Omega_e \tau_w \left(1 + \frac{\Delta\tau}{\tau}\right) + \dot{\Omega}_w \right\}$$

$$+ \Omega_e \left\{ t_{2f} + t^* - t_t - t_{ascent} \right\}$$

$$\mp \sin^{-1}\left(\frac{\tan L_L}{\tan i}\right) - \delta\, 180°$$

$$+ \Omega_e \left\{ \left(\frac{\theta_f}{360°}\right)\left(\Delta\tau_f + \dot{\Omega}_f\right) \right.$$

$$\left. + \left(\frac{\theta_t}{360°}\right)\left(\Delta\tau_t + \dot{\Omega}_t\right) \right\}$$

Once all of the orbital parameters have been established, this equation becomes that of a straight line. Launch sites which satisfy the timing requirements for various values of n may be solved for.

For a given launch site, the number of revolutions is given by:

$$n = \frac{\Omega_e}{\Omega_e \tau_w \left(1 + \frac{\Delta\tau}{\tau}\right) + \dot{\Omega}_w} \left\{ \frac{\tau_f}{360°} [E_{2f} \right.$$

$$- e_f \sin E_{2f}] - \frac{\tau_t}{360°} [E_t - e_t \sin E_t]$$

$$- t_{ascent} + t^* - \frac{1}{\Omega_e} [(\Omega - \Lambda_L)$$

2.7 Match Launch Time with Time Launch Site Crosses Orbital Plane (Continued)

$$- \left(\frac{\theta_t}{360°}\right) \dot{\Omega}_t - \left(\frac{\theta_f}{360°}\right) \dot{\Omega}_f$$

$$\pm \sin^{-1} \left(\frac{\tan L_L}{\tan i}\right) + \delta\, 180° \,]\, \}$$

An estimate of the number of revolutions required for the desired launch site may be obtained by dropping all of the perturbing terms, and assuming circular orbits with transfer by Hohmann ellipse. In this case,

$$n = \frac{t_{2f} + t^* - t_{ascent}}{\tau_w} - \frac{1}{2} \sqrt{\frac{a^3{}_t}{a^3{}_w}}$$

$$- \frac{(\Omega - \Lambda_L) \pm \sin^{-1} \left(\frac{\tan L_L}{\tan i}\right) + \delta\, 180°}{\Omega_e \; \tau_w}$$

2.8 Iterate on Altitude of Waiting Orbit

The procedure is repeated with new orbital parameters obtained from the new $a_w = r_{pt}$ and the associated t_{ascent}. Eventually, the parameters which meet the timing and geographic requirements will be found.

2.9 Solve for Maneuver Positions and Launch Azimuth

These positions are references to geocentric equatorial coordinates as used in Figure 2-7.

Latitudes and longitudes are obtained simply by spherical trigonometry.

(a) Injection into Final Orbit

As given by the Handbook, "the angle from the ascending node to the radius at which transfer into the final orbit occurs (projected along the equator of a non-rotating earth) is

2.9 Solve for Maneuver Positions and Launch Azimuth (Continued)

$A_S - \Omega = \tan^{-1} [\cos i_t \tan(\omega_t + \theta_t)]$"

A_S = right ascension of the satellite at the point of injection into the final orbit.

L_S = latitude of the point of injection

$L_S = \sin^{-1} (\sin i_t \sin (\omega_t + \theta_t))$

(b) Injection Into Transfer Orbit

(Assuming injection occurs at perigee of transfer orbit)

$A_p - \Omega = \tan^{-1} [\cos i_t \tan \omega_t]$

$L_p = \sin^{-1} [\sin i_t \sin \omega_t]$

($\theta_t = 0$ at perigee)

(c) Injection Into Intermediate Orbit

$A_{BO} - \Omega = \tan^{-1} [\cos i_t \tan(\omega_t - \phi)]$

$L_{BO} = \sin^{-1} [\sin i_t \sin(\omega_t - \phi)]$

ϕ = central angle in waiting orbit, $\phi = \omega + \theta$.

(d) Position of Launch Site

$$A_L - \Omega = \tan^{-1} [\cos i_t \tan(\omega_t + \phi - \frac{x}{Re})]$$

$$L_L = \sin^{-1} [\sin i_t \sin (\omega_t - \phi - \frac{x}{Re})]$$

x = ground range attained in ascent to the waiting orbit over a non-rotating earth and is obtained from the launch vehicle data.

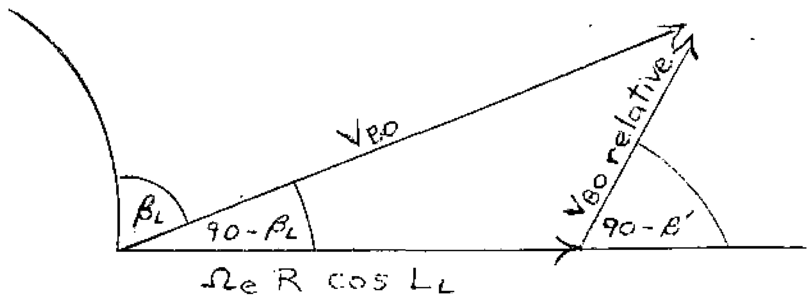
(e) Launch Azimuth

From spherical trigonometry, the uncorrected launch azimuth is given by:

2.9 Solve for Maneuver Positions and Launch Azimuth (Continued)

$\beta_L = \sin^{-1} [\cos i_t / \cos L_L]$

An additional component is produced by the earth's rotation which is approximately 465 cos L_L mps.



$$V_{BO}^2 \text{relative} = V_{BO}^2 + (\Omega_e R \cos L_L)^2 - 2 V_{BO} \Omega_e R \cos L_L \cos (90 - \beta_L)$$

$$\cos (90° - \beta_L) = \sin \beta_L = \frac{\cos i_t}{\cos L_L}$$

$$V_{BO}^2 \text{rel} = V_{BO}^2 (\Omega_e R_e \cos L_L)^2 - 2 V_{BO} \Omega_e R \cos i$$

$$\frac{V_{BO}}{\sin (90° + \beta^1)} = \frac{V_{BO} \text{ rel}}{\sin (90° - \beta_L)}$$

$$\frac{V_{BO}}{\cos \beta^1} = \frac{V_{BO}\text{rel}}{\cos \beta_L}$$

$$\cos \beta^1 = \frac{V_{BO}}{V_{BO} \text{ rel}} \cos \beta_L$$

B^1 = azimuth in which the vehicle must be fired.

Assumption: distance and time spent during ascent to the point of burnout are small.

3.0 SAMPLE CASE

As illustration for the rendezvous procedure, a launch from Kourou on Ariane is used to rendezvous with a low earth orbiting satellite. This launch site is at 5.24°N latitude, 52.77° W longitude, and requires launch in the north direction.

