Update to *History of On-Orbit Satellite Fragmentations*

Updates to the Eleventh Edition of the *History of On-Orbit Satellite Fragmentations* (JSC 28382) publication are included in this document. The updates reflect event and environment changes during the period July 1999 to July 2000. The following list describes the specific pages to be removed from the Eleventh Edition and replaced with the appropriate corresponding pages within this document. It is recommended that you annotate the existing Table of Contents with the new page insertions.

REMOVE Eleventh Edition pages:	REPLACE with document pages:
9-20	9-20
51-54	51-54
263-264	263, 263 A", 263 B", 263 A', 263 B', (263 A, 263 B Jul 99 Edition), 264
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TABLE 2.1 HISTORY OF SATELLITE BREAKUPS BY LAUNCH DATE

NAME	INTERNATIONAL DESIGNATOR	CATALOG NUMBER	LAUNCH DATE	EVENT DATE	DEBRIS CATALOGED	DEBRIS LEFT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	COMMENT
TRANSIT 4A R/B	1961-015C.	118	29-Jun-61	29-Jun-61	298	194	995	880	66.8	PROPULSION	ABLESTAR STAGE
SPUTNIK 29	1962-057A	443	24-Oct-62	29-Oct-62	24	0	260	200	65.1	PROPULSION	MOLNIYA FINAL STAGE
ATLAS CENTAUR 2	1963-047A	694	27-Nov-63	27-Nov-63	19	9	1785	475	30.3	PROPULSION	CENTAUR STAGE
ELEKTRON 1/2 R/B	1964-006D	751	30-Jan-64	13-Feb-98	2	1	56315	90	56.2	AERODYNAMICS	VOSTOK FINAL STAGE
COSMOS 50	1964-070A	919	28-Oct-64	5-Nov-64	96	0	220	175	51.2	DELIBERATE	SELF-DESTRUCT
COSMOS 57	1965-012A	1093	22-Feb-65	22-Feb-65	167	0	425	165	64.8	DELIBERATE	SELF-DESTRUCT
COSMOS 61-63 R/B	1965-020D	1270	15-Mar-65	15-Mar-65	147	22	1825	260	56.1	UNKNOWN	COSMOS SECOND STAGE
OV2-1/LCS 2 R/B	1965-082B	1640	15-Oct-65	15-Oct-65	470	46	790	710	32.2	PROPULSION	TITAN TRANSTAGE
COSMOS 95	1965-088A	1706	4-Nov-65	15-Jan-66	1	0	520	210	48.4	UNKNOWN	
OPS 3031	1966-012C	2015	15-Feb-66	15-Feb-66	38	0	270	150	96.5	UNKNOWN	INFLATABLE SPHERE
GEMINI 9 ATDA R/B	1966-046B	2188	1-Jun-66	Mid-Jun-66	51	0	275	240	28.8	UNKNOWN	ATLAS CORE STAGE
PAGEOS	1966-056A	2253	24-Jun-66	12-Jul-75	79	2	5170	3200	85.3	UNKNOWN	INFLATABLE SPHERE
AS-203	1966-059A	2289	5-Jul-66	5-Jul-66	34	0	215	185	32	DELIBERATE	SATURN S-IVB STAGE
COSMOS U-1	1966-088A	2437	17-Sep-66	17-Sep-66	53	0	855	140	49.6	DELIBERATE	SELF-DESTRUCT
COSMOS U-2	1966-101A	2536	2-Nov-66	2-Nov-66	41	0	885	145	49.6	DELIBERATE	SELF-DESTRUCT
COSMOS 199	1968-003A	3099	16-Jan-68	24-Jan-68	3	0	355	200	65.6	DELIBERATE	SELF-DESTRUCT
APOLLO 6 R/B (S4B)	1968-025B	3171	4-Apr-68	13-Apr-68	16	0	360	200	32.6	PROPULSION	SATURN S-IVB STAGE
OV2-5 R/B	1968-081E	3432	26-Sep-68	21-Feb-92	3	3	35810	35100	11.9	UNKNOWN	TITAN TRANSTAGE
COSMOS 248	1968-090A	3503	19-Oct-68	1-Nov-68	5	0	545	475	62.2	DELIBERATE	DEBRIS IMPACT
COSMOS 249	1968-091A	3504	20-Oct-68	20-Oct-68	108	50	2165	490	62.3	DELIBERATE	SELF-DESTRUCT
COSMOS 252	1968-097A	3530	1-Nov-68	1-Nov-68	140	50	2140	535	62.3	DELIBERATE	SELF-DESTRUCT
METEOR 1-1 R/B	1969-029B	3836	26-Mar-69	28-Mar-69	37	0	850	460	81.2	UNKNOWN	VOSTOK FINAL STAGE
INTELSAT 3 F-5 R/B	1969-064B	4052	26-Jul-69	26-Jul-69	25	1	5445	270	30.4	PROPULSION	TE 364-4 STAGE
OPS 7613 R/B	1969-082AB	4159	30-Sep-69	4-Oct-69	259	86	940	905	70	UNKNOWN	AGENA D STAGE
NIMBUS 4 R/B	1970-025C	4367	8-Apr-70	17-Oct-70	372	266	1085	1065	99.9	UNKNOWN	AGENA D STAGE
COSMOS 374	1970-089A	4594	23-Oct-70	23-Oct-70	102	33	2130	530	62.9	DELIBERATE	SELF-DESTRUCT
COSMOS 375	1970-091A	4598	30-Oct-70	30-Oct-70	47	24	2100	525	62.8	DELIBERATE	SELF-DESTRUCT
COSMOS 397	1971-015A	4964	25-Feb-71	25-Feb-71	116	52	2200	575	65.8	DELIBERATE	SELF-DESTRUCT
COSMOS 462	1971-106A	5646	3-Dec-71	3-Dec-71	25	0	1800	230	65.7	DELIBERATE	SELF-DESTRUCT
LANDSAT 1 R/B	1972-058B	6127	23-Jul-72	22-May-75	226	42	910	635	98.3	PROPULSION	DELTA SECOND STAGE
SALYUT 2 R/B	1973-017B	6399	3-Apr-73	3-Apr-73	25	0	245	195	51.5	PROPULSION	PROTON-K SECOND STAGE

TABLE 2.1 HISTORY OF SATELLITE BREAKUPS BY LAUNCH DATE (CONT'D)

NAME	INTERNATIONAL DESIGNATOR	CATALOG NUMBER	LAUNCH DATE	EVENT DATE	DEBRIS CATALOGED	DEBRIS LEFT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	COMMENT
COSMOS 554	1973-021A	6432	19-Apr-73	6-May-73	195	0	350	170	72.9	DELIBERATE	SELF-DESTRUCT
NOAA 3 R/B	1973-086B	6921	6-Nov-73	28-Dec-73	197	178	1510	1500	102.1	PROPULSION	DELTA SECOND STAGE
NOAA 4 R/B	1974-089D	7532	15-Nov-74	20-Aug-75	146	128	1460	1445	101.7	PROPULSION	DELTA SECOND STAGE
COSMOS 699	1974-103A	7587	24-Dec-74	17-Apr-75	50	0	445	425	65	UNKNOWN	COSMOS 699 CLASS
LANDSAT 2 R/B	1975-004B	7616	22-Jan-75	9-Feb-76	206	35	915	740	97.8	PROPULSION	DELTA SECOND STAGE
NIMBUS 6 R/B	1975-052B	7946	12-Jun-75	1-May-91	239	187	1105	1095	99.6	PROPULSION	DELTA SECOND STAGE
COSMOS 758	1975-080A	8191	5-Sep-75	6-Sep-75	76	0	325	175	67.1	DELIBERATE	SELF-DESTRUCT
COSMOS 777	1975-102A	8416	29-Oct-75	25-Jan-76	62	0	440	430	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 838	1976-063A	8932	2-Jul-76	17-May-77	40	0	445	415	65.1	UNKNOWN	COSMOS 699 CLASS
COSMOS 839	1976-067A	9011	8-Jul-76	29-Sep-77	69	67	2100	980	65.9	BATTERY	
COSMOS 844	1976-072A	9046	22-Jul-76	25-Jul-76	248	0	355	170	67.1	DELIBERATE	SELF-DESTRUCT
NOAA 5 R/B	1976-077B	9063	29-Jul-76	24-Dec-77	159	153	1520	1505	102	PROPULSION	DELTA SECOND STAGE
COSMOS 862	1976-105A	9495	22-Oct-76	15-Mar-77	11	11	39645	765	63.2	DELIBERATE	SELF-DESTRUCT
COSMOS 880	1976-120A	9601	9-Dec-76	27-Nov-78	50	2	620	550	65.8	BATTERY	
COSMOS 884	1976-123A	9614	17-Dec-76	29-Dec-76	2	0	320	170	65	DELIBERATE	SELF-DESTRUCT
COSMOS 886	1976-126A	9634	27-Dec-76	27-Dec-76	76	63	2295	595	65.8	DELIBERATE	SELF-DESTRUCT
COSMOS 903	1977-027A	9911	11-Apr-77	8-Jun-78	2	2	39035	1325	63.2	DELIBERATE	SELF-DESTRUCT
COSMOS 917	1977-047A	10059	16-Jun-77	30-Mar-79	1	1	38725	1645	62.9	DELIBERATE	SELF-DESTRUCT
HIMAWARI 1 R/B	1977-065B	10144	14-Jul-77	14-Jul-77	169	70	2025	535	29	PROPULSION	DELTA SECOND STAGE
COSMOS 931	1977-068A	10150	20-Jul-77	24-Oct-77	6	3	39665	680	62.9	DELIBERATE	SELF-DESTRUCT
EKRAN 2	1977-092A	10365	20-Sep-77	23-Jun-78	2	2	35800	35785	0.1	BATTERY	
COSMOS 970	1977-121A	10531	21-Dec-77	21-Dec-77	70	66	1140	945	65.8	DELIBERATE	SELF-DESTRUCT
LANDSAT 3 R/B	1978-026C	10704	5-Mar-78	27-Jan-81	209	136	910	900	98.8	PROPULSION	DELTA SECOND STAGE
COSMOS 1030	1978-083A	11015	6-Sep-78	10-Oct-78	4	4	39760	665	62.8	DELIBERATE	SELF-DESTRUCT
NIMBUS 7 R/B	1978-098B	11081	24-Oct-78	26-Dec-81	1	1	955	935	99.3	UNKNOWN	DELTA SECOND STAGE
COSMOS 1045 R/B	1978-100D	11087	26-Oct-78	9-May-88	48	44	1705	1685	82.6	UNKNOWN	TSYKLON THIRD STAGE
P-78 (SOLWIND)	1979-017A	11278	24-Feb-79	13-Sep-85	285	6	545	515	97.6	DELIBERATE	HYPERVELOCITY IMPACT
COSMOS 1094	1979-033A	11333	18-Apr-79	17-Sep-79	1	0	405	380	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1109	1979-058A	11417	27-Jun-79	Mid-Feb-80	8	8	39425	960	63.3	DELIBERATE	SELF-DESTRUCT
COSMOS 1124	1979-077A	11509	28-Aug-79	9-Sep-79	4	4	39795	570	63	DELIBERATE	SELF-DESTRUCT
CAT R/B	1979-104B	11659	24-Dec-79	Apr-80	9	6	33140	180	17.9	UNKNOWN	ARIANE 1 FINAL STAGE

TABLE 2.1 HISTORY OF SATELLITE BREAKUPS BY LAUNCH DATE (CONT'D)

NAME	INTERNATIONAL DESIGNATOR	CATALOG NUMBER	LAUNCH DATE	EVENT DATE	DEBRIS CATALOGED	DEBRIS LEFT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	COMMENT
COSMOS 1167	1980-021A	11729	14-Mar-80	15-Jul-81	12	0	450	355	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1172	1980-028A	11758	12-Apr-80	23-Dec-97	2	0	5125	75	61.8	AERODYNAMICS	
COSMOS 1174	1980-030A	11765	18-Apr-80	18-Apr-80	46	8	1660	380	66.1	DELIBERATE	SELF-DESTRUCT
COSMOS 1191	1980-057A	11871	2-Jul-80	14-May-81	3	3	39255	1110	62.6	DELIBERATE	SELF-DESTRUCT
COSMOS 1217	1980-085A	12032	24-Oct-80	12-Feb-83	1	1	38830	1530	65.2	DELIBERATE	SELF-DESTRUCT
COSMOS 1220	1980-089A	12054	4-Nov-80	20-Jun-82	81	2	885	570	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1247	1981-016A	12303	19-Feb-81	20-Oct-81	4	4	39390	970	63	DELIBERATE	SELF-DESTRUCT
COSMOS 1260	1981-028A	12364	20-Mar-81	8-May-82	68	0	750	450	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1261	1981-031A	12376	31-Mar-81	Apr-81	4	4	39765	610	63	DELIBERATE	SELF-DESTRUCT
COSMOS 1275	1981-053A	12504	4-Jun-81	24-Jul-81	305	272	1015	960	83	BATTERY	
MOLNIYA 3-16	1981-054A	12512	9-Jun-81	5-Feb-98	1	0	7670	85	62.1	AERODYNAMICS	
COSMOS 1278	1981-058A	12547	19-Jun-81	Early-Dec-86	2	2	37690	2665	67.1	DELIBERATE	SELF-DESTRUCT
COSMOS 1285	1981-071A	12627	4-Aug-81	21-Nov-81	7	7	40100	720	63.1	DELIBERATE	SELF-DESTRUCT
COSMOS 1286	1981-072A	12631	4-Aug-81	29-Sep-82	2	0	325	300	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1305 R/B	1981-088F	12827	11-Sep-81	11-Sep-81	8	8	13795	605	62.8	PROPULSION	MOLNIYA FINAL STAGE
COSMOS 1306	1981-089A	12828	14-Sep-81	12-Jul-82	8	0	405	380	64.9	UNKNOWN	COSMOS 699 CLASS
COSMOS 1317	1981-108A	12933	31-Oct-81	25-28 -Jan-84	4	4	39055	1315	62.8	DELIBERATE	SELF-DESTRUCT
COSMOS 1355	1982-038A	13150	29-Apr-82	8-Aug-83	29	0	395	360	65.1	UNKNOWN	COSMOS 699 CLASS
COSMOS 1375	1982-055A	13259	6-Jun-82	21-Oct-85	59	58	1000	990	65.8	BATTERY	
COSMOS 1405	1982-088A	13508	4-Sep-82	20-Dec-83	32	0	340	310	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1423 R/B	1982-115E	13696	8-Dec-82	8-Dec-82	29	0	425	235	62.9	PROPULSION	MOLNIYA FINAL STAGE
ASTRON ULLAGE MOTOR	1983-020B	13902	23-Mar-83	3-Sep-84	1	0	1230	220	51.5	PROPULSION	PROTON-K BLOCK DM SOZ
NOAA 8	1983-022A	13923	28-Mar-83	30-Dec-85	7	1	830	805	98.6	BATTERY	
COSMOS 1456	1983-038A	14034	25-Apr-83	13-Aug-83	4	0	39630	730	63.3	DELIBERATE	SELF-DESTRUCT
COSMOS 1461	1983-044A	14064	7-May-83	11-Mar-85	158	2	890	570	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1481	1983-070A	14182	8-Jul-83	9-Jul-83	3	3	39225	625	62.9	DELIBERATE	SELF-DESTRUCT
COSMOS 1484	1983-075A	14207	24-Jul-83	18-Oct-93	48	1	595	550	97.5	UNKNOWN	
COSMOS 1519-1521 ULLAGE MOTOR	1983-127H	14608	29-Dec-83	4-Feb-91	6	4	18805	340	51.9	PROPULSION	PROTON-K BLOCK DM SOZ
PALAPA B2 R/B	1984-011E	14693	3-Feb-84	6-Feb-84	3	1	285	275	28.5	PROPULSION	PAM-D UPPER STAGE
WESTAR 6 R/B	1984-011F	14694	3-Feb-84	3-Feb-84	14	1	310	305	28.5	PROPULSION	PAM-D UPPER STAGE
COSMOS 1588	1984-083A	15167	7-Aug-84	23-Feb-86	45	0	440	410	65	UNKNOWN	COSMOS 699 CLASS