3.1 Determine Parameters of the Target Orbit

For illustration, the orbital parameters of a known satellite are used. This satellite is in a near polar circular orbit of radius 7385 km and inclination 99.52°. The nodal period is 6312 seconds and at epoch 90:12:21/16:41:23 the right ascension of the ascending node is 55.6°. Perigee is defined to be at the node.

$r_{af} = r_{pf} = a_f = P_f = 7385$ km (as $e = 0$)
$\tau_f = 6312$ sec.
$i_f = 99.52°$
$\omega_f = 0$
$\Omega = 55.6°$ at epoch

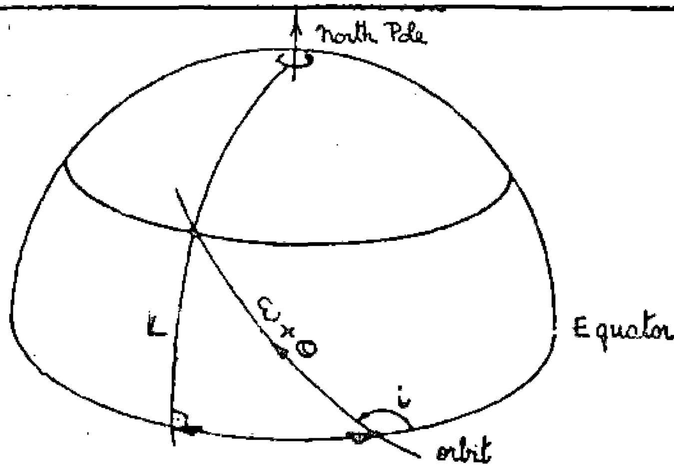
3.2 Assume a Rendezvous Point

This calls for selecting some parameters of the waiting and transfer orbits. The scheme of launching into the plane of motion of the target at the time the launch site is in this plane assures that the three orbits are coplanar : inclinations and nodes are equivalent for the three orbits. For rendezvous to occur the central angles of the final and transfer orbits must be equal at the rendezvous point : $\omega_f + \theta_f = \omega_t + \theta_t$. (See figure 2-3)

For simplicity assume that rendezvous occurs at tangency of the transfer and final orbits. (Any point could be selected) For visibility during a critical maneuver assume that this interception occurs at the latitude of the launch site. (Any such constraint could be selected.)

$L_R = L_L = 5.24°$N geodetic $= 5.205°$ geocentric

The central angle $\theta_f + \omega_f$ may now be obtained from the spherical triangle below showing the retrograde target orbit.



$\sin(\omega + \Theta) = \frac{\sin L}{\sin(180 - i)}$

$\sin(\omega_f + \Theta_f) = \frac{\sin 5.205}{\sin 80.48}$

$= 5.28$

Since $\omega_f = 0$, $\Theta_f = 5.28$

Note that Θ_f is measured from perigee of the final orbit to the rendezvous point.

An arbitrary altitude upon which to iterate is then selected for the waiting orbit. Launch vehicle data are used to obtain corresponding time of ascent and ground range. Ariane data are taken from figure 2-4:

h	(km)	400	600	850
t_{ascent}	(sec)	370	500	850
x	(km)	600	1100	2800

For the initial iteration $a_w = 600 + 6378 = 6978$ km is selected. The waiting orbit parameters are then:

$a_w = 6978$ km
$\tau_w = 5801$ sec
$i_w = 99.52^\circ = i_f$
$e_w = 0$

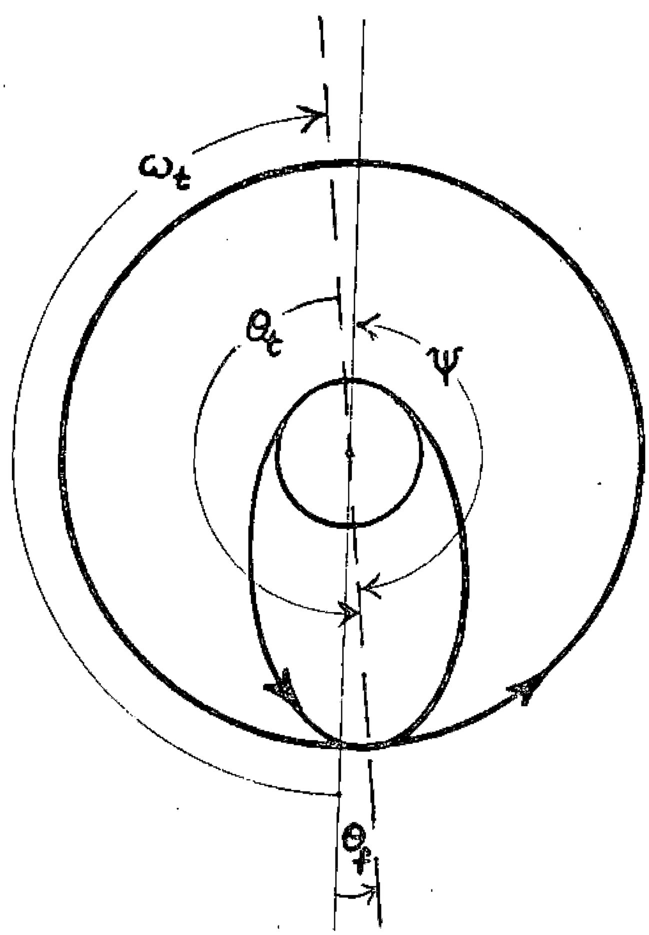
3.3 Predict the Transfer Orbit Parameters

As the transfer is between circular orbits and interception is to occur at tangency, the transfer orbit is Hohmann.
The radius of perigee of the transfer orbit will be equal to the semi-major axis of the circular waiting orbit and the radius of apogee will be equal to the semi-major axis of the circular target orbit. Since the transfer is between circular orbits and the point of rendezvous is at tangency of the transfer and final orbits, then $\Theta_t = 180^\circ$ and the time for the transfer will simply be half the transfer orbit period. (For other orbits these parameters would be calculated.)

The transfer orbit parameters are thereby predicted to be:

r_{pt}	= 6978 km	$= a_w$
r_{at}	= 7385 km	$= a_f$
a_t	= 7181.5 km	$= (r_{at} + r_{pt})/2$
e_t	= 0.0283	$= (r_{at} - r_{pt})/(r_{at} + r_{pt})$
i_t	= 99.52	$= i_f$
τ_t	= 6057 sec	$= 2\pi(a_t^3/\mu)^{1/2}$
θ_t	= 180°	
ω_t	= - 174.72°	= 5.28° - 180°
t_t	= 3028.5 sec	$= \tau_t/2$

The relations between the three orbits are illustrated schematically below.