TABLE 2.1 HISTORY OF SATELLITE BREAKUPS BY LAUNCH DATE (CONT'D)

NAME	INTERNATIONAL DESIGNATOR	CATALOG NUMBER	LAUNCH DATE	EVENT DATE	DEBRIS CATALOGED	DEBRIS LEFT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	COMMENT
COSMOS 1603 ULLAGE MOTOR	1984-106F	15338	28-Sep-84	5-Sep-92	22	1	845	835	66.6	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 1646	1985-030A	15653	18-Apr-85	20-Nov-87	24	0	410	385	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1650-1652 ULLAGE MOTOR	1985-037G	15714	17-May-85	29-Nov-98	1	1	18620	310	52	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 1654	1985-039A	15734	23-May-85	21-Jun-85	18	0	300	185	64.9	DELIBERATE	SELF-DESTRUCT
COSMOS 1656 ULLAGE MOTOR	1985-042E	15773	30-May-85	5-Jan-88	6	6	860	810	66.6	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 1682	1985-082A	16054	19-Sep-85	18-Dec-86	23	0	475	385	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1691	1985-094B	16139	9-Oct-85	22-Nov-85	14	11	1415	1410	82.6	BATTERY	
COSMOS 1710-1712 ULLAGE MOTOR	1985-118L	16446	24-Dec-85	29-Dec-91	12	9	18885	655	65.3	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 1714 R/B	1985-121F	16439	28-Dec-85	28-Dec-85	2	0	830	165	71	PROPULSION	ZENIT SECOND STAGE
SPOT 1 R/B	1986-019C	16615	22-Feb-86	13-Nov-86	488	47	835	805	98.7	UNKNOWN	ARIANE 1 FINAL STAGE
COSMOS 1769	1986-059A	16895	4-Aug-86	21-Sep-87	4	0	445	310	65	UNKNOWN	COSMOS 699 CLASS
USA 19	1986-069A	16937	5-Sep-86	5-Sep-86	13	0	745	210	39.1	DELIBERATE	HYPERVELOCITY IMPACT
USA 19 R/B	1986-069B	16938	5-Sep-86	5-Sep-86	5	0	610	220	22.8	DELIBERATE	HYPERVELOCITY IMPACT
COSMOS 1813	1987-004A	17297	15-Jan-87	29-Jan-87	194	0	415	360	72.8	DELIBERATE	SELF-DESTRUCT
COSMOS 1823	1987-020A	17535	20-Feb-87	17-Dec-87	112	40	1525	1480	73.6	BATTERY	
COSMOS 1866	1987-059A	18184	9-Jul-87	26-Jul-87	9	0	255	155	67.1	DELIBERATE	SELF-DESTRUCT
COSMOS 1869	1987-062A	18214	16-Jul-87	27-Nov-97	2	2	635	605	83	UNKNOWN	
METEOR 2-16 R/B	1987-068B	18313	18-Aug-87	15-Feb-98	79	22	960	940	82.6	UNKNOWN	TSYKLON THIRD STAGE
AUSSAT K3/ECS 4 R/B	1987-078C	18352	16-Sep-87	16-19 -Sep-87	3	1	36515	245	6.9	UNKNOWN	ARIANE 3 FINAL STAGE
COSMOS 1883-1885 ULLAGE MOTOR	1987-079G	18374	16-Sep-87	1-Dec-96	14	11	19120	335	64.9	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 1906	1987-108A	18713	26-Dec-87	31-Jan-88	37	0	265	245	82.6	DELIBERATE	SELF-DESTRUCT
EKRAN 17 ULLAGE MOTOR	1987-109E	18719	27-Dec-87	22-May-97	1	1	22975	310	46.6	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 1916	1988-007A	18823	3-Feb-88	27-Feb-88	1	0	230	150	64.8	DELIBERATE	SELF-DESTRUCT
COSMOS 1970-1972 ULLAGE MOTOR	1988-085G	19537	16-Sep-88	9-Mar-99	1	1	18950	300	64.6	PROPULSION	PROTON-K BLOCK DM SOZ
SKYNET 4B/ASTRA 1A R/B	1988-109C	19689	11-Dec-88	17-Feb-98	7	7	35875	435	7.3	UNKNOWN	ARIANE 4 H10 FINAL STAGE
COSMOS 1987-1989	1987-89	19755	10-Jan-89	3-Aug-98	7	6	19055	340	64.9	PROPULSION	PROTON-K BLOCK DM SOZ
GORIZONT 17 ULLAGE MOTOR	1989-004E	19771	26-Jan-89	17-18 -Dec-92	1	0	17575	195	46.7	PROPULSION	PROTON-K BLOCK DM SOZ
GORIZONT 18 ULLAGE MOTOR	1989-052F	20116	5-Jul-89	12-Jan-93	1	0	36745	260	46.8	PROPULSION	PROTON-K BLOCK DM SOZ

TABLE 2.1 HISTORY OF SATELLITE BREAKUPS BY LAUNCH DATE (CONT'D)

NAME	INTERNATIONAL DESIGNATOR	CATALOG NUMBER	LAUNCH DATE	EVENT DATE	DEBRIS CATALOGED	DEBRIS LEFT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	COMMENT
COSMOS 2030	1989-054A	20124	12-Jul-89	28-Jul-89	1	0	215	150	67.1	DELIBERATE	SELF-DESTRUCT
COSMOS 2031	1989-056A	20136	18-Jul-89	31-Aug-89	9	0	365	240	50.5	DELIBERATE	SELF-DESTRUCT
MOLNIYA 3-36	1989-94A	20338	28-Nov-89	19-May-00	2	1	1800	80	63.4	AERODYNAMICS	
MOLNIYA FINAL STAGE	1989-94B	20339	28-Nov-89	28-Jun-00	0	0	7145	75	63.6	AERODYNAMICS	
COSMOS 2053 R/B	1989-100B	20390	27-Dec-89	18-Apr-99	26	2	485	475	73.5	UNKNOWN	TSYKLON THIRD STAGE
COSMOS 2054 ULLAGE MOTOR	1989-101E	20399	27-Dec-89	Jul-92 (?)	9	8	27650	345	47.1	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2079-2081	1990-045G	20631	19-May-90	~28-Mar-99	1	1	19065	405	64.8	PROPULSOPM	PROTON-K BLOCK DM SOZ
FENGYUN 1-2 R/B	1990-081D	20791	3-Sep-90	4-Oct-90	83	74	895	880	98.9	PROPULSION	CZ-4A FINAL STAGE
COSMOS 2101	1990-087A	20828	1-Oct-90	30-Nov-90	4	0	280	195	64.8	DELIBERATE	SELF-DESTRUCT
GORIZONT 22 ULLAGE MOTOR	1990-102E	20957	23-Nov-90	~14 Dec 95	2	1	13105	170	46.5	PROPULSION	PROTON-K BLOCK DM SOZ
USA 68	1990-105A	20978	1-Dec-90	1-Dec-90	28	2	850	610	98.9	PROPULSION	TE-M-364-15 UPPER STAGE
COSMOS 2109-2111 ULLAGE MOTOR	1990-110H	21013	8-Dec-90	14-Mar-98	2	2	18995	520	65.1	PROPULSION	PROTON-K BLOCK DM SOZ
ITALSAT 1 R/B/ EUTELSAT 2 F2	1991-003C	21057	15-Jan-91	Late Apr / Early May 96	8	6	30930	235	6.7	UNKNOWN	ARIANE 4 H10 FINAL STAGE
COSMOS 2125-2132 R/B	1991-009J	21108	12-Feb-91	5-Mar-91	86	86	1725	1460	74	PROPULSION	COSMOS SECOND STAGE
COSMOS 2133 ULLAGE MOTOR	1991-010D	21114	12-Feb-91	7-May-94	3	3	21805	225	46.6	PROPULSION	PROTON-K BLOCK DM SOZ
ASTRA 1B/MOP 2 R/B	1991-015C	21141	2-Mar-91	27-Apr-94	5	4	17630	205	6.8	UNKNOWN	ARIANE 4 H10 FINAL STAGE
COSMOS 2157-2162 R/B	1991-068G	21734	28-May-91	9-Oct-99	34	34	1485	1410	82.6	UNKNOWN	TSYKLON THIRD STAGE
COSMOS 2163	1991-071A	21741	9-Oct-91	6-Dec-91	1	0	260	185	64.8	DELIBERATE	SELF-DESTRUCT
TELECOM 2B/ INMARSAT 2 R/B	1992-021C	21941	15-Apr-92	21-Apr-93	12	12	34080	235	4	UNKNOWN	ARIANE H10 + FINAL STAGE
COSMOS 2204-2206 ULLAGE MOTOR	1992-047H	22067	30-Jul-92	8-Nov-94	3	3	19035	480	64.8	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2225	1992-091A	22280	22-Dec-92	18-Feb-93	6	0	280	225	64.9	DELIBERATE	SELF-DESTRUCT
COSMOS 2227 R/B	1992-093B	22285	25-Dec-92	26-Dec-92	219	191	855	845	71	PROPULSION	ZENIT-2 SECOND STAGE
COSMOS 2237 R/B	1993-016B	22566	26-Mar-93	28-Mar-93	29	27	850	840	71	PROPULSION	ZENIT-2 SECOND STAGE
COSMOS 2238	1993-018A	22585	3-Mar-93	1-Dec-94	1	0	303	210	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 2243	1993-028A	22641	27-Apr-93	27-Apr-93	1	0	225	180	70.4	DELIBERATE	SELF-DESTRUCT
COSMOS 2259	1993-045A	22716	14-Jul-93	25-Jul-93	1	0	320	175	67.1	DELIBERATE	SELF-DESTRUCT
COSMOS 2262	1993-057A	22789	7-Sep-93	18-Dec-93	0	0	295	170	64.9	DELIBERATE	SELF-DESTRUCT
CLEMINTINE R/B	1994-004B	22974	25-Jan-94	7-Feb-94	0	0	295	240	67	UNKNOWN	
STEP II R/B	1994-029B	23106	19-May-94	3-Jun-96	703	170	820	585	82	UNKNOWN	PEGASUS HAPS

TABLE 2.1 HISTORY OF SATELLITE BREAKUPS BY LAUNCH DATE (CONT'D)

NAME	INTERNATIONAL DESIGNATOR	CATALOG NUMBER	LAUNCH DATE	EVENT DATE	DEBRIS CATALOGED	DEBRIS LEFT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	COMMENT
COSMOS 2282 ULLAGE MOTOR	1994-038F	23174	6-Jul-94	~21 Oct 95	1	1	34930	280	47	PROPULSION	PROTON-K BLOCK DM SOZ
ETS-VI R/B	1994-056B	23231	28-Aug-94	31-Mar-95	1	0	4840	100	28.6	AERODYNAMICS	H-II SECOND STAGE
ELEKTRO ULLAGE MOTOR	1994-069E	23338	31-Oct-94	11-May-95	1	0	35465	155	46.9	PROPULSION	PROTON-K BLOCK DM SOZ
RS-15 R/B	1994-085B	23440	26-Dec-94	26-Dec-94	23	21	2200	1880	64.8	UNKNOWN	
COSMOS 2313	1995-028A	23596	8-Jun-95	26-Jun-97	13	0	325	210	65	UNKNOWN	COSMOS 699 CLASS
CERISE	1995-033B	23606	7-Jul-95	24-Jul-96	2	2	675	665	98.1	COLLISION	
RADUGA 33 R/B	1996-010D	23797	19-Feb-96	19-Feb-96	2	1	36505	240	48.7	PROPULSION	PROTON-K BLOCK DM
GORIZONT 32 ULLAGE MOTOR	1996-034F	23887	23-May-96	~13-Dec-99	1	0	5605	145	46.5	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2343	1997-024A	24805	15-May-97	16-Sep-97	1	0	285	225	65	DELIBERATE	SELF-DESTRUCT
COSMOS 2347	1997-079A	25088	9-Dec-97	22-Nov-99	9	0	410	230	65	UNKNOWN	COSMOS 699 CLASS
ASIASAT 3 R/B	1997-086D	25129	24-Dec-97	25-Dec-97	1	1	35995	270	51	PROPULSION	PROTON-K BLOCK DM
COMETS R/B	1998-011B	25176	21-Feb-98	21-Feb-98	1	0	1880	245	30	PROPULSION	H-II SECOND STAGE
CBERS-1/SACI-1 R/B	1999-057C	25942	14-Oct-99	11-Mar-00	225	223	746	726	98.5	PROPULSION	LONG MARCH 4 THIRD STAGE
				TOTAL	9331	3486					