3.4 Establish Position of Target at Time of Launch

As given in Section 2.5, $t_{if} = t_{2f} - t_c - t_w - t_{ascent}$ .Since the final orbit is circular, $e_f = 0$ and the eccentric anomaly equals the true anomaly ($E_{2f} = \theta_{2f} = 5.28°$). Therefore t_{2f} is simply $\tau_f(5.28)/360 = 92.58$ sec. Time in the transfer orbit has been determined to be 3028.5 seconds. Time in the waiting orbit may be taken as the number of revolutions in this orbit multiplied by its period, as the oblateness correction is very small. The time of ascent to 600 km for Ariane is 500 sec.

$$t_{if} = 92.58 - 3028.5 - 5801\ n - 500$$
$$t_{if} = -5801\ n - 3435.92$$
$$\theta_{if} = E_{if} = 360(t_{if}/\tau_f) \text{ as } e_f = 0.$$

The position of the target at the time of launch is established as a function of the number (n) of revolutions in the phasing orbit.

$$\theta_{if} = 360(-5801\ n - 3435.92)/6312$$

3.5 Establish Time Launch Site Crosses Orbital Plane

For this sample case the oblateness corrections are taken as negligible. For the northerly launch from Kourou,

$$t_L = (1/\Omega_e)[\Omega - \Lambda_L + \sin^{-1}(\tan L_L/\tan(180 - i))]$$
$$t_L = (1/\Omega_e)[\Omega - \Lambda_L + 0.88]$$
$$\Omega_e = 4.1781\ E-3$$
$$\Lambda_L = 307.23$$

3.6 Match Launch Time with Time Launch Site Crosses Orbital Plane

As developed in Section 2.7 this comprises setting $t_1 = t_L$.

$$t_1 = t_{if} + t^* = -5801\ n - 3435.92 + t^* = t_L$$

The time t^* for the satellite to travel from the projection of the perigee radius in the equatorial plane to the vernal equinox direction is also a function of the right ascension of the ascending node.

$$t^* = \frac{\tau_f}{360}\tan^{-1}(\tan\Omega/|\cos i|)$$

$$-5801\ n - 3435.92 + \frac{\tau_f}{360}\tan^{-1}(\tan\Omega/|\cos i|) = \frac{1}{\Omega_e}(\Omega - 306.35)$$

$$\Omega - \Omega_e\frac{\tau_f}{360}\tan^{-1}(\tan\Omega/|\cos i|) = \Omega_e(-5801\ n - 3435.92) + 306.35$$

This may be solved iteratively simply by the x = g(x) method.

$$\Omega = \tan^{-1}\frac{(6.04625\ \tan\Omega)}{13.65} - 24.2372\ n + 292$$

For each integer n a particular value of Ω results. Figure 3-1 gives some solutions for this sample case. Only the values corresponding to integer n are actual solutions.

The constraints applied to this sample problem dictate that the node of the target orbit must be 306.35° East of Greenwich for the orbit in which rendezvous will occur. $\Omega_r = -53.65°$.
As shown in Figure 2-7,
$A_L - \Omega = \Delta_L - \Omega_r$ or $\Omega_r = \Delta_L - (A_L - \Omega)$
$= 307.23° - 0.88° = 306.35°$
From the Radarsat Timeline, node number 156 is at - 53.13° at 271.07 hours MET, and will repeat every 219 orbits, or about 384 hours. At the first node (at epoch), Ω = 55.6°, and node 156 is 273.52 hours later. Adding this to the epoch 90:12:21/16:41:23 yields 91:01:02/02:12:35. For this epoch, Θ_g = 134.36° (Aries to Greenwich). This requires Ω = 80.7°. Nine revolutions in the phasing orbit correlates with Ω = 80.34° which is close enough for this exercise.

The position of the target at the time of launch (3.4) was established as a function of n. With n = 9, Θ_{IF} = -3173.63 and t_{IF} = - 55,644.4 sec. These values lead to
t_L = - 54094 sec. t* = 1549.7 sec. (t_I = - 54094 as it should.)

These negative times imply launch is prior to the beginning of the time record, which starts at 91:01:02/02:12:35. Counting backwards 54,094 seconds from epoch gives
t_L = 91:01:01/11:11:01
The position of the target is 3173.63° before perigee, which is 8 orbits and 293.63° before perigee of the rendezvous orbit.

3.7 Iterate on Altitude of Waiting Orbit

This will not be done for this sample case, but it could yield a shorter time for rendezvous. Finding a node corresponding to a small number of revolutions in the phasing orbit was serendipitous in this example.

3.8 Solve for Maneuver Positions and Launch Azimuth

Due to the simplifying assumptions made in this example the maneuver positions are apparent. Injection into the final orbit occurs at the latitude of the launch site. (L = 5.24°N) Injection into the transfer orbit is at 5.24° S. The uncorrected launch azimuth is 9.56°.

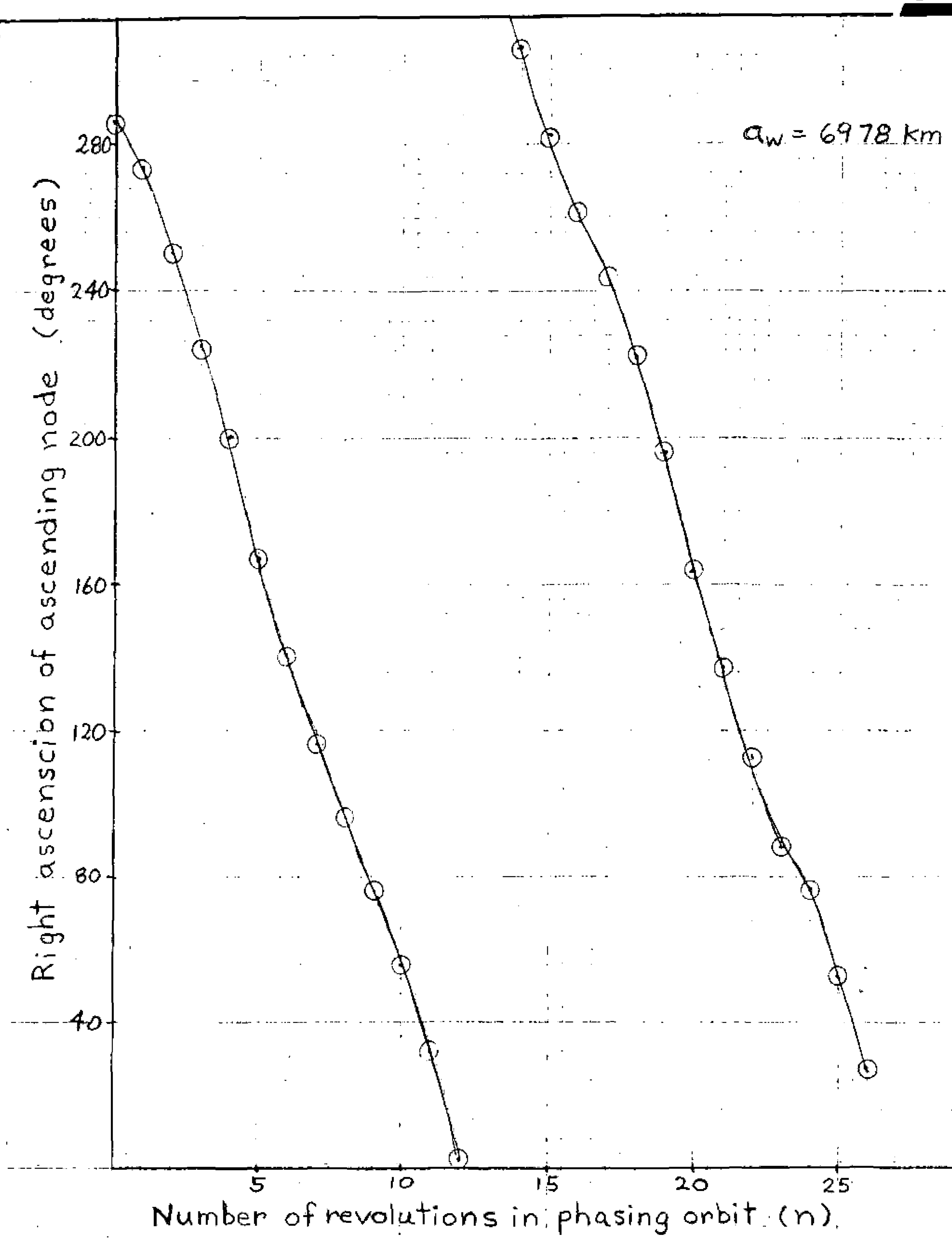


Figure 3-1 ASCENDING NODE AS FUNCTION OF TIME IN PHASING ORBIT

4.0 SUMMARY

Ground station controlled maneuvers may be used to bring a satellite into acquisition range for rendezvous. The procedure involved rests on careful timing of all events.

To avoid excessive fuel costs imposed by planar changes launch is planned for the time the launch site crosses the target orbital plane. A phasing orbit is used to establish the necessary relative positions of the two satellites. A planar transfer is then made to reach the intercept point.

The timing of all maneuvers is critical to this procedure. Any deviation from the time of launch results in fuel costs for adjustments. A missed launch time would require waiting for the repetition cycle of the target orbit to repeat, or in redesign of the rendezvous procedure.

The procedure allows selection of the point of rendezvous and incorporation of geographic constraints. Parameters which are adjusted to meet the conditions for rendezvous are those of the phasing orbit. Due to the timing restrictions only a few solutions are available for any given launch site.

B2.0 DERIVATION OF $\frac{\partial(\Delta V_a)}{\partial a}$ FOR CIRCULAR ORBITS

Hohmann transfer delta-V is given by

$$\Delta V_a = \sqrt{\frac{\mu}{a+\Delta a}} - \sqrt{\frac{\mu}{a}} + \sqrt{\frac{\mu}{a+\frac{\Delta a}{2}}}\left(\sqrt{\frac{a+\Delta a}{a}} - \sqrt{\frac{a}{a+\Delta a}}\right) \qquad \text{(B2.1)}$$

Taking Taylor's expansion of $\frac{1}{\sqrt{a+\Delta a}}$ and $\sqrt{a+\Delta a}$

$$\frac{1}{\sqrt{a+\Delta a}} \doteq \frac{1}{\sqrt{a}} - \frac{\Delta a}{2\sqrt{a^3}} \qquad \text{(B2.2)}$$

$$\sqrt{a+\Delta a} \doteq \sqrt{a} + \frac{\Delta a}{2\sqrt{a}} \qquad \text{(B2.3)}$$

Substituting Equations (B.2) and (B.3) into (B.1) gives

$$\frac{\Delta V_a}{\sqrt{\mu}} \doteq \frac{1}{\sqrt{a}} - \frac{\Delta a}{2\sqrt{a^3}} - \frac{1}{\sqrt{a}} + \left(\frac{1}{\sqrt{a}} - \frac{\Delta a}{4\sqrt{a^3}}\right)\left(\frac{\sqrt{a} + \frac{\Delta a}{2\sqrt{a}}}{\sqrt{a}} - \sqrt{a}\left(\frac{1}{\sqrt{a}} - \frac{\Delta a}{2\sqrt{a^3}}\right)\right)$$

Simplifying and setting $\Delta a^2 = 0$ gives

$$\frac{\Delta(\Delta V_a)}{\Delta a} \doteq \sqrt{\frac{\mu}{4a^3}}$$

and, as $\Delta a \to 0$

$$\boxed{\frac{\partial(\Delta V_a)}{\partial a} = \frac{1}{2a}\sqrt{\frac{\mu}{a}}}$$

B3.0 DERIVATION OF $\frac{\partial V_e}{\partial e}$ FOR AN INITIALLY CIRCULAR ORBIT

$$\Delta V_e = \sqrt{\frac{2\mu}{a}\frac{(1+e)}{(2+e)}} - \sqrt{\frac{\mu}{a}} + \sqrt{\frac{2\mu}{a(1+e)(2+e)}} - \sqrt{\frac{\mu}{a}\frac{(1-e)}{(1+e)}} \qquad (B3.1)$$

Using series expansion, the following approximations are introduced.

$$\sqrt{1+e} \doteq 1 + e/2 \qquad (B3.2)$$

$$\sqrt{1-e} \doteq 1 - e/2 \qquad (B3.3)$$

$$\frac{1}{\sqrt{1+e}} \doteq 1 - e/2 \qquad (B3.4)$$

$$\frac{1}{\sqrt{2+e}} \doteq \frac{1}{\sqrt{2}}\left(1 - \frac{e}{4}\right) \qquad (B3.5)$$

Substituting Equations (B3.2) through (B3.5) into (B3.1) simplifying and eliminating second order terms in e gives

$$\Delta V_e \doteq \sqrt{\frac{\mu}{a}}\left(\frac{e}{2}\right)$$

Since the initial state is assumed to be e = o, therefore

$$e = \Delta e$$

and so, as $\Delta e \rightarrow o$

$$\frac{\partial(\Delta V_e)}{\partial e} = \frac{1}{2}\sqrt{\frac{\mu}{a}}$$

B4.0 **CHANGING THE SEMI-MAJOR AXIS OF AN INITIALLY ECCENTRIC ORBIT**

Initial Orbital Elements a_1, e (Orbit 1)

Final Orbital Elements a_2, e (Orbit 2) $a_2 > a_1$

Semi-major axis increased by an initial burn at perigee followed by a correcting burn at apogee.