TABLE 2.2 HISTORY OF SATELLITE BREAKUPS BY EVENT DATE

NAME	INTERNATIONAL DESIGNATOR	CATALOG NUMBER	LAUNCH DATE	EVENT DATE	DEBRIS CATALOGED	DEBRIS LEFT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	COMMENT
TRANSIT 4A R/B	1961-015C	118	29-Jun-61	29-Jun-61	298	194	995	880	66.8	PROPULSION	ABLESTAR STAGE
SPUTNIK 29	1962-057A	443	24-Oct-62	29-Oct-62	24	0	260	200	65.1	PROPULSION	MOLNIYA FINAL STAGE
ATLAS CENTAUR 2	1963-047A	694	27-Nov-63	27-Nov-63	19	9	1785	475	30.3	PROPULSION	CENTAUR STAGE
COSMOS 50	1964-070A	919	28-Oct-64	5-Nov-64	96	0	220	175	51.2	DELIBERATE	SELF-DESTRUCT
COSMOS 57	1965-012A	1093	22-Feb-65	22-Feb-65	167	0	425	165	64.8	DELIBERATE	SELF-DESTRUCT
COSMOS 61-63 R/B	1965-020D	1270	15-Mar-65	15-Mar-65	147	22	1825	260	56.1	UNKNOWN	COSMOS SECOND STAGE
OV2-1/LCS 2 R/B	1965-082B	1640	15-Oct-65	15-Oct-65	470	46	790	710	32.2	PROPULSION	TITAN TRANSTAGE
COSMOS 95	1965-088A	1706	4-Nov-65	15-Jan-66	1	0	520	210	48.4	UNKNOWN	
OPS 3031	1966-012C	2015	15-Feb-66	15-Feb-66	38	0	270	150	96.5	UNKNOWN	INFLATABLE SPHERE
GEMINI 9 ATDA R/B	1966-046B	2188	1-Jun-66	Mid-Jun-66	51	0	275	240	28.8	UNKNOWN	ATLAS CORE STAGE
AS-203	1966-059A	2289	5-Jul-66	5-Jul-66	34	0	215	185	32	DELIBERATE	SATURN S-IVB STAGE
COSMOS U-1	1966-088A	2437	17-Sep-66	17-Sep-66	53	0	855	140	49.6	DELIBERATE	SELF-DESTRUCT
COSMOS U-2	1966-101A	2536	2-Nov-66	2-Nov-66	41	0	885	145	49.6	DELIBERATE	SELF-DESTRUCT
COSMOS 199	1968-003A	3099	16-Jan-68	24-Jan-68	3	0	355	200	65.6	DELIBERATE	SELF-DESTRUCT
APOLLO 6 R/B (S4B)	1968-025B	3171	4-Apr-68	13-Apr-68	16	0	360	200	32.6	PROPULSION	SATURN S-IVB STAGE
COSMOS 249	1968-091A	3504	20-Oct-68	20-Oct-68	108	50	2165	490	62.3	DELIBERATE	SELF-DESTRUCT
COSMOS 248	1968-090A	3503	19-Oct-68	1-Nov-68	5	0	545	475	62.2	DELIBERATE	DEBRIS IMPACT
COSMOS 252	1968-097A	3530	1-Nov-68	1-Nov-68	140	50	2140	535	62.3	DELIBERATE	SELF-DESTRUCT
METEOR 1-1 R/B	1969-029B	3836	26-Mar-69	28-Mar-69	37	0	850	460	81.2	UNKNOWN	VOSTOK FINAL STAGE
INTELSAT 3 F-5 R/B	1969-064B	4052	26-Jul-69	26-Jul-69	25	1	5445	270	30.4	PROPULSION	TE 364-4 STAGE
OPS 7613 R/B	1969-082AB	4159	30-Sep-69	4-Oct-69	259	86	940	905	70	UNKNOWN	AGENA D STAGE
NIMBUS 4 R/B	1970-025C	4367	8-Apr-70	17-Oct-70	372	266	1085	1065	99.9	UNKNOWN	AGENA D STAGE
COSMOS 374	1970-089A	4594	23-Oct-70	23-Oct-70	102	33	2130	530	62.9	DELIBERATE	SELF-DESTRUCT
COSMOS 375	1970-091A	4598	30-Oct-70	30-Oct-70	47	24	2100	525	62.8	DELIBERATE	SELF-DESTRUCT
COSMOS 397	1971-015A	4964	25-Feb-71	25-Feb-71	116	52	2200	575	65.8	DELIBERATE	SELF-DESTRUCT
COSMOS 462	1971-106A	5646	3-Dec-71	3-Dec-71	25	0	1800	230	65.7	DELIBERATE	SELF-DESTRUCT
SALYUT 2 R/B	1973-017B	6399	3-Apr-73	3-Apr-73	25	0	245	195	51.5	PROPULSION	PROTON-K SECOND STAGE
COSMOS 554	1973-021A	6432	19-Apr-73	6-May-73	195	0	350	170	72.9	DELIBERATE	SELF-DESTRUCT
NOAA 3 R/B	1973-086B	6921	6-Nov-73	28-Dec-73	197	178	1510	1500	102.1	PROPULSION	DELTA SECOND STAGE
COSMOS 699	1974-103A	7587	24-Dec-74	17-Apr-75	50	0	445	425	65	UNKNOWN	COSMOS 699 CLASS
LANDSAT 1 R/B	1972-058B	6127	23-Jul-72	22-May-75	226	42	910	635	98.3	PROPULSION	DELTA SECOND STAGE

TABLE 2.2 HISTORY OF SATELLITE BREAKUPS BY EVENT DATE (CONT'D)

NAME	INTERNATIONAL DESIGNATOR	CATALOG NUMBER	LAUNCH DATE	EVENT DATE	DEBRIS CATALOGED	DEBRIS LEFT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	COMMENT
PAGEOS	1966-056A	2253	24-Jun-66	12-Jul-75	79	2	5170	3200	85.3	UNKNOWN	INFLATABLE SPHERE
NOAA 4 R/B	1974-089D	7532	15-Nov-74	20-Aug-75	146	128	1460	1445	101.7	PROPULSION	DELTA SECOND STAGE
COSMOS 758	1975-080A	8191	5-Sep-75	6-Sep-75	76	0	325	175	67.1	DELIBERATE	SELF-DESTRUCT
COSMOS 777	1975-102A	8416	29-Oct-75	25-Jan-76	62	0	440	430	65	UNKNOWN	COSMOS 699 CLASS
LANDSAT 2 R/B	1975-004B	7616	22-Jan-75	9-Feb-76	206	35	915	740	97.8	PROPULSION	DELTA SECOND STAGE
COSMOS 844	1976-072A	9046	22-Jul-76	25-Jul-76	248	0	355	170	67.1	DELIBERATE	SELF-DESTRUCT
COSMOS 886	1976-126A	9634	27-Dec-76	27-Dec-76	76	63	2295	595	65.8	DELIBERATE	SELF-DESTRUCT
COSMOS 884	1976-123A	9614	17-Dec-76	29-Dec-76	2	0	320	170	65	DELIBERATE	SELF-DESTRUCT
COSMOS 862	1976-105A	9495	22-Oct-76	15-Mar-77	11	11	39645	765	63.2	DELIBERATE	SELF-DESTRUCT
COSMOS 838	1976-063A	8932	2-Jul-76	17-May-77	40	0	445	415	65.1	UNKNOWN	COSMOS 699 CLASS
HIMAWARI 1 R/B	1977-065B	10144	14-Jul-77	14-Jul-77	169	70	2025	535	29	PROPULSION	DELTA SECOND STAGE
COSMOS 839	1976-067A	9011	8-Jul-76	29-Sep-77	69	67	2100	980	65.9	BATTERY	
COSMOS 931	1977-068A	10150	20-Jul-77	24-Oct-77	6	3	39665	680	62.9	DELIBERATE	SELF-DESTRUCT
COSMOS 970	1977-121A	10531	21-Dec-77	21-Dec-77	70	66	1140	945	65.8	DELIBERATE	SELF-DESTRUCT
NOAA 5 R/B	1976-077B	9063	29-Jul-76	24-Dec-77	159	153	1520	1505	102	PROPULSION	DELTA SECOND STAGE
COSMOS 903	1977-027A	9911	11-Apr-77	8-Jun-78	2	2	39035	1325	63.2	DELIBERATE	SELF-DESTRUCT
EKRAN 2	1977-092A	10365	20-Sep-77	23-Jun-78	2	2	35800	35785	0.1	BATTERY	
COSMOS 1030	1978-083A	11015	6-Sep-78	10-Oct-78	4	4	39760	665	62.8	DELIBERATE	SELF-DESTRUCT
COSMOS 880	1976-120A	9601	9-Dec-76	27-Nov-78	50	2	620	550	65.8	BATTERY	
COSMOS 917	1977-047A	10059	16-Jun-77	30-Mar-79	1	1	38725	1645	62.9	DELIBERATE	SELF-DESTRUCT
COSMOS 1124	1979-077A	11509	28-Aug-79	9-Sep-79	4	4	39795	570	63	DELIBERATE	SELF-DESTRUCT
COSMOS 1094	1979-033A	11333	18-Apr-79	17-Sep-79	1	0	405	380	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1109	1979-058A	11417	27-Jun-79	Mid-Feb-80	8	8	39425	960	63.3	DELIBERATE	SELF-DESTRUCT
CAT R/B	1979-104B	11659	24-Dec-79	Apr-80	9	6	33140	180	17.9	UNKNOWN	ARIANE 1 FINAL STAGE
COSMOS 1174	1980-030A	11765	18-Apr-80	18-Apr-80	46	8	1660	380	66.1	DELIBERATE	SELF-DESTRUCT
LANDSAT 3 R/B	1978-026C	10704	5-Mar-78	27-Jan-81	209	136	910	900	98.8	PROPULSION	DELTA SECOND STAGE
COSMOS 1261	1981-031A	12376	31-Mar-81	Apr-81	4	4	39765	610	63	DELIBERATE	SELF-DESTRUCT
COSMOS 1191	1980-057A	11871	2-Jul-80	14-May-81	3	3	39255	1110	62.6	DELIBERATE	SELF-DESTRUCT
COSMOS 1167	1980-021A	11729	14-Mar-80	15-Jul-81	12	0	450	355	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1275	1981-053A	12504	4-Jun-81	24-Jul-81	305	272	1015	960	83	BATTERY	
COSMOS 1305 R/B	1981-088F	12827	11-Sep-81	11-Sep-81	8	8	13795	605	62.8	PROPULSION	MOLNIYA FINAL STAGE
COSMOS 1247	1981-016A	12303	19-Feb-81	20-Oct-81	4	4	39390	970	63	DELIBERATE	SELF-DESTRUCT

TABLE 2.2 HISTORY OF SATELLITE BREAKUPS BY EVENT DATE (CONT'D)

NAME	INTERNATIONAL DESIGNATOR	CATALOG NUMBER	LAUNCH DATE	EVENT DATE	DEBRIS CATALOGED	DEBRIS LEFT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	COMMENT
COSMOS 1285	1981-071A	12627	4-Aug-81	21-Nov-81	7	7	40100	720	63.1	DELIBERATE	SELF-DESTRUCT
NIMBUS 7 R/B	1978-098B	11081	24-Oct-78	26-Dec-81	1	1	955	935	99.3	UNKNOWN	DELTA SECOND STAGE
COSMOS 1260	1981-028A	12364	20-Mar-81	8-May-82	68	0	750	450	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1220	1980-089A	12054	4-Nov-80	20-Jun-82	81	2	885	570	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1306	1981-089A	12828	14-Sep-81	12-Jul-82	8	0	405	380	64.9	UNKNOWN	COSMOS 699 CLASS
COSMOS 1286	1981-072A	12631	4-Aug-81	29-Sep-82	2	0	325	300	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1423 R/B	1982-115E	13696	8-Dec-82	8-Dec-82	29	0	425	235	62.9	PROPULSION	MOLNIYA FINAL STAGE
COSMOS 1217	1980-085A	12032	24-Oct-80	12-Feb-83	1	1	38830	1530	65.2	DELIBERATE	SELF-DESTRUCT
COSMOS 1481	1983-070A	14182	8-Jul-83	9-Jul-83	3	3	39225	625	62.9	DELIBERATE	SELF-DESTRUCT
COSMOS 1355	1982-038A	13150	29-Apr-82	8-Aug-83	29	0	395	360	65.1	UNKNOWN	COSMOS 699 CLASS
COSMOS 1456	1983-038A	14034	25-Apr-83	13-Aug-83	4	0	39630	730	63.3	DELIBERATE	SELF-DESTRUCT
COSMOS 1405	1982-088A	13508	4-Sep-82	20-Dec-83	32	0	340	310	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1317	1981-108A	12933	31-Oct-81	25-28 -Jan-84	4	4	39055	1315	62.8	DELIBERATE	SELF-DESTRUCT
WESTAR 6 R/B	1984-011F	14694	3-Feb-84	3-Feb-84	14	1	310	305	28.5	PROPULSION	PAM-D UPPER STAGE
PALAPA B2 R/B	1984-011E	14693	3-Feb-84	6-Feb-84	3	1	285	275	28.5	PROPULSION	PAM-D UPPER STAGE
ASTRON ULLAGE MOTOR	1983-020B	13902	23-Mar-83	3-Sep-84	1	0	1230	220	51.5	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 1461	1983-044A	14064	7-May-83	11-Mar-85	158	2	890	570	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1654	1985-039A	15734	23-May-85	21-Jun-85	18	0	300	185	64.9	DELIBERATE	SELF-DESTRUCT
P-78 (SOLWIND)	1979-017A	11278	24-Feb-79	13-Sep-85	285	6	545	515	97.6	DELIBERATE	HYPERVELOCITY IMPACT
COSMOS 1375	1982-055A	13259	6-Jun-82	21-Oct-85	59	58	1000	990	65.8	BATTERY	
COSMOS 1691	1985-094B	16139	9-Oct-85	22-Nov-85	14	11	1415	1410	82.6	BATTERY	
COSMOS 1714 R/B	1985-121F	16439	28-Dec-85	28-Dec-85	2	0	830	165	71	PROPULSION	ZENIT SECOND STAGE
NOAA 8	1983-022A	13923	28-Mar-83	30-Dec-85	7	1	830	805	98.6	BATTERY	
COSMOS 1588	1984-083A	15167	7-Aug-84	23-Feb-86	45	0	440	410	65	UNKNOWN	COSMOS 699 CLASS
USA 19	1986-069A	16937	5-Sep-86	5-Sep-86	13	0	745	210	39.1	DELIBERATE	HYPERVELOCITY IMPACT
USA 19 R/B	1986-069B	16938	5-Sep-86	5-Sep-86	5	0	610	220	22.8	DELIBERATE	HYPERVELOCITY IMPACT
SPOT 1 R/B	1986-019C	16615	22-Feb-86	13-Nov-86	488	47	835	805	98.7	UNKNOWN	ARIANE 1 FINAL STAGE
COSMOS 1278	1981-058A	12547	19-Jun-81	Early-Dec-86	2	2	37690	2665	67.1	DELIBERATE	SELF-DESTRUCT
COSMOS 1682	1985-082A	16054	19-Sep-85	18-Dec-86	23	0	475	385	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1813	1987-004A	17297	15-Jan-87	29-Jan-87	194	0	415	360	72.8	DELIBERATE	SELF-DESTRUCT
COSMOS 1866	1987-059A	18184	9-Jul-87	26-Jul-87	9	0	255	155	67.1	DELIBERATE	SELF-DESTRUCT