$$R_{P1} = a_1\,(1-e) \qquad R_{P2} = a_2\,(1-e)$$
$$R_{A1} = a_1\,(1-e) \qquad R_{A2} = a_2\,(1-e)$$

$$V_{P1} = \sqrt{\frac{2\mu}{R_{P1}+R_{A1}} \cdot \frac{R_{A1}}{R_{P1}}}$$ initial perigee velocity

$$V_{PT} = \sqrt{\frac{2\mu}{R_{P1}+R_{A2}} \cdot \frac{R_{A2}}{R_{P1}}}$$ transfer orbit perigee velocity

$$V_{AT} = \sqrt{\frac{2\mu}{R_{P1}+R_{A2}} \cdot \frac{R_{P1}}{R_{A2}}}$$ transfer orbit apogee velocity

$$V_{A2} = \sqrt{\frac{2\mu}{R_{A2}+R_{P2}} \cdot \frac{R_{P2}}{R_{A2}}}$$ final orbit apogee velocity

$$\Delta V = V_{PT} - V_{P1} + V_{A2} - V_{AT}$$

$$\Delta V_{Ae} = \sqrt{\frac{2\mu}{a_1(1-e)+a_2(1+e)} \cdot \frac{a_2(1+e)}{a_1(1-e}} - \sqrt{\frac{2\mu}{a_1(1-e)+a_1(1+e)} \cdot \frac{a_1(1+e)}{a_1(1-e)}}$$

$$+ \sqrt{\frac{2\mu}{a_2(1-e)+a_2(1+e)} \cdot \frac{a_2(1-e)}{a_2(1+e)}} - \sqrt{\frac{2\mu}{a_1(1-e)+a_2(1+e)} \cdot \frac{a_1(1-e)}{a_2(1+e)}}$$

$$\frac{\Delta V_{Ae}}{\sqrt{\mu}} = \left(\frac{1}{\sqrt{a + \frac{\Delta a(1+e)}{2}}}\right)\left(\sqrt{1+e}\,\sqrt{a+\Delta a}\right)\left(\frac{1}{\sqrt{1-e}\,\sqrt{a}}\right)$$

$$- \sqrt{\frac{1+e}{1-e}}\sqrt{\frac{1}{a}} + \sqrt{\frac{1-e}{1+e}}\sqrt{\frac{1}{a+\Delta a}}$$

$$- \frac{1}{\sqrt{a + \frac{\Delta a(1+e)}{2}}}\left(\sqrt{1-e}\,\sqrt{a}\right)\left(\frac{1}{\sqrt{1+e}\,\sqrt{a+\Delta a}}\right)$$

now letting

$$\sqrt{a+\Delta a} \doteq \sqrt{a} + \frac{\Delta a}{2\sqrt{a}}$$

$$\frac{1}{\sqrt{a+\Delta a}} \doteq \frac{1}{\sqrt{a}} - \frac{\Delta a}{2\sqrt{a}}$$

substituting, and letting $\Delta a \to o$ gives

$$\frac{\partial(\Delta V_{Ae})}{\partial a} = \frac{1}{2a}\sqrt{\frac{\mu(1+e)(1-e)}{a}}$$

Note: Letting e = 0 gives

$$\frac{\partial(\Delta V_{Ae})}{\partial a} = \frac{1}{2a}\sqrt{\frac{\mu}{a}}$$

the same result as deduced before for circular orbits.

B5.0 CHANGING THE ECCENTRICITY OF AN INITIALLY ECCENTRIC ORBIT

Initial Orbital Elements   a, e1 (Orbit 1)

Final Orbital Elements   a, e2 (Orbit 2)

Eccentricity is increased by an initial burn at perigee followed by a burn at apogee.

The same formulations for velocities are used as in the calculation for semi-major axis correction, except

$$\Delta V_{ee} = V_{PT} - V_{P1} + V_{AT} - V_{A2}$$

because the second burn slows the velocity to increase eccentricity

$$\Delta V_{ee} = \sqrt{\frac{2\mu}{a(1-e_1)+a(1+e_2)} \cdot \frac{a(1+e_2)}{a(1-e_1)}} - \sqrt{\frac{\mu}{a} \cdot \frac{(1+e_1)}{(1-e_1)}}$$

$$+ \sqrt{\frac{2\mu}{a(1-e_1)+a(1+e_2)} \cdot \frac{a(1-e_1)}{a(1+e_2)}} - \sqrt{\frac{\mu}{a} \frac{(1-e_2)}{(1+e_2)}}$$

Letting

$$e_2 = e + \Delta e$$
$$e_1 = e$$

$$\frac{1}{\sqrt{1+\frac{\Delta e}{2}}} \doteq 1 - \frac{\Delta e}{4}$$

$$\sqrt{1+\frac{\Delta e}{1+e}} \doteq 1 + \frac{\Delta e}{2(1+e)}$$

$$\frac{1}{\sqrt{1+\frac{\Delta e}{1+e}}} \doteq 1 - \frac{\Delta e}{2(1+e)}$$

$$\sqrt{1-\frac{\Delta e}{1-e}} \doteq 1 + \left(\frac{-\Delta e}{2(1-e)}\right)$$

then substituting, simplifying, and letting $\Delta e = 0$ gives

$$\frac{\partial(\Delta V_{ee})}{\partial e} = \frac{1}{2}\sqrt{\frac{\mu}{a}}\frac{1}{\sqrt{(1+e)(1-e)}}$$

B6.0 A DIRECT EXPRESSION FOR LINES OF CONSTANT VIEW TIME AS A FUNCTION OF RELATIVE INCLINATION AND PHASE

$$\frac{D^2}{2R^2} = 1 - \cos(\theta+\phi)\cos\theta - \sin(\theta+\phi)\sin\theta\cos i$$

is the initial expression for range given the T (time of viewing) should be a function symmetric about $\theta = -\phi/2$

let

$$\theta = -\frac{\phi}{2} + \omega t_1$$

then

$$\frac{D^2}{2R^2} = 1 - \cos\left(\frac{\phi}{2}+\omega t_1\right)\cos\left(\frac{\phi}{2}-\omega t_1\right) + \sin\left(\frac{\phi}{2}+\omega t_1\right)\sin\left(\frac{\phi}{2}+\omega t_1\right)\cos i$$

where

$$\omega t_1 = \frac{\phi}{2} + \omega t$$

$$t_1 = \frac{\phi}{2\omega} + t$$

This function is symmetric in + and - t,

Setting a camera range: $D = CR$

and setting a time t_1 : $t_1 = \frac{T}{2}$

gives a parametric equation between ϕ and i.

Let

$$K = \frac{CR}{R} = \frac{\text{camera range}}{\text{orbit radius}}$$

$$\frac{K^2}{2} = 1 - \cos\left(\frac{\phi}{2} + \frac{\omega T}{2}\right)\cos\left(+\frac{\phi}{2} - \frac{\omega T}{2}\right) + \sin\left(\frac{\phi}{2} + \frac{\omega T}{2}\right)\sin\left(\frac{\phi}{2} - \frac{\omega T}{2}\right)\cos i$$

$$\cos i = \frac{\frac{K^2}{2} + \cos\theta_+ \cos\theta_- - 1}{\sin\theta_+ \sin\theta_-}$$

where $\theta_+ = \frac{\phi}{2} + \frac{\omega T}{2}$

$\theta_- = \frac{\phi}{2} - \frac{\omega T}{2}$

and K = CR/R

This parametric equation gives ϕ as a function of i for any given T.