TABLE 2.2 HISTORY OF SATELLITE BREAKUPS BY EVENT DATE (CONT'D)

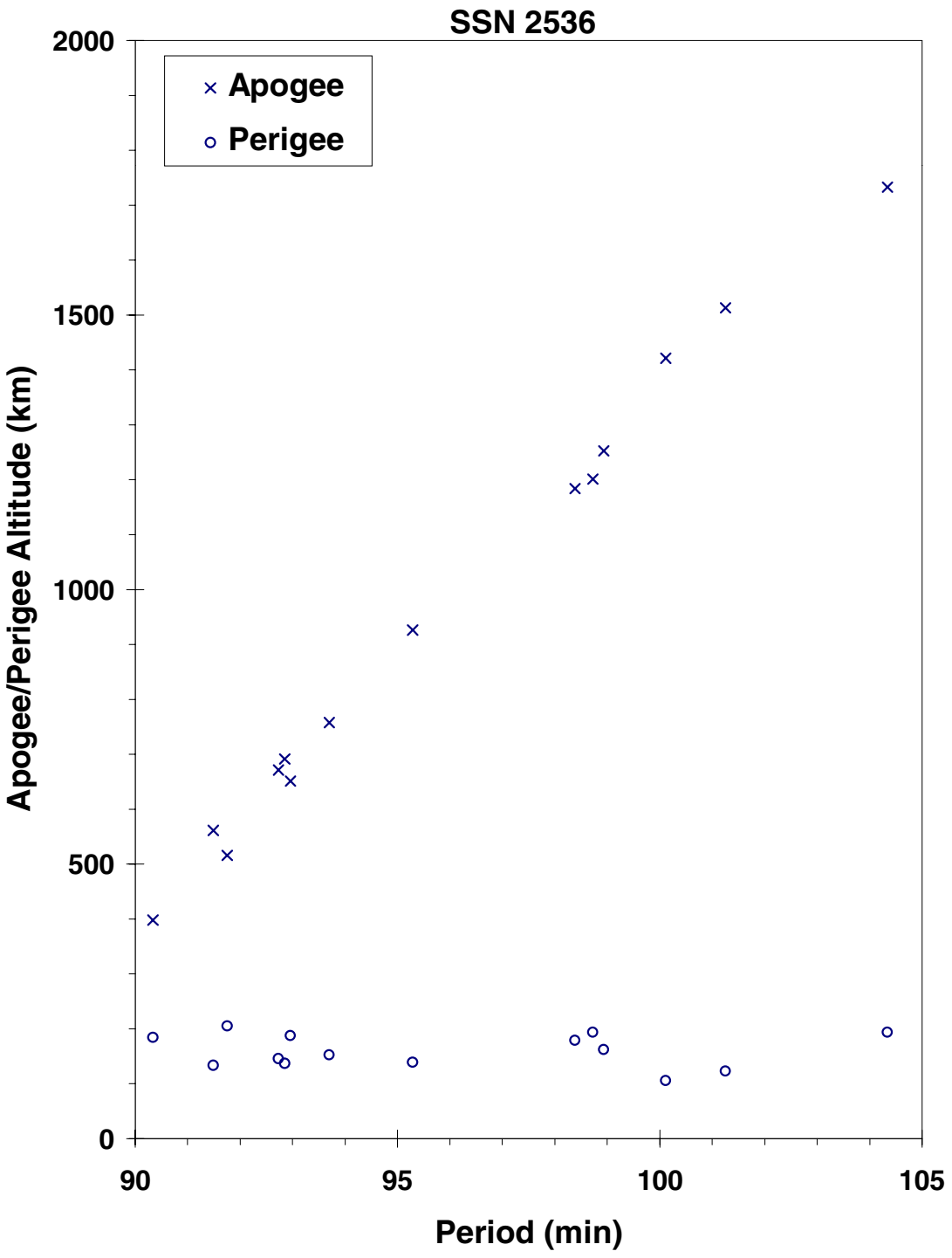
NAME	INTERNATIONAL DESIGNATOR	CATALOG NUMBER	LAUNCH DATE	EVENT DATE	DEBRIS CATALOGED	DEBRIS LEFT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	COMMENT
AUSSAT K3/ECS 4 R/B	1987-078C	18352	16-Sep-87	16-19 -Sep-87	3	1	36515	245	6.9	UNKNOWN	ARIANE 3 FINAL STAGE
COSMOS 1769	1986-059A	16895	4-Aug-86	21-Sep-87	4	0	445	310	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1646	1985-030A	15653	18-Apr-85	20-Nov-87	24	0	410	385	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 1823	1987-020A	17535	20-Feb-87	17-Dec-87	112	40	1525	1480	73.6	BATTERY	
COSMOS 1656 ULLAGE MOTOR	1985-042E	15773	30-May-85	5-Jan-88	6	6	860	810	66.6	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 1906	1987-108A	18713	26-Dec-87	31-Jan-88	37	0	265	245	82.6	DELIBERATE	SELF-DESTRUCT
COSMOS 1916	1988-007A	18823	3-Feb-88	27-Feb-88	1	0	230	150	64.8	DELIBERATE	SELF-DESTRUCT
COSMOS 1045 R/B	1978-100D	11087	26-Oct-78	9-May-88	48	44	1705	1685	82.6	UNKNOWN	TSYKLON THIRD STAGE
COSMOS 2030	1989-054A	20124	12-Jul-89	28-Jul-89	1	0	215	150	67.1	DELIBERATE	SELF-DESTRUCT
COSMOS 2031	1989-056A	20136	18-Jul-89	31-Aug-89	9	0	365	240	50.5	DELIBERATE	SELF-DESTRUCT
FENGYUN 1-2 R/B	1990-081D	20791	3-Sep-90	4-Oct-90	83	74	895	880	98.9	PROPULSION	CZ-4A FINAL STAGE
COSMOS 2101	1990-087A	20828	1-Oct-90	30-Nov-90	4	0	280	195	64.8	DELIBERATE	SELF-DESTRUCT
USA 68	1990-105A	20978	1-Dec-90	1-Dec-90	28	2	850	610	98.9	PROPULSION	TE-M-364-15 UPPER STAGE
COSMOS 1519-1521 ULLAGE MOTOR	1983-127H	14608	29-Dec-83	4-Feb-91	6	4	18805	340	51.9	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2125-2132 R/B	1991-009J	21108	12-Feb-91	5-Mar-91	86	86	1725	1460	74	PROPULSION	COSMOS SECOND STAGE
NIMBUS 6 R/B	1975-052B	7946	12-Jun-75	1-May-91	239	187	1105	1095	99.6	PROPULSION	DELTA SECOND STAGE
COSMOS 2163	1991-071A	21741	9-Oct-91	6-Dec-91	1	0	260	185	64.8	DELIBERATE	SELF-DESTRUCT
COSMOS 1710-1712 ULLAGE MOTOR	1985-118L	16446	24-Dec-85	29-Dec-91	12	9	18885	655	65.3	PROPULSION	PROTON-K BLOCK DM SOZ
OV2-5 R/B	1968-081E	3432	26-Sep-68	21-Feb-92	3	3	35810	35100	11.9	UNKNOWN	TITAN TRANSTAGE
COSMOS 2054 ULLAGE MOTOR	1989-101E	20399	27-Dec-89	Jul-92	9	8	27650	345	47.1	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 1603 ULLAGE MOTOR	1984-106F	15338	28-Sep-84	5-Sep-92	22	1	845	835	66.6	PROPULSION	PROTON-K BLOCK DM SOZ
GORIZONT 17 ULLAGE MOTOR	1989-004E	19771	26-Jan-89	17-18 -Dec-92	1	0	17575	195	46.7	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2227 R/B	1992-093B	22285	25-Dec-92	26-Dec-92	219	191	855	845	71	PROPULSION	ZENIT-2 SECOND STAGE
GORIZONT 18 ULLAGE MOTOR	1989-052F	20116	5-Jul-89	12-Jan-93	1	0	36745	260	46.8	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2225	1992-091A	22280	22-Dec-92	18-Feb-93	6	0	280	225	64.9	DELIBERATE	SELF-DESTRUCT
COSMOS 2237 R/B	1993-016B	22566	26-Mar-93	28-Mar-93	29	27	850	840	71	PROPULSION	ZENIT-2 SECOND STAGE
TELECOM 2B/ INMARSAT 2 R/B	1992-021C	21941	15-Apr-92	21-Apr-93	12	12	34080	235	4	UNKNOWN	ARIANE H10 + FINAL STAGE
COSMOS 2243	1993-028A	22641	27-Apr-93	27-Apr-93	1	0	225	180	70.4	DELIBERATE	SELF-DESTRUCT
COSMOS 2259	1993-045A	22716	14-Jul-93	25-Jul-93	1	0	320	175	67.1	DELIBERATE	SELF-DESTRUCT

TABLE 2.2 HISTORY OF SATELLITE BREAKUPS BY EVENT DATE (CONT'D)

NAME	INTERNATIONAL DESIGNATOR	CATALOG NUMBER	LAUNCH DATE	EVENT DATE	DEBRIS CATALOGED	DEBRIS LEFT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	COMMENT
COSMOS 1484	1983-075A	14207	24-Jul-83	18-Oct-93	48	1	595	550	97.5	UNKNOWN	
COSMOS 2262	1993-057A	22789	7-Sep-93	18-Dec-93	0	0	295	170	64.9	DELIBERATE	SELF-DESTRUCT
CLEMINTINE R/B	1994-004B	22974	25-Jan-94	7-Feb-94	0	0	295	240	67	UNKNOWN	
ASTRA 1B/MOP 2 R/B	1991-015C	21141	2-Mar-91	27-Apr-94	5	4	17630	205	6.8	UNKNOWN	ARIANE 4 H10 FINAL STAGE
COSMOS 2133 ULLAGE MOTOR	1991-010D	21114	12-Feb-91	7-May-94	3	3	21805	225	46.6	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2204-2206 ULLAGE MOTOR	1992-047H	22067	30-Jul-92	8-Nov-94	3	3	19035	480	64.8	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2238	1993-018A	22585	3-Mar-93	1-Dec-94	1	0	303	210	65	UNKNOWN	COSMOS 699 CLASS
RS-15 R/B	1994-085B	23440	26-Dec-94	26-Dec-94	23	21	2200	1880	64.8	UNKNOWN	
ETS-VI R/B	1994-056B	23231	28-Aug-94	31-Mar-95	1	0	4840	100	28.6	AERODYNAMICS	H-II SECOND STAGE
ELEKTRO ULLAGE MOTOR	1994-069E	23338	31-Oct-94	11-May-95	1	0	35465	155	46.9	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2282 ULLAGE MOTOR	1994-038F	23174	6-Jul-94	~21 Oct 95	1	1	34930	280	47	PROPULSION	PROTON-K BLOCK DM SOZ
GORIZONT 22 ULLAGE MOTOR	1990-102E	20957	23-Nov-90	~14 Dec 95	2	1	13105	170	46.5	PROPULSION	PROTON-K BLOCK DM SOZ
RADUGA 33 R/B	1996-010D	23797	19-Feb-96	19-Feb-96	2	1	36505	240	48.7	PROPULSION	PROTON-K BLOCK DM
ITALSAT 1 R/B/ EUTELSAT 2 F2	1991-003C	21057	15-Jan-91	Late Apr / Early May 96	8	6	30930	235	6.7	UNKNOWN	ARIANE 4 H10 FINAL STAGE
STEP II R/B	1994-029B	23106	19-May-94	3-Jun-96	703	170	820	585	82	UNKNOWN	PEGASUS HAPS
CERISE	1995-033B	23606	7-Jul-95	24-Jul-96	2	2	675	665	98.1	COLLISION	
COSMOS 1883-1885 ULLAGE MOTOR	1987-079G	18374	16-Sep-87	1-Dec-96	14	11	19120	335	64.9	PROPULSION	PROTON-K BLOCK DM SOZ
EKRAN 17 ULLAGE MOTOR	1987-109E	18719	27-Dec-87	22-May-97	1	1	22975	310	46.6	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2313	1995-028A	23596	8-Jun-95	26-Jun-97	13	0	325	210	65	UNKNOWN	COSMOS 699 CLASS
COSMOS 2343	1997-024A	24805	15-May-97	16-Sep-97	1	0	285	225	65	DELIBERATE	SELF-DESTRUCT
COSMOS 1869	1987-062A	18214	16-Jul-87	27-Nov-97	2	2	635	605	83	UNKNOWN	
COSMOS 1172	1980-028A	11758	12-Apr-80	23-Dec-97	2	0	5125	75	61.8	AERODYNAMICS	
ASIASAT 3 R/B	1997-086D	25129	24-Dec-97	25-Dec-97	1	1	35995	270	51	PROPULSION	PROTON-K BLOCK DM
MOLNIYA 3-16	1981-054A	12512	9-Jun-81	5-Feb-98	1	0	7670	85	62.1	AERODYNAMICS	
ELEKTRON 1/2 R/B	1964-006D	751	30-Jan-64	13-Feb-98	2	1	56315	90	56.2	AERODYNAMICS	VOSTOK FINAL STAGE
METEOR 2-16 R/B	1987-068B	18313	18-Aug-87	15-Feb-98	79	22	960	940	82.6	UNKNOWN	TSYKLON THIRD STAGE
SKYNET 4B/ASTRA 1A R/B	1988-109C	19689	11-Dec-88	17-Feb-98	7	7	35875	435	7.3	UNKNOWN	ARIANE 4 H10 FINAL STAGE
COMETS R/B	1998-011B	25176	21-Feb-98	21-Feb-98	1	0	1880	245	30	PROPULSION	H-II SECOND STAGE
COSMOS 2109-2111 ULLAGE MOTOR	1990-110H	21013	8-Dec-90	14-Mar-98	2	2	18995	520	65.1	PROPULSION	PROTON-K BLOCK DM SOZ

TABLE 2.2 HISTORY OF SATELLITE BREAKUPS BY EVENT DATE (CONT'D)

NAME	INTERNATIONAL DESIGNATOR	CATALOG NUMBER	LAUNCH DATE	EVENT DATE	DEBRIS CATALOGED	DEBRIS LEFT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	COMMENT
ULLAGE MOTOR											
COSMOS 1987-1989	1987-89	19755	10-Jan-89	3-Aug-98	7	6	19055	340	64.9	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 1650-1652 ULLAGE MOTOR	1985-037G	15714	17-May-85	29-Nov-98	1	1	18620	310	52	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 1970-1972 ULLAGE MOTOR	1988-085G	19537	16-Sep-88	9-Mar-99	1	1	18950	300	64.6	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2079-2081	1990-045G	20631	19-May-90	~28-Mar-99	1	1	19065	405	64.8	PROPULSOPM	PROTON-K BLOCK DM SOZ
COSMOS 2053 R/B	1989-100B	20390	27-Dec-89	18-Apr-99	26	2	485	475	73.5	UNKNOWN	TSYKLON THIRD STAGE
COSMOS 2157-2162 R/B	1991-068G	21734	28-May-91	9-Oct-99	34	34	1485	1410	82.6	UNKNOWN	TSYKLON THIRD STAGE
COSMOS 2347	1997-079A	25088	9-Dec-97	22-Nov-99	9	0	410	230	65	UNKNOWN	COSMOS 699 CLASS
GORIZONT 32 ULLAGE MOTOR	1996-034F	23887	23-May-96	~13-Dec-99	1	0	5605	145	46.5	PROPULSION	PROTON-K BLOCK DM SOZ
CBERS-1/SACI-1 R/B	1999-057C	25942	14-Oct-99	11-Mar-00	225	223	746	726	98.5	PROPULSION	LONG MARCH 4 THIRD STAGE
MOLNIYA 3-36	1989-94A	20338	28-Nov-89	19-May-00	2	1	1800	80	63.4	AERODYNAMICS	
MOLNIYA FINAL STAGE	1989-94B	20339	28-Nov-89	28-Jun-00	0	0	7145	75	63.6	AERODYNAMICS	
				TOTAL	9331	3486					



Cosmos U-2 debris cloud composed of 14 different orbits as developed by the US SSN within one week of the event.

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COSMOS 199 **1968-003A** **3099**

SATELLITE DATA

TYPE:	Payload
OWNER:	CIS
LAUNCH DATE:	16.50 Jan 1968
DRY MASS (KG):	5500
MAIN BODY:	Sphere-cylinder; 2.4 m diameter by 6.0 m length
MAJOR APPENDAGES:	None
ATTITUDE CONTROL:	Active, 3-axis
ENERGY SOURCES:	On-board propellants, 10 kg TNT explosive charge

EVENT DATA

DATE:	24 Jan 1968	LOCATION:	Unknown
TIME:	Unknown	ASSESSED CAUSE:	Deliberate
ALTITUDE:	Unknown		

PRE-EVENT ELEMENTS

EPOCH:	68024. 25242706	MEAN ANOMALY:	305.4920
RIGHT ASCENSION:	247.4278	MEAN MOTION:	15.98596524
INCLINATION:	65.6289	MEAN MOTION DOT/2:	0.00196964
ECCENTRICITY:	0.0118074	MEAN MOTION DOT DOT/6:	0
ARG. OF PERIGEE:	55.7254	BSTAR:	0

DEBRIS CLOUD DATA

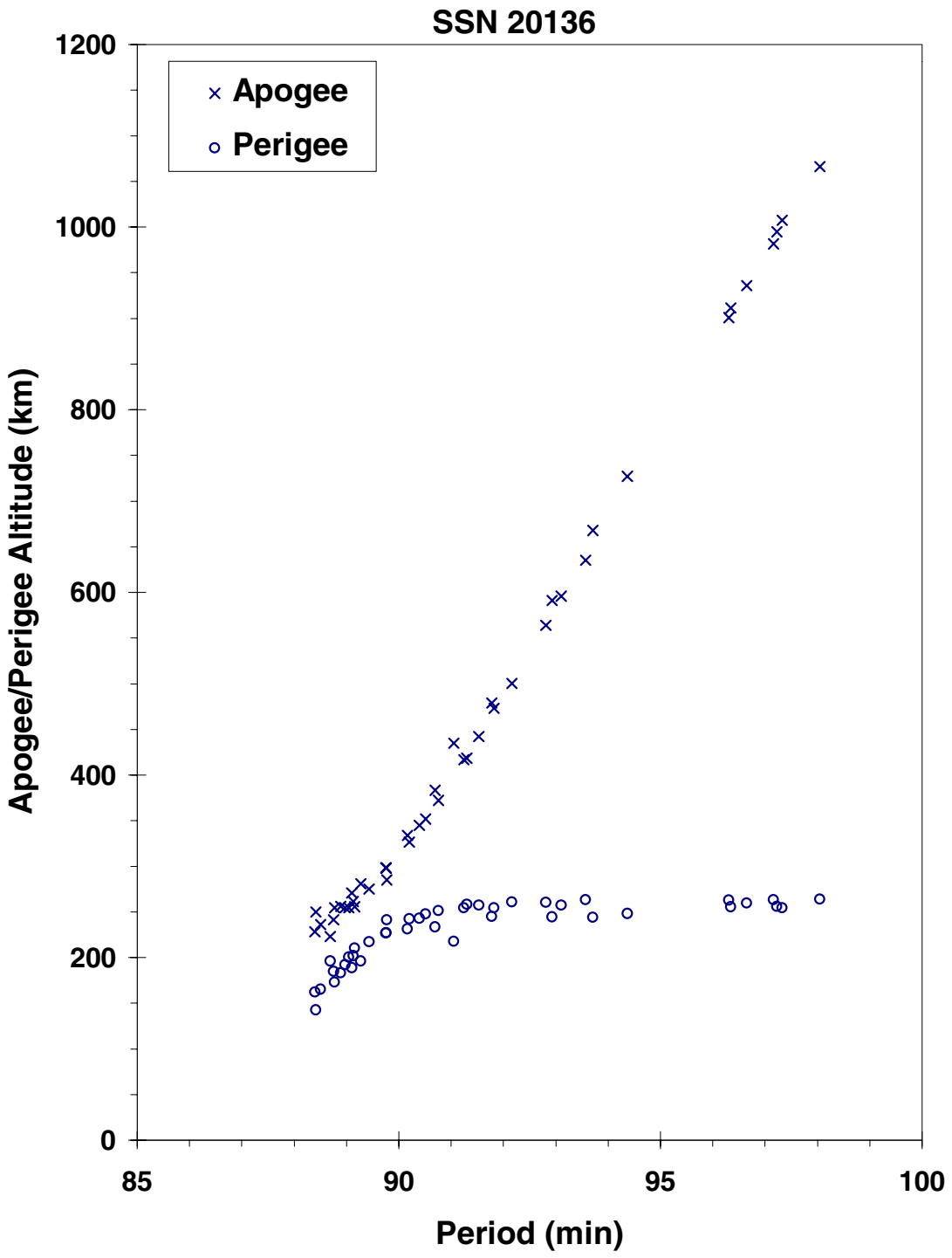
MAXIMUM ΔP:	Unknown
MAXIMUM ΔI:	Unknown

COMMENTS

Spacecraft was destroyed after a malfunction prevented reentry and landing in the Soviet Union.

REFERENCE DOCUMENT

History of Soviet/Russian Satellite Fragmentations-A Joint U.S.-Russian Investigation, N. L. Johnson et al, Kaman Sciences Corporation, October 1995.



Cosmos 2031 debris cloud remnant of 43 objects three days after the event as reconstructed from Naval Space Surveillance System database. This diagram is taken from the cited reference.

MOLNIYA 3-36 **1989-094A** **20338**

SATELLITE DATA

TYPE:	Payload
OWNER:	CIS
LAUNCH DATE:	28.42 Nov 1989
DRY MASS (KG):	1600
MAIN BODY:	Cylinder: 1.4 m diameter by 4.4 m length
MAJOR APPENDAGES:	Solar Panels, antenna
ATTITUDE CONTROL:	None at time of event
ENERGY SOURCES:	Unknown

EVENT DATA

DATE:	~19 May 2000	LOCATION:	Unknown
TIME:	Unknown	ASSESSED CAUSE:	Aerodynamics
ALTITUDE:	Unknown, probably less than 100 km		

PRE-EVENT ELEMENTS

EPOCH:	140.38538624	MEAN ANOMALY:	99.0739
RIGHT ASCENSION:	346.7803	MEAN MOTION:	13.87465052
INCLINATION:	63.3968	MEAN MOTION DOT/2:	.99999999
ECCENTRICITY:	.1173030	MEAN MOTION DOT DOT/6:	-.000020887
ARG. OF PERIGEE:	249.1246	BSTAR:	.0017249

DEBRIS CLOUD DATA

MAXIMUM ΔP:	Unknown
MAXIMUM ΔI:	Unknown

COMMENTS

This event was similar to the breakup of Molniya 3-16 in February 1998. In both cases the perigees of the spacecraft were less than 100 km, and the vehicles were within 24 hours of reentry. The breakups are assessed to have been caused by severe aerodynamic forces as the spacecraft decayed from highly elliptical orbits. The debris is likely to have been related to solar panels and other spacecraft appendages. The breakup produced no long-term environmental consequences.

REFERENCE DOCUMENT

"A New Category For Satellite Breakups", The Orbital Debris Quarterly News, NASA JSC, April 1998. Available online at http://sn-callisto.jsc.nasa.gov/newsletter/v3i2/v3i2.html#news2.

Insufficient data to construct a Gabbard diagram.

MOLNIYA FINAL STAGE **1989-094B** **20339**

SATELLITE DATA

TYPE:	Molniya Rocket Body
OWNER:	CIS
LAUNCH DATE:	28.42 Nov 1989
DRY MASS (KG):	1100
MAIN BODY:	Cylinder; 2.7 m diameter by 3.0 m length
MAJOR APPENDAGES:	None
ATTITUDE CONTROL:	None
ENERGY SOURCES:	On-board propellants ?

EVENT DATA

DATE:	28 Jun 2000	LOCATION:	Unknown
TIME:	Unknown	ASSESSED CAUSE:	Aerodynamic
ALTITUDE:	Unknown		

PRE-EVENT ELEMENTS

EPOCH:	00179.25366538	MEAN ANOMALY:	307.0966
RIGHT ASCENSION:	9.4642	MEAN MOTION:	8.69482942
INCLINATION:	63.6040	MEAN MOTION DOT/2:	.19857645
ECCENTRICITY:	.3538917	MEAN MOTION DOT DOT/6:	.0000026326
ARG. OF PERIGEE:	244.9420	BSTAR:	.00038122

DEBRIS CLOUD DATA

MAXIMUM ΔP:	Unknown
MAXIMUM ΔI:	Unknown

COMMENTS

This rocket body was associated with the Molniya 3-36 communication spacecraft, satellite number 20338, which suffered aerodynamic breakup on 19 May 2000. In both cases the perigees of the spacecraft were less than 100 km, and the vehicles were within 24 hours of reentry. Any debris created was likely to have been related to spacecraft appendages. No long-term environmental consequences are expected.

REFERENCE DOCUMENT

"A New Category for Satellite Breakups", The Orbital Debris Quarterly News, NASA JSC, April 1998. Available on-line at http://sn-callisto.jsc.nasa.gov/newsletter/v3i2/v3i2.html#news2.

Insufficient data to construct a Gabbard diagram.

COSMOS 2054 ULLAGE MOTOR 1989-101E 20399

SATELLITE DATA

TYPE:	Mission Related Debris
OWNER:	CIS
LAUNCH DATE:	27.47 Dec 1989
DRY MASS (KG):	55
MAIN BODY:	Ellipsoid; 0.6 m diameter by 1 m length
MAJOR APPENDAGES:	None
ATTITUDE CONTROL:	None
ENERGY SOURCES:	On-board propellants

EVENT DATA

DATE:	Jul 1992 (?)	LOCATION:	Unknown
TIME:	Unknown	ASSESSED CAUSE:	Propulsion
ALTITUDE:	Unknown		

PRE-EVENT ELEMENTS

EPOCH:	92182.661921495	MEAN ANOMALY:	6.2737
RIGHT ASCENSION:	305.7529	MEAN MOTION:	2.98492104
INCLINATION:	47.1115	MEAN MOTION DOT/2:	.00001757
ECCENTRICITY:	.6700939	MEAN MOTION DOT DOT/6:	.0
ARG. OF PERIGEE:	319.3202	BSTAR:	.0014976

DEBRIS CLOUD DATA

MAXIMUM ΔP:	Unknown
MAXIMUM ΔI:	Unknown

COMMENTS

Parent satellite was one of two small engine units which are routinely released after the first burn of the Proton fourth stage. The nature of these objects was identified by Dr. Boris V. Chernlatiev, Deputy Constructor for the Energiya NPO, in October, 1992. The cause of this fragmentation is assumed to be related to the residual hypergolic propellants on board and failure of the membrane separating the fuel and oxidizer. NAVSPASUR observed 18 objects which were associated with this breakup. Twelve element sets were generated, but were of insufficient quality for a credible Gabbard Diagram or BLAST point. One object was cataloged on this event in early August, 1992. This was the fifth in a series of fragmentations of this object type, and was the first located in a geosynchronous transfer orbit.