2 T is the encounter time per orbit.

APPENDIX C

BASIC PRINCIPLES AND DESCRIPTIVE PARAMETERS IN PHYSICAL OPTICS

C1.0 DIFFRACTION

A distant point source of light, when imaged by a circular lens or mirror displays the familiar airy intensity pattern around the image point. Instead of a single point image, the image is a bright central disc surrounded by a series of progressively weaker dark and light rings. The width of the central maximum is governed by the diameter of the circular aperture and the wavelength of the light in the relationship

$$\theta = \frac{\lambda}{D} \text{ radians}$$

where θ is the angular spread of the central maximum between the half power intensity points, is the wavelength of the light, and D is the diameter of the circular aperture. The Rayleigh criterion according established by Lord Rayleigh, states that the images of two point sources are resolved if the central maximum of one coincides with the first dark ring of the other. This angular resolution, θ_r, is defined by

$$\theta_r = \frac{1.22\lambda}{D} \text{ radians}$$

The combined intensity curve of the images of the two points has a slight dip between the peaks.

Figure C-1 illustrates the numerical relationship between aperture size and diffraction limited angular beamwidth at an operating wavelength of 500 nm. Beamwidth varies linearly with wavelength for the same aperture, so the beamwidths at 1,000 nm and 250 nm are twice and half that for the 500 nm cases, respectively.

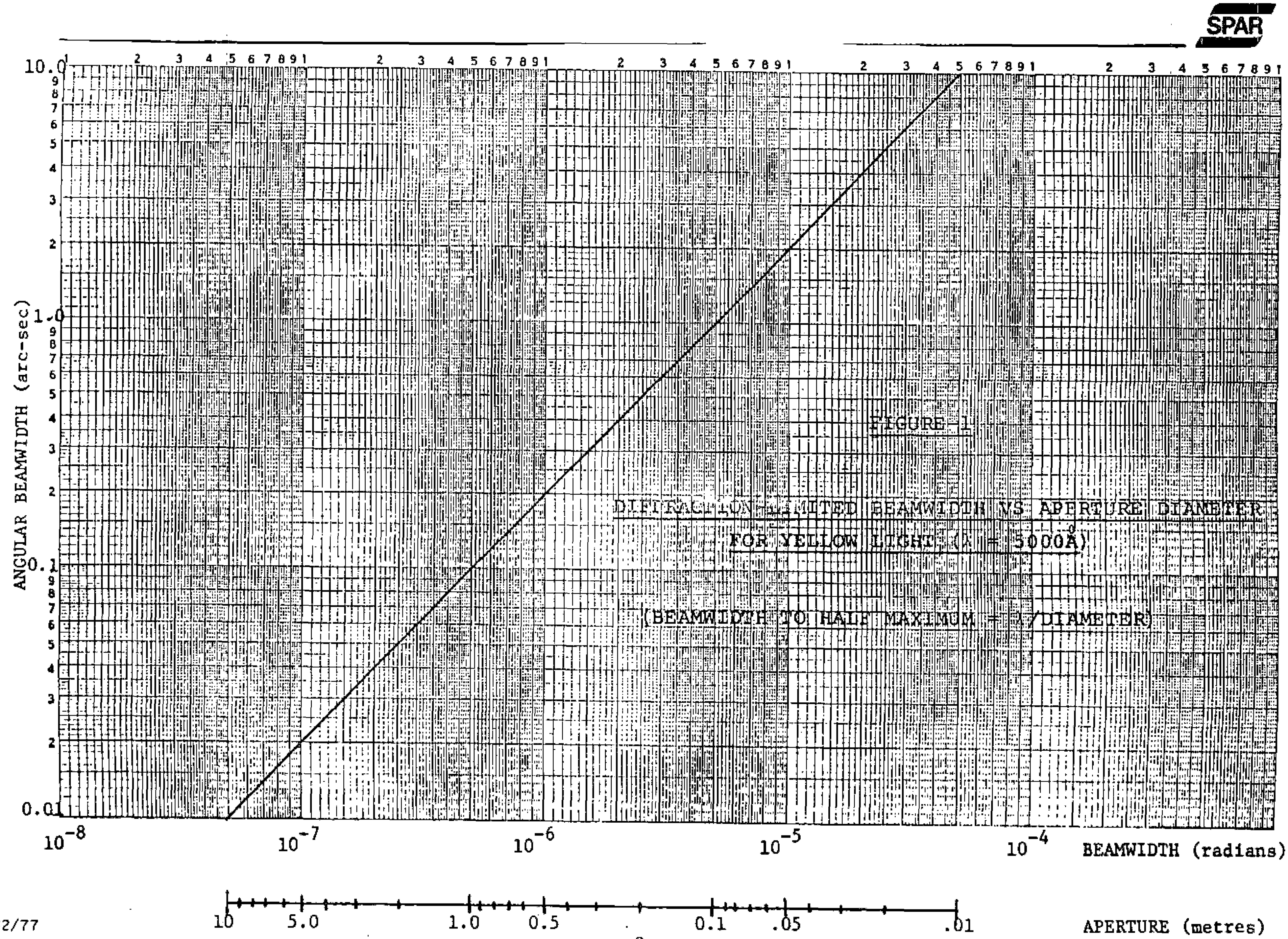


FIGURE 1

DIFFRACTION-LIMITED BEAMWIDTH VS APERTURE DIAMETER FOR YELLOW LIGHT (λ = 5000Å)

(BEAMWIDTH TO HALF MAXIMUM = λ/DIAMETER)

C2.0 THE MODULATION TRANSFER FUNCTION

The Rayleigh criterion is specialized for resolution of stars against a dark background. It is less useful for image problems in which the sensor must distinguish a range of radiances and a variety of shapes.

A more useful parameter is the Modulation Transfer Function (MTF). MTF is useful in describing the overall performance of an optical imaging system because the MTF's of different system elements can be combined linearly into a single overall MTF. The MTF essentially describes the optical system as an angular filter, with an angular cut-off frequency. It provides a measure of the contrast in the final image relative to the objects and is usually given as a function of the angular spatial frequency of the object.

The MTF for a perfect optical system having a uniformly transmitting circular aperture is

$$MTF(\nu) = \frac{2}{\pi}(\phi - \cos\phi \sin\phi)$$

where

$$\phi = \cos^{-1}\left(\frac{\lambda\nu}{2NA}\right)$$

The cut-off frequency

$$\nu_o = \frac{2(NA)}{\lambda} = \frac{(fno.)}{\lambda}$$

where

NA	=	n sin U the numerical aperture of the system
λ	=	wavelength of the light
(fno.)	=	effective speed or relative aperture of the system

C2.0 THE MODULATION TRANSFER FUNCTION (Continued)

ν is the spatial frequency normalized to the cut-off spatial frequency ν_o.