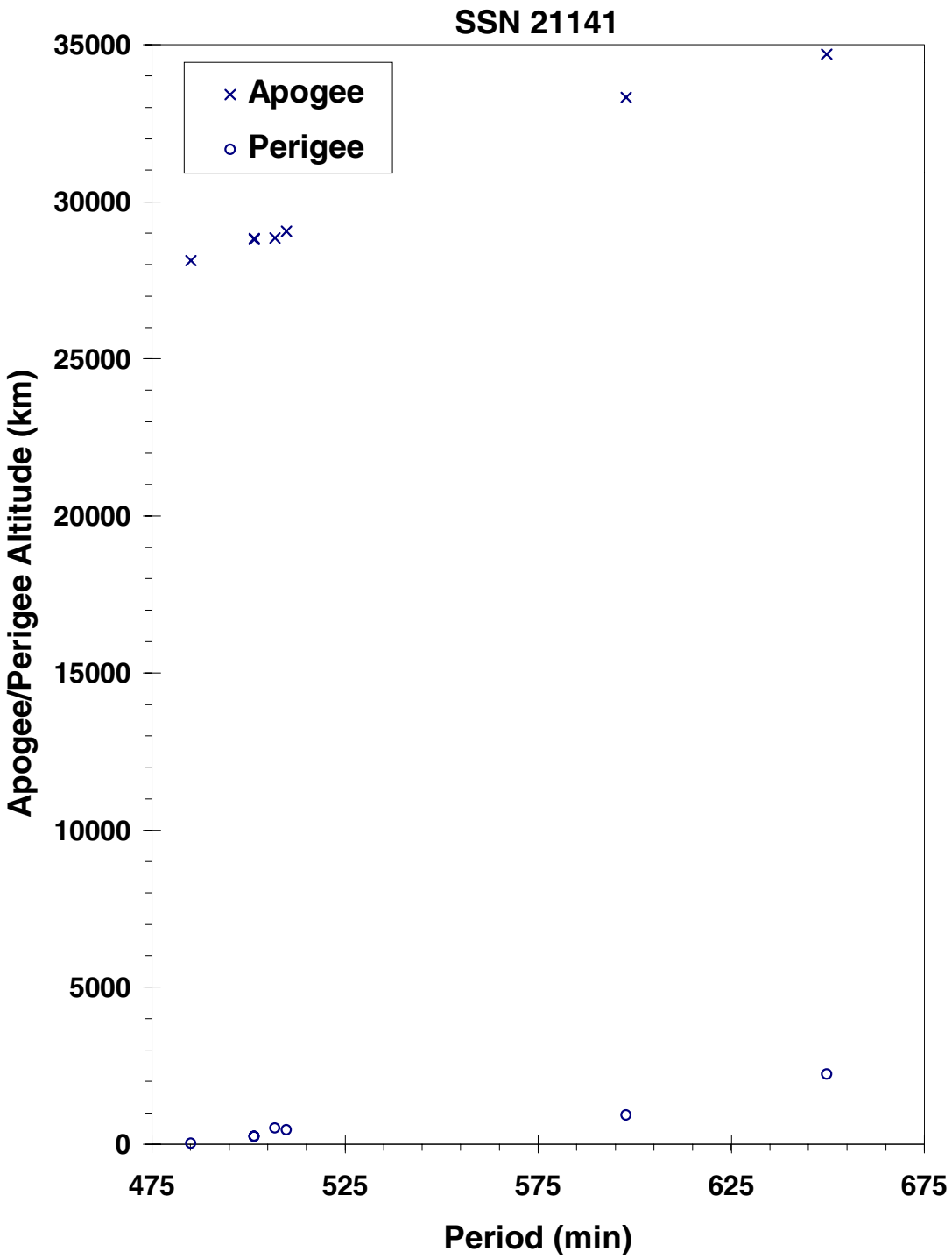
REFERENCE DOCUMENTS

The Fragmentation of Proton Debris, D. J. Nauer, TBE Technical Report CS93-LKD-004, Teledyne Brown Engineering, Colorado Springs, 31 December 1992.

Analysis of Fragmentations From December 1992 - February 1993, TBE Technical Report CS93-LKD-010, Teledyne Brown Engineering, Colorado Springs, 30 March 1993.

History of Soviet/Russian Satellite Fragmentations-A Joint U.S.-Russian Investigation, N. L. Johnson et al, Kaman Sciences Corporation, October 1995.

"Identification and Resolution of an Orbital Debris Problem with the Proton Launch Vehicle", B. V. Cherniatiev et al, Proceedings of the First European Conference on Space Debris, April 1993.



Astra 1B/MOP 2 R/B debris cloud of 7 fragments as reconstructed from US SSN database.

COSMOS 2157-2162 R/B **1991-068G** **21734**

SATELLITE DATA

TYPE:	Tsyklon Third Stage
OWNER:	CIS
LAUNCH DATE:	28.30 Sep 1991
DRY MASS (KG):	1360
MAIN BODY:	Cone-cylinder; 2.1 m diameter by 2.4 m length
MAJOR APPENDAGES:	None
ATTITUDE CONTROL:	None
ENERGY SOURCES:	Unknown

EVENT DATA

DATE:	09 Oct 1999	LOCATION:	41.5N, 217.9E
TIME:	1508 GMT	ASSESSED CAUSE:	Unknown
ALTITUDE:	1460 km		

PRE-EVENT ELEMENTS

EPOCH:	99281.98318497	MEAN ANOMALY:	220.2415
RIGHT ASCENSION:	96.5043	MEAN MOTION:	12.54216420
INCLINATION:	82.5731	MEAN MOTION DOT/2:	.00000027
ECCENTRICITY:	.0046780	MEAN MOTION DOT DOT/6:	.0
ARG. OF PERIGEE:	140.1600	BSTAR:	.00010000

DEBRIS CLOUD DATA

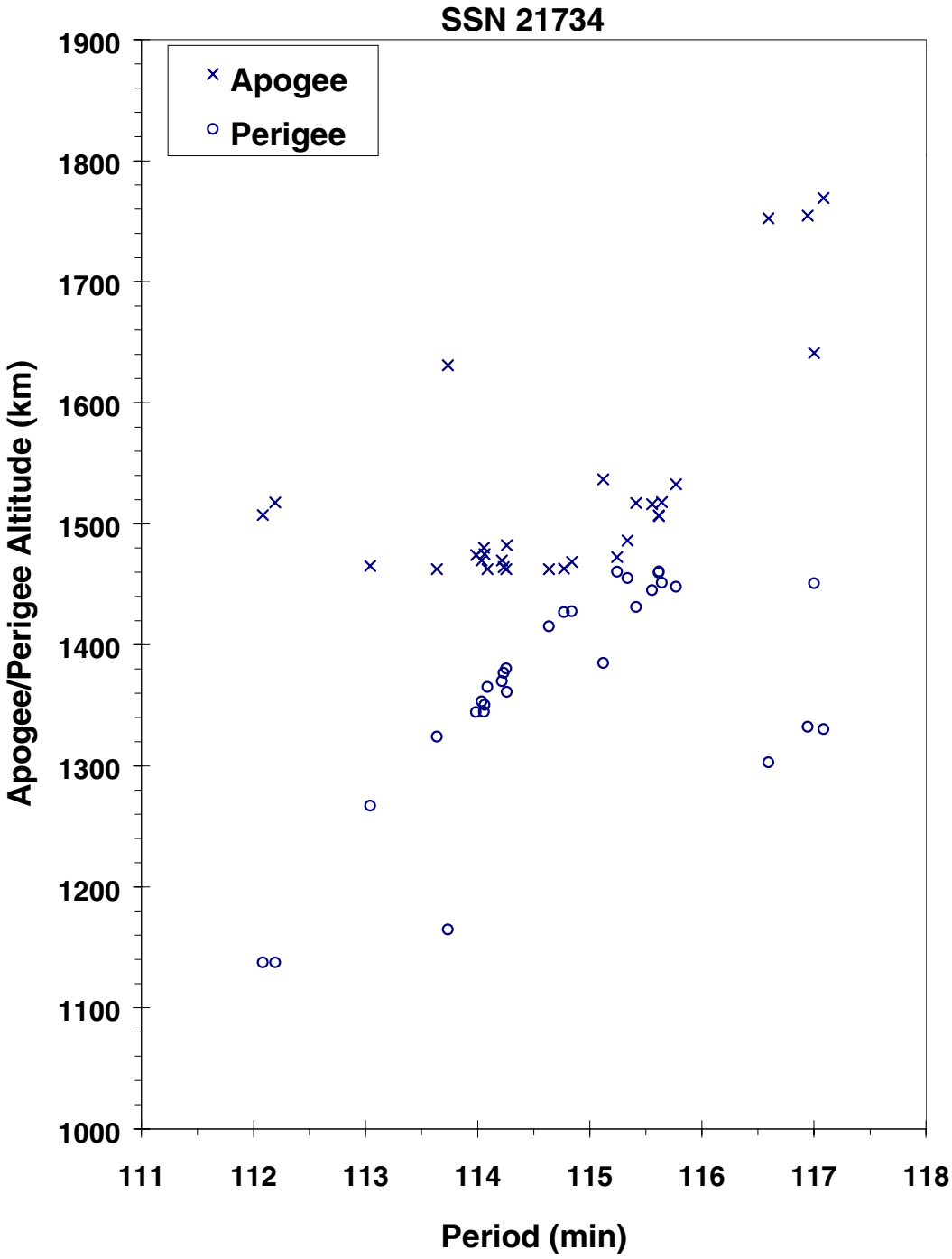
MAXIMUM ΔP:	2.716 min
MAXIMUM ΔI:	0.79 deg

COMMENTS

This is the 4th event of this class identified to date and the second of 1999. All stages have been about 8-10 years old at the time of breakup. The vehicle is a Ukrainian-produced stage, using UDMH and N_2O_4 as propellants. To date these stages have not been passivated at end of mission and may contain up to 300 kg of residual propellants. The issue of Tsyklon orbital stage breakups was discussed with representatives of the National Space Agency of Ukraine during 11-13 October 1999 in Darmstadt, Germany. More than 100 of these stages are currently in Earth orbit. Although the exact cause of these breakups remains unknown, all four events have occurred during periods of high solar flux, i.e., near solar maximum.

REFERENCE DOCUMENT

"Third Tsyklon Upper Stage Breaks Up", The Orbital Debris Quarterly News, NASA JSC, July 1999. Available online at http://sn-callisto.jsc.nasa.gov/newsletter/v4i3/v4i3-2.html#news7.



Cosmos 2157-2162 rocket body debris cloud of 31 fragments within one day of the event as reconstructed from US SSN database.

COSMOS 2163 **1991-071A** **21741**

SATELLITE DATA

TYPE:	Payload
OWNER:	CIS
LAUNCH DATE:	9.55 October 1991
DRY MASS (KG):	6500
MAIN BODY:	Cylinder; 2.4 m diameter by 7 m length
MAJOR APPENDAGES:	Solar panels
ATTITUDE CONTROL:	Active, 3-axis
ENERGY SOURCES:	On-board propellants, explosive charge

EVENT DATA

DATE:	6 December 1991	LOCATION:	55N, 154E (dsc)
TIME:	2021 GMT	ASSESSED CAUSE:	Deliberate
ALTITUDE:	210 km		

PRE-EVENT ELEMENTS

EPOCH:	91340.51933896	MEAN ANOMALY:	213.3470
RIGHT ASCENSION:	37.7884	MEAN MOTION:	16.18797546
INCLINATION:	64.7678	MEAN MOTION DOT/2:	.00862876
ECCENTRICITY:	.0054670	MEAN MOTION DOT DOT/6:	.000035685
ARG. OF PERIGEE:	147.5032	BSTAR:	.00035926

DEBRIS CLOUD DATA

MAXIMUM ΔP:	>9.8 min*
MAXIMUM ΔI:	0.2 deg*

*Based on uncataloged debris data

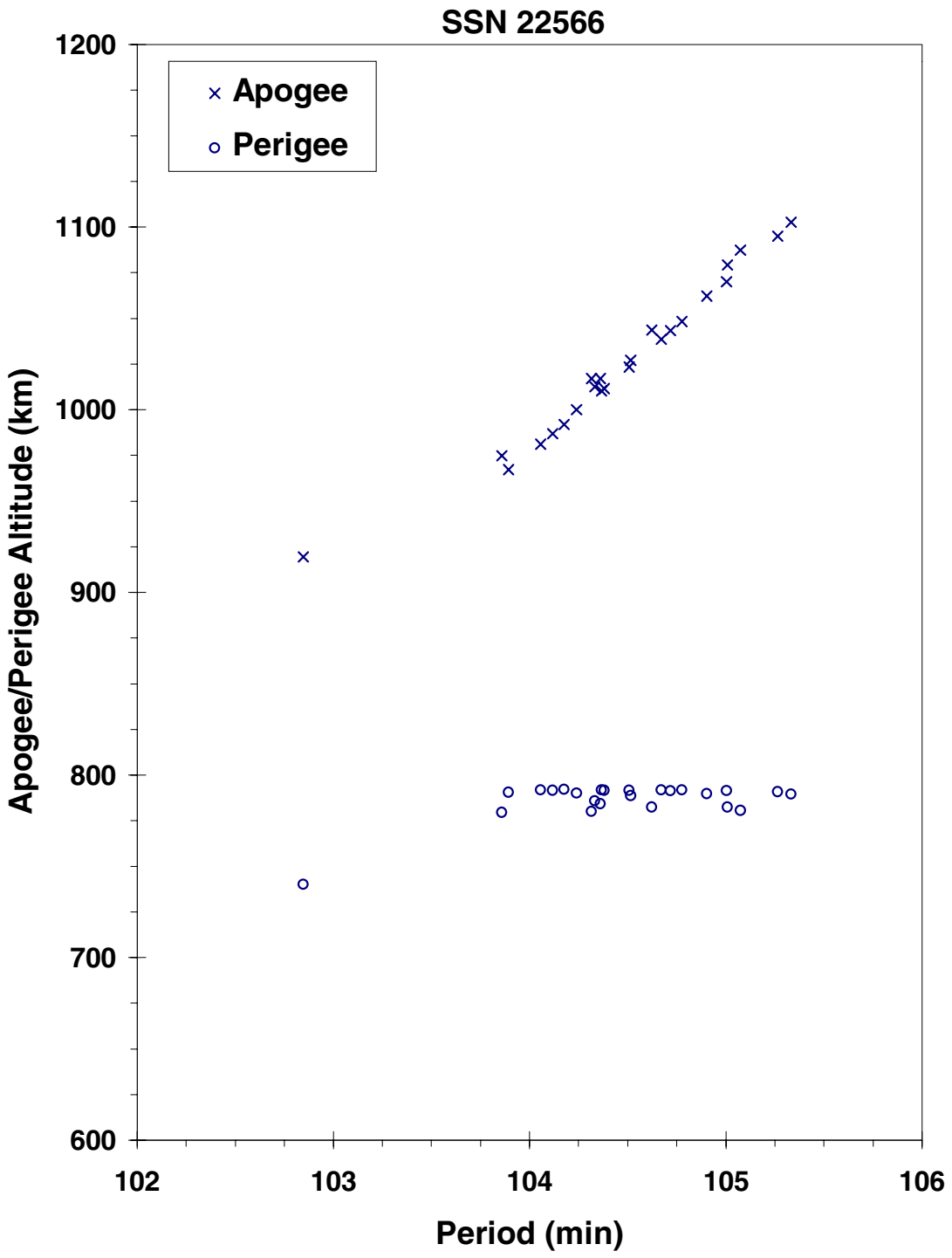
COMMENTS

Spacecraft was destroyed with a planned detonation. Third fragmentation of the Cosmos 2031 subclass. Early elements on only 8 objects available. All debris reentered before being officially cataloged.

REFERENCE DOCUMENTS

The Fragmentation of Kosmos 2163, Technical Report CS92-TR-JSC-002, Teledyne Brown Engineering, Colorado Springs, Colorado, January 1992.

History of Soviet/Russian Satellite Fragmentations-A Joint U.S.-Russian Investigation, N. L. Johnson et al, Kaman Sciences Corporation, October 1995.



Naval Space Surveillance System generated 24 initial element sets which are plotted on the Gabbard diagram above.

COSMOS 2238 **1993-018A** **22585**

SATELLITE DATA

TYPE:	Payload
OWNER:	CIS
LAUNCH DATE:	30.50 Mar 1993
DRY MASS (KG):	3000
MAIN BODY:	Cylinder; 1.3 m diameter by 17 m long
MAJOR APPENDAGES:	Solar panels
ATTITUDE CONTROL:	Active, 3-axis
ENERGY SOURCES:	On-board propellants, explosive charge (?)

EVENT DATA

DATE:	1 Dec 1994	LOCATION:	6.5 S, 243.0 E
TIME:	1111 GMT	ASSESSED CAUSE:	Unknown
ALTITUDE:	275 km		

PRE-EVENT ELEMENTS

EPOCH:	94335.21831221	MEAN ANOMALY:	119.6648
RIGHT ASCENSION:	124.7826	MEAN MOTION:	16.06466469
INCLINATION:	65.0063	MEAN MOTION DOT/2:	.00787680
ECCENTRICITY:	.0069696	MEAN MOTION DOT DOT/6:	.0000095760
ARG. OF PERIGEE:	239.7651	BSTAR:	.00073936

DEBRIS CLOUD DATA

MAXIMUM ΔP:	Unknown
MAXIMUM ΔI:	Unknown

COMMENTS

Cosmos 2238 was a member of the Cosmos 699-type and the first such spacecraft to breakup for seven years. As many as 26 debris were detected; however, additional debris probably decayed before they were observed.

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Insufficient data to construct a Gabbard diagram.

COSMOS 2243 **1993-028A** **22641**

SATELLITE DATA

TYPE:	Payload
OWNER:	CIS
LAUNCH DATE:	27.44 Apr 1993
DRY MASS (KG):	6700
MAIN BODY:	Cone-cylinder; 2.4 m diameter by 7.0 m length
MAJOR APPENDAGES:	Solar panels
ATTITUDE CONTROL:	Active, 3-axis
ENERGY SOURCES:	On-board propellants, explosive charge

EVENT DATA

DATE:	27 Apr 1993	LOCATION:	61N, 81E (asc)
TIME:	1044 GMT	ASSESSED CAUSE:	Deliberate
ALTITUDE:	200 km		

PRE-EVENT ELEMENTS *

EPOCH:	93119.28633059	MEAN ANOMALY:	283.6524
RIGHT ASCENSION:	51.8515	MEAN MOTION:	16.26199828
INCLINATION:	70.3602	MEAN MOTION DOT/2:	.02823100
ECCENTRICITY:	.0032877	MEAN MOTION DOT DOT/6:	.000019668
ARG. OF PERIGEE:	76.8057	BSTAR:	.00077017

* Note: Element Set 1 not generated until ~2 days after the event.

DEBRIS CLOUD DATA

MAXIMUM ΔP:	7.1 min
MAXIMUM ΔI:	0.4 deg

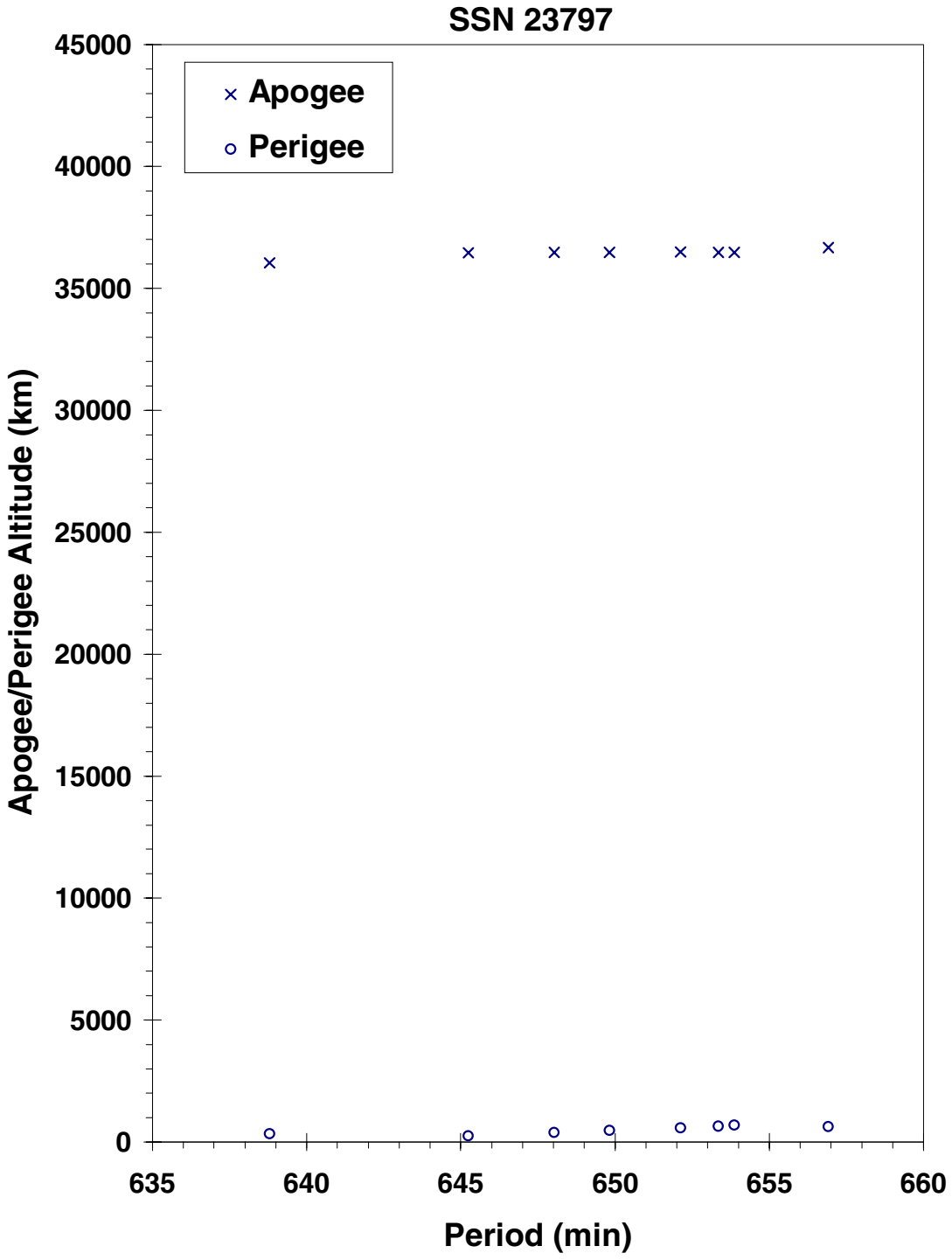
COMMENTS

Although this event was originally thought to be a fragmentation of the Soyuz final stage rocket body, it was actually the payload which fragmented. This event occurred near orbital insertion into the operational orbit. It is unclear whether the payload was attached at the time of the event. The payload malfunctioned and self-destructed. There were 25 initial element sets available after launch. NAVSPASUR reported tracking approximately 27 objects on 30 April 1993, and detected as many as 20 more unknowns. The final official piece count associated with this event was 172 objects. Due to the very low altitude, most objects decayed from this cloud within 2 weeks of launch. No cataloged element sets were released until almost 2 days after the event.

REFERENCE DOCUMENTS

The Fragmentation of the Cosmos 2237 & 2243 Rocket Bodies, D. J. Nauer, TBE Technical Report CS93-LKD-016, Teledyne Brown Engineering, Colorado Springs, 15 June 1993.

History of Soviet/Russian Satellite Fragmentations-A Joint U.S.-Russian Investigation, N. L. Johnson et al, Kaman Sciences Corporation, October 1995.



Gabbard diagram from Raduga 33 from NAVSPOC elements.

GORIZONT 32 ULLAGE MOTOR 1996-034F 23887

SATELLITE DATA

TYPE:	Mission Related Debris
OWNER:	CIS
LAUNCH DATE:	25.09 May 1996
DRY MASS (KG):	~55
MAIN BODY:	Ellipsoid; 0.6 m by 1 m
MAJOR APPENDAGES:	None
ATTITUDE CONTROL:	Unknown
ENERGY SOURCES:	On-board Propellants

EVENT DATA

DATE:	~13 Dec 1999	LOCATION:	Unknown
TIME:	Unknown	ASSESSED CAUSE:	Propulsion-Related
ALTITUDE:	Unknown		

PRE-EVENT ELEMENTS

EPOCH:	99347.02294368	MEAN ANOMALY:	314.8549
RIGHT ASCENSION:	194.3249	MEAN MOTION:	9.75630550
INCLINATION:	46.4558	MEAN MOTION DOT/2:	.00969995
ECCENTRICITY:	.2950283	MEAN MOTION DOT DOT/6:	.0000015400
ARG. OF PERIGEE:	75.9037	BSTAR:	.00055450

CATALOGED DEBRIS CLOUD DATA

MAXIMUM ΔP:	Unknown
MAXIMUM ΔI:	Unknown

COMMENTS

This is 21st breakup event for an object of this class, and the third in 1999. The breakups are believed to be caused by residual propellants. Russian officials have been aware of the problem since 1992 and have made design changes, although the date of full implementation is unknown. This is the most recently launched object to breakup (age = ~3.5 years). The environmental consequence of the breakup was short-lived; the object was in catastrophic decay from a geosynchronous transfer orbit.

REFERENCE DOCUMENTS

The Fragmentation of Proton Debris, D. J. Nauer, TBE Technical Report CS93-LKD-004, Teledyne Brown Engineering, Colorado Springs, 31 December 1992.

Analysis of Fragmentations From December 1992 - February 1993, TBE Technical Report CS93-LKD-010, Teledyne Brown Engineering, Colorado Springs, 30 March 1993.

Insufficient data to construct a Gabbard diagram.