Note that ν_o is the frequency at which all information is lost, not the '3 dB' frequency frequently used in electrical filter theory. The MTF is the inverse Fourier transform of the image produced by a slit source. MTF can be obtained by measuring the intensity $S(\alpha)$ across an image distorted by diffraction and blur, and calculating the inverse Fourier transform. α is the angular instantaneous field of view.

A detector array in the image plane of a telescope has an MTF defined by

$$MTF(f) = \frac{\sin \pi \left(\frac{\Delta x}{2P} \quad \frac{f}{fs} \right)}{\left(\pi \quad \frac{\Delta x}{2P} \quad \frac{f}{f_s} \right)}$$

P	=	the center-to-center spacing of the detector elements
Δx	=	the width of the active area of an element
fs	=	spatial cut-off frequency $\frac{1}{2P}$
f	=	spatial, as opposed to angular, frequency in the image plane.

The MTF for an array is the Fourier transform of the pixel spread function.

C3.0 THE POINT SPREAD FUNCTION

A third useful parameter in describing an optical imaging system is the Point Spread Function (PSF). In an analogy to the airy pattern, the PSF represents all of the first order and higher order aberrations in an imaging system.

It is sometimes characterized for a particular instrument as a central maximum with secondary maxima, as in an antenna pattern; at other times it is appropriate to represent it as a Gaussian intensity distribution. PSF are arbitrarily given for 50% to 90% of the 'encircled energy', depending upon the purpose of the analysis. There is no universally agreed upon definition.

APPENDIX D

A POSSIBLE PAXSAT COMPUTER

D1.0 INTRODUCTION

Complex low earth-orbiting satellites rely more and more on on-board computers to provide increased flexibility, spacecraft autonomy, and extended operational life.

These demands can be met by using a microcomputer with the following key characteristics:

(a) Adaptable to support different mission requirements,

(b) Modular multiprocessor design suitable for distributed processing,

(c) Interrupt driven, multitasking operating system for real-time applications,

(d) In-orbit reprogramming capability,

(e) Use of non-volatile memory for mass-storage of programs,

(f) Redundancy cross-strapping applied at the module level of the computer, and

(g) Fault-tolerance and selftest capability.

Current spacecraft designs are based on two computer implementation concepts. Major subsystems are controlled by a central computer, typically via the spacecraft data bus of the command and telemetry subsystem, and/or by dedicated computers which form an integral part of the subsystem.

The Paxsat computer described in this section falls into the former category.

D2.0 PAXSAT COMPUTER REQUIREMENTS

The Paxsat computer may be a centralized, general purpose computer which interfaces with the GFSC Multimission Modular Spacecraft (MMS) Communications and Data Handling (C&DH) Subsystem.

The computer will communicate with other spacecraft subsystems through the MMS Multiplex Data Bus.

The physical interface with the C&DH subsystem will be provided by the DMA interface of the computer, which replaces the STACC Interface Unit (STINT) of the C&DH subsystem.

The computer will accomodate the following tasks through this interface:

(a) Delayed command storage,

(b) Loading and dumping of programs and data,

(c) Telemetry input and command output,

(d) Telemetry format control,

(e) Data output to real-time telemetry.

Other functions to be carried out by the computer include:

(a) Attitude determination and control,

(b) Housekeeping functions such as monitoring and controlling thermal and power subsystems,

(c) Limit checks to monitor and control spacecraft health and safety,

(d) Generation of summary status and messages,

(e) Mission-unique functions.

The Paxsat computer will receive prime and redundant secondary power rails (+5 V, +10 V, +12 V) from the spacecraft.

D2.1 Spar On-board Modular Microcomputer

The architecture of the SPAR On-board Modular Microcomputer (SOMM) meets the key characteristics of advanced spacecraft computers outlined in section 1.1 and is the proposed computer for Paxsat missions.

The following description highlights the flexibility and expansion capability of SOMM.

D2.1.1 Configuration

SOMM can be configured from a pool of modules by switching secondary power rails to individual modules. A total of 16 prime modules connected to the unit bus may be powered at any given time.

D2.1.2 Unit Bus

A serial data communications bus (unit bus) interconnects modules within SOMM and supports bus access by priority arbitration, synchronous operation, shared resources, and multiprocessing capability.

The unit bus controller provides and conditions all unit bus signals, which are clock, sync, command data, reply data, real-time clock, reset, and bus select.

The transmission of 16-bit data words at a clock rate of 1 MHz yields a data rate of approximately 46K bytes/S.

D2.1.3 16-Bit CPU Module

The central processor of the 16-bit CPU module is the Texas Instruments SBP9989 operating at 3 MHz.

The 16-bit CPU memory contains up to 4K bytes of power-strobed PROM and 60K bytes of RAM.

Memory data error protection and correction (EDC) is achieved by means of PROM error detection (parity checking at the bit level) as well as RAM single error correction and double error detection (Hamming code).

Other features of the CPU module include real-time clock process control, priority interrupt handling, DMA, memory-mapped I/O, memory write protection, and process protection by a watch-dog timer.

D2.1.4 PROM Memory Module

The memory module can be used for off-line storage of software and pre-defined data. It is organized in 16-bit words and contains up to 128K bytes of power-strobed PROM memory per module.

D2.1.5 Manager Module

The manager module generates sequential module power on/off commands, maintains subsystem status information, and provides autonomous operation of SOMM to the extent required by a mission.

D2.2 Paxsat Computer Configuration

The Paxsat computer configuration shown in Figure D-1 provides full redundancy (cold) at the module level to permit cross-strapping of modules for reliability purposes. The block diagram of the CPU module is shown in Figure D-2.

The CPU memory required to execute the tasks described in section 1.2 is summarized below:

FUNCTION	ROM (bytes)	RAM (bytes)
Bootstrap	3K	
Executive, C&DH Control		8K
Command Storage		8K
Status Buffer		8K
Support Software		6K
Subsystem Control *		16K
Selftest		2K
Spare	1K	12K
TOTAL	4K	60K

* Including attitude/thermal/power control, and mission-unique functions

The memory size assigned to the PROM memory module, which is powered during program load only, is 64K bytes.

D2.2 Paxsat Computer Configuration (Continued)

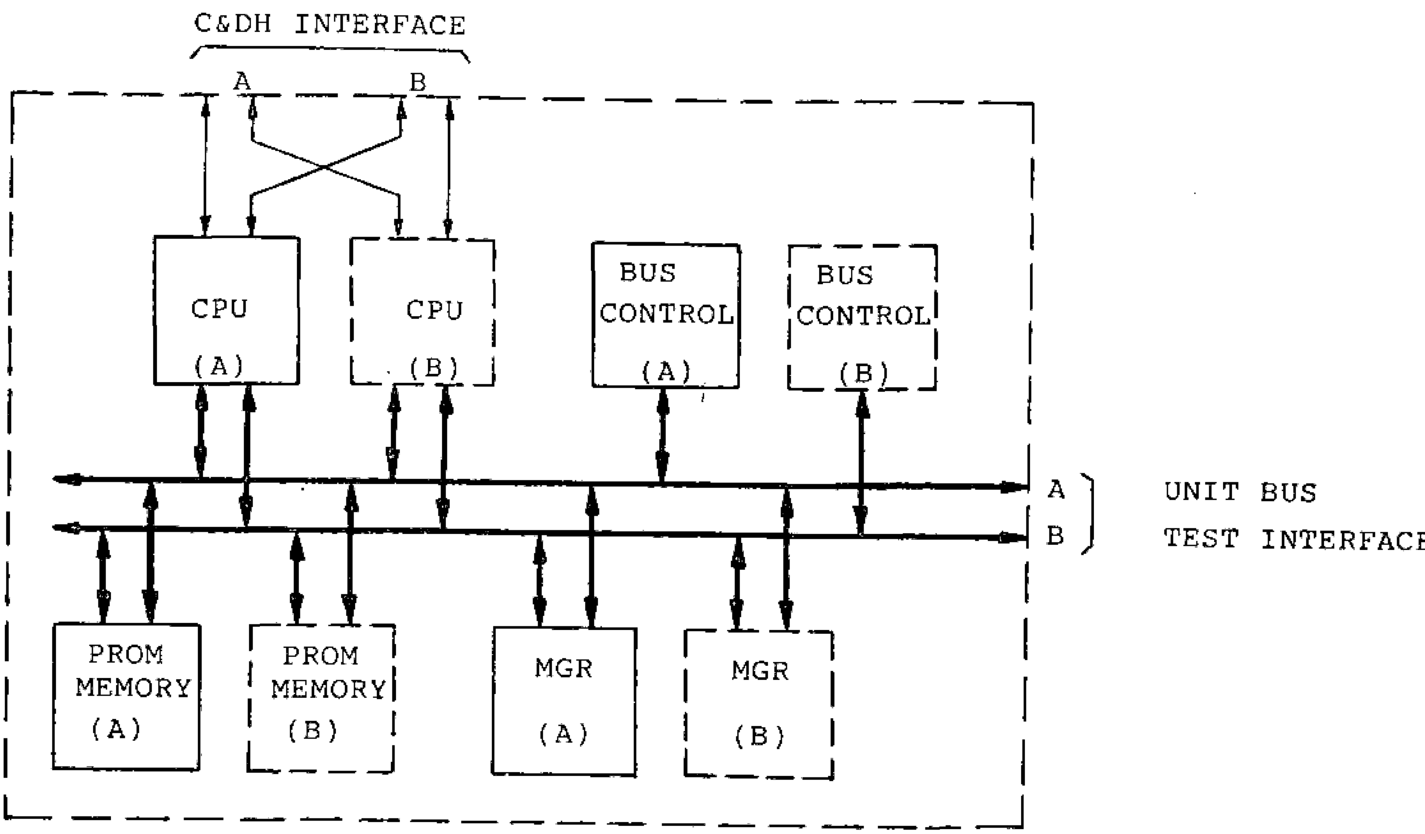
The physical characteristics established for the PAXSAT computer are:

(a) Power ** : 17 W

(b) Size *** : 7.0 L x 8.75 W x 9.5 H (inches)

(c) Weight *** : 23 lbs

** When operating in a nonredundant configuration.
*** Includes redundancy, excludes DC/DC converter.



NOTE: DASHED BOXES INDICATE COLD REDUNDANCY

FIGURE D-1 PAXSAT COMPUTER BLOCK DIAGRAM

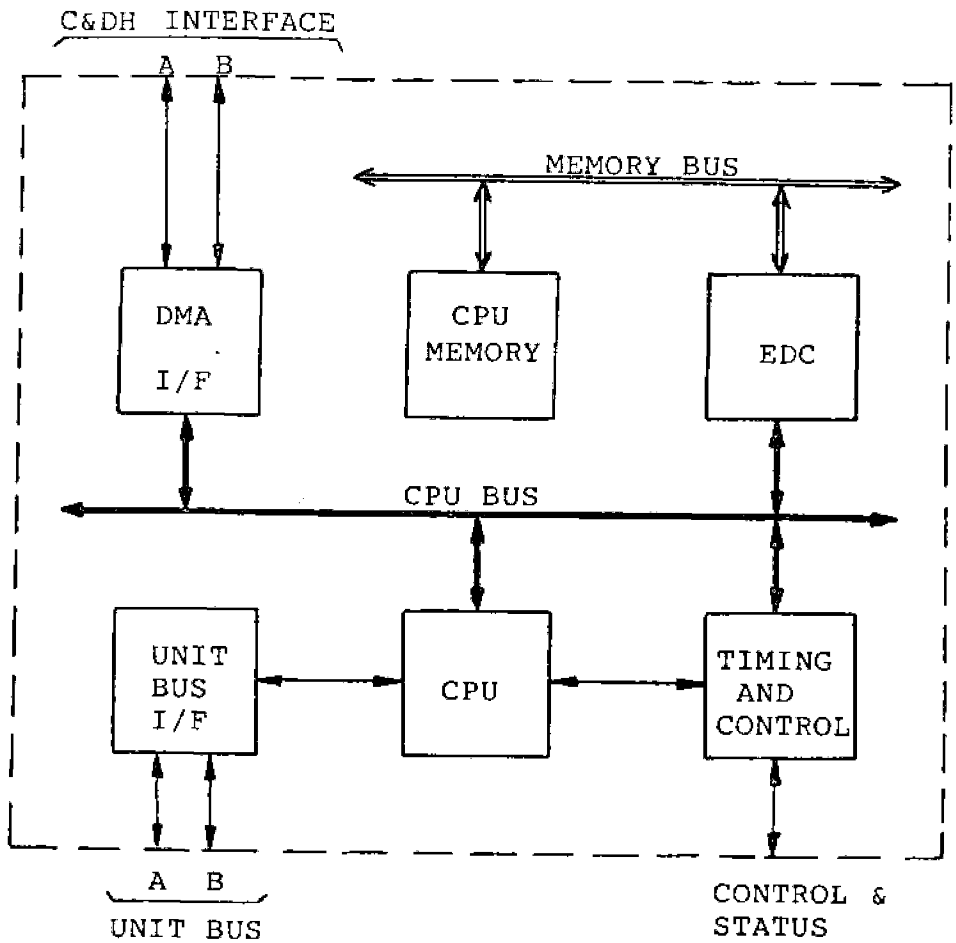


FIGURE D-2 CPU MODULE BLOCK DIAGRAM