COSMOS 2343 **1997-024A** **24805**

SATELLITE DATA

TYPE:	Payload
OWNER:	CIS
LAUNCH DATE:	15.51 May 1997
DRY MASS (KG):	6500
MAIN BODY:	Cylinder; 2.4 m diameter by 7 m length
MAJOR APPENDAGES:	Solar arrays
ATTITUDE CONTROL:	Active, 3-axis
ENERGY SOURCES:	On-board propellants, explosive charge

EVENT DATA

DATE:	16 Sep 1997	LOCATION:	58.2 N, 157.5 E (asc.)
TIME:	2208 GMT	ASSESSED CAUSE:	Deliberate
ALTITUDE:	230 km		

PRE-EVENT ELEMENTS

EPOCH:	97258.16080604	MEAN ANOMALY:	247.0345
RIGHT ASCENSION:	1.1478	MEAN MOTION:	16.06645410
INCLINATION:	64.8485	MEAN MOTION DOT/2:	0.00206295
ECCENTRICITY:	0.0048612	MEAN MOTION DOT DOT/6:	0.000026376
ARG. OF PERIGEE:	113.5945	BSTAR:	0.00022999

DEBRIS CLOUD DATA

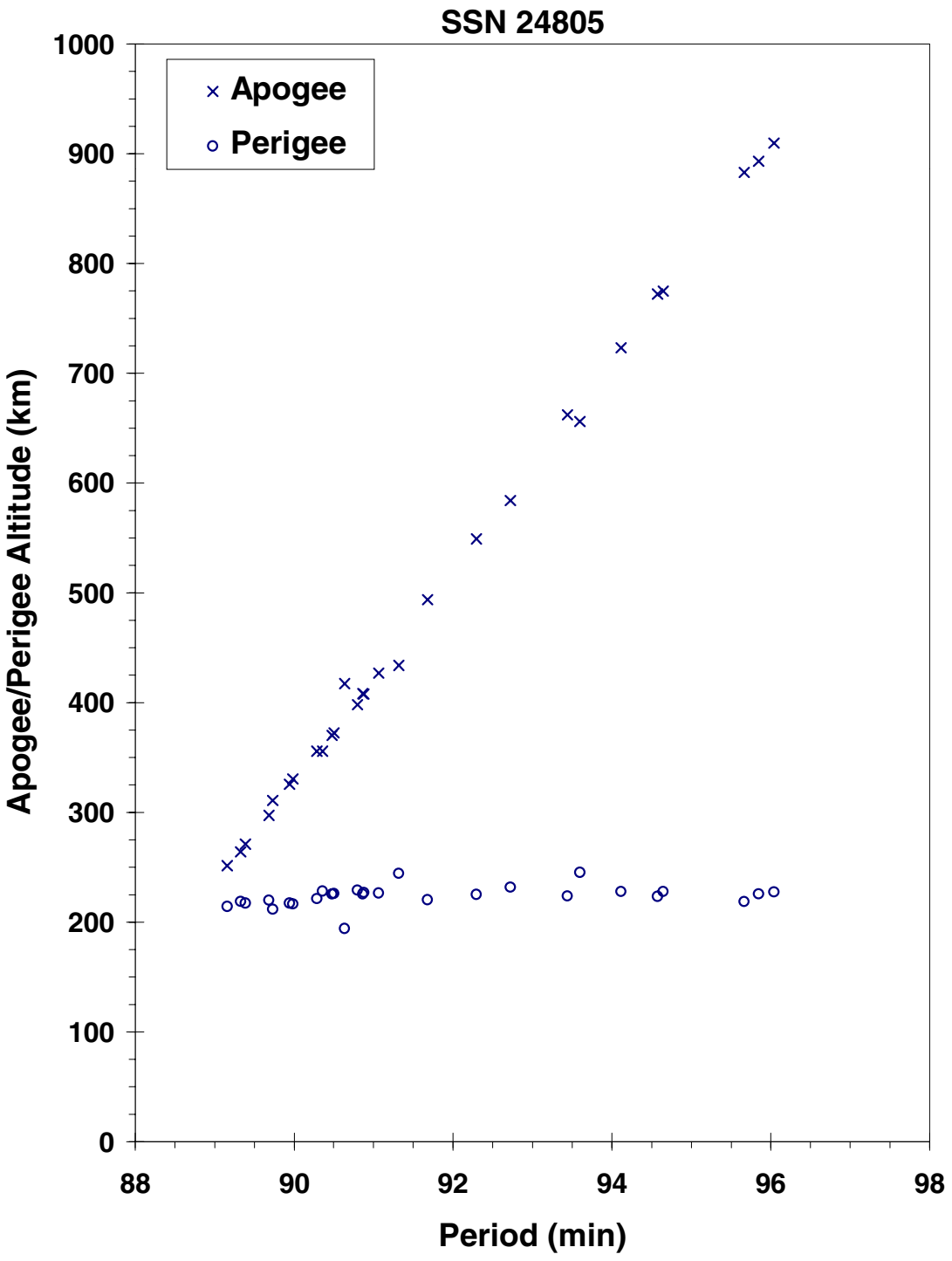
MAXIMUM ΔP:	7.3 min
MAXIMUM ΔI:	0.9 deg

COMMENTS

Cosmos 2343 was the sixth of the Cosmos 2031 class of spacecraft which debuted in 1989 but was not flown since 1993. In all five previous missions (1989-1993), the spacecraft was deliberately exploded at the end of mission. Previous missions of this type include Cosmos 2031, Cosmos 2101, Cosmos 2163, Cosmos 2225, and Cosmos 2262. All such events have occurred over Eastern Russia. This event, as with three of the previous events, occurred over the Kamchatka Peninsula. Highest previous piece count for large debris for this class of vehicle was 180, although more were probably created. Due to the low altitude of the breakup, the debris were short-lived.

REFERENCE DOCUMENT

"International LEO Spacecraft Breakup in September", N. L. Johnson, The Orbital Debris Quarterly News, NASA JSC, Oct.-Dec 1997, p. 2.



Cosmos 2343 debris cloud of 28 fragments as reconstructed from US SSN database.

COSMOS 2347 **1997-079A** **25088**

SATELLITE DATA

TYPE:	Payload
OWNER:	CIS
LAUNCH DATE:	9.30 Dec 1997
DRY MASS (KG):	3000
MAIN BODY:	1.3 m diameter by 17 m length, plus solar arrays
MAJOR APPENDAGES:	Solar arrays
ATTITUDE CONTROL:	Active, 3-axis
ENERGY SOURCES:	On-board propellants, explosive charge ?

EVENT DATA

DATE:	22 Nov 1999	LOCATION:	31.6N, 4.3E
TIME:	0440 GMT	ASSESSED CAUSE:	Unknown
ALTITUDE:	370 km		

PRE-EVENT ELEMENTS

EPOCH:	99325.85267585	MEAN ANOMALY:	85.1293
RIGHT ASCENSION:	332.8746	MEAN MOTION:	15.83563975
INCLINATION:	65.0115	MEAN MOTION DOT/2:	.00295116
ECCENTRICITY:	.0134056	MEAN MOTION DOT DOT/6:	.000036131
ARG. OF PERIGEE:	273.4567	BSTAR:	.00065869

DEBRIS CLOUD DATA

MAXIMUM ΔP:	2.834 min
MAXIMUM ΔI:	0.22 deg

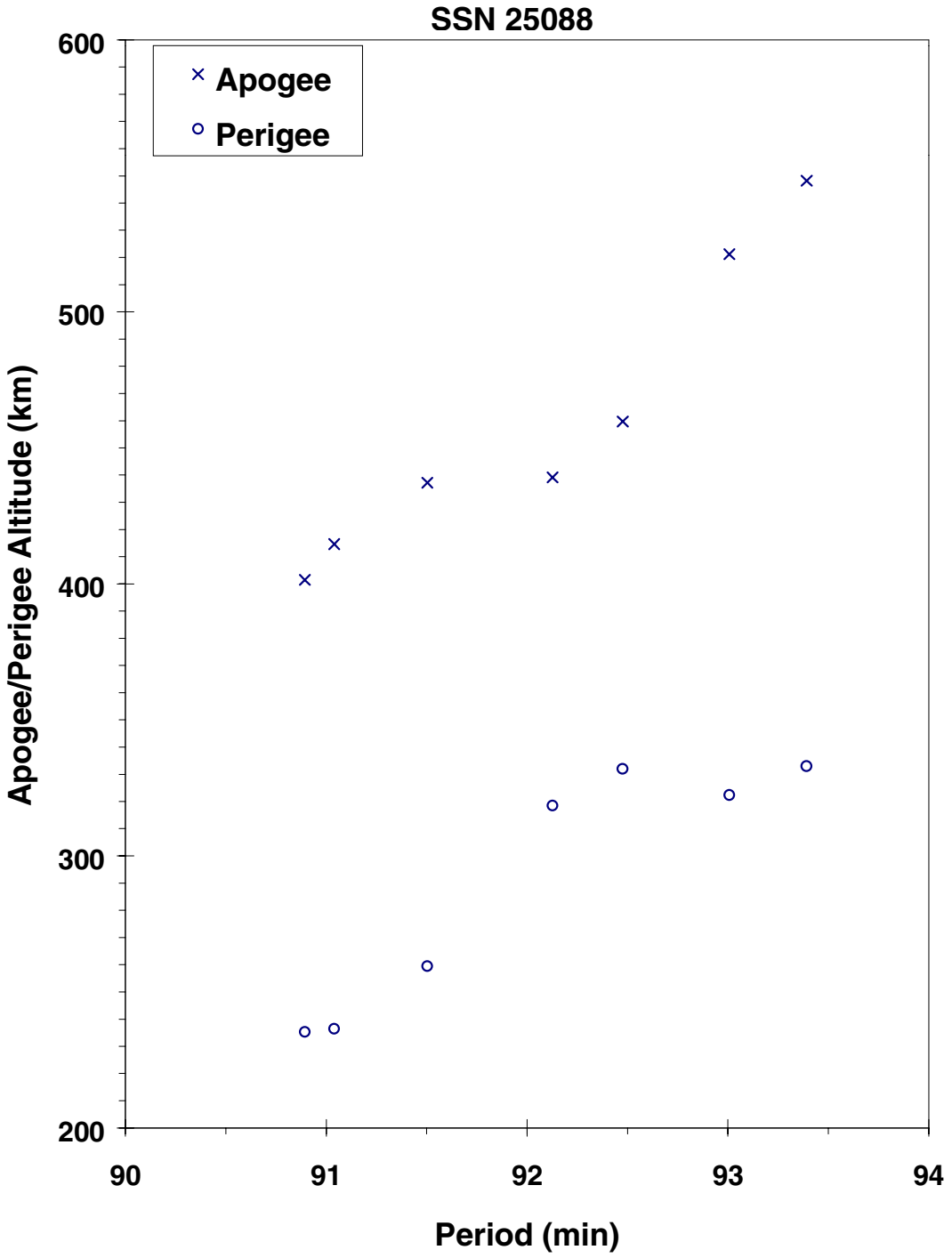
COMMENTS

Cosmos 2347 was the 18th spacecraft of this type known to have experienced a major fragmentation. Such events were common prior to 1988, but only three breakups have occurred during the past 12 years: Cosmos 2347, Cosmos 2238 (1 Dec 1994), and Cosmos 2313 (26 June 1997). In this case Cosmos 2347 had performed a standard end-of-mission maneuver on 19 November 1999, a little more than two days before the breakup. Extensive analyses of these events have been conducted, although the cause is still unknown in the open literature.

A second breakup of Cosmos 2347 was discovered on 10 December when the spacecraft's orbit had decayed to 175 km by 250 km. Three dozen new debris were detected after the second event, but the very low altitude made it difficult to assess accurately the number of large debris. Prior spacecraft (especially Cosmos 1220, 1260, and 1306) also experienced multiple fragmentations.

REFERENCE DOCUMENT

"Satellite Breakups Increase in Last Quarter of 1999", The Orbital Debris Quarterly News, NASA JSC, January 2000. Available online at http:/sn-callisto.jsc.nasa.gov/newlsetter/v5i1/v5i1.html#news2.



Cosmos 2347 debris cloud of 7 fragments within one day of the event as reconstructed from US SSN database.

ASIASAT 3 R/B (2) **1997-086D** **25129**

SATELLITE DATA

TYPE:	Proton Block DM Fourth Stage
OWNER:	CIS
LAUNCH DATE:	24.97 Dec 1997
DRY MASS (KG):	3400 (?)
MAIN BODY:	Cylinder; 3.7 m diameter by 6.3 m length
MAJOR APPENDAGES:	None
ATTITUDE CONTROL:	Active, 3-axis
ENERGY SOURCES:	On-board propellants

EVENT DATA

DATE:	25 Dec 1997	LOCATION:	0.3 S, 91.2 E (dsc)
TIME:	0550 GMT	ASSESSED CAUSE:	Propulsion
ALTITUDE:	35995 km		

POST-EVENT ELEMENTS

EPOCH:	97359.90803672	MEAN ANOMALY:	359.8589
RIGHT ASCENSION:	92.0594	MEAN MOTION:	2.26580509
INCLINATION:	51.4499	MEAN MOTION DOT/2:	-0.00000507
ECCENTRICITY:	0.7304004	MEAN MOTION DOT DOT/6:	0
ARG. OF PERIGEE:	1.0181	BSTAR:	0

DEBRIS CLOUD DATA

MAXIMUM ΔP:	Unknown
MAXIMUM ΔI:	Unknown

COMMENTS

The commercial Asiasat 3 spacecraft was launched by a Proton launch vehicle at 2319 GMT, 24 December 1997. The fourth stage completed its first burn successfully about 0035 GMT, 25 December, placing the R/B-S/C combination into a GTO. When the vehicle reached its first apogee, the main engine was restarted but shutdown within one second, apparently due to a catastrophic failure. The U.S. Space Surveillance Network detected less than 10 objects, and by 9 January only 1-2 were still being observed. The fragmentation is similar to the breakup of the Raduga 33 upper stage on 19 Feb 1996. In that case, nearly 200 debris were detected by the SSN.

REFERENCE DOCUMENT

"Recent Satellite Fragmentation Investigations", N. L. Johnson, The Orbital Debris Quarterly News, January 1998, p. 3.

Insufficient data to construct a Gabbard diagram.

CBERS-1 / SACI-1 R/B **1999-057C** **25942**

SATELLITE DATA

TYPE:	Long March 4 third stage
OWNER:	PRC
LAUNCH DATE:	14.14 Oct 1999
DRY MASS (KG):	1000
MAIN BODY:	Cylinder nozzle; 2.9 m diameter by ~5 m length
MAJOR APPENDAGES:	None
ATTITUDE CONTROL:	None
ENERGY SOURCES:	On-board propellants

EVENT DATA

DATE:	11 Mar 2000	LOCATION:	51.2S, 48.5W
TIME:	1304 UTC	ASSESSED CAUSE:	Propulsion
ALTITUDE:	741 km		

PRE-EVENT ELEMENTS

EPOCH:	00069.14898026	MEAN ANOMALY:	43.0989
RIGHT ASCENSION:	145.5131	MEAN MOTION:	14.46866365
INCLINATION:	98.5373	MEAN MOTION DOT/2:	.00001603
ECCENTRICITY:	.0012467	MEAN MOTION DOT DOT/6:	.0
ARG. OF PERIGEE:	316.9224	BSTAR:	.00045410

DEBRIS CLOUD DATA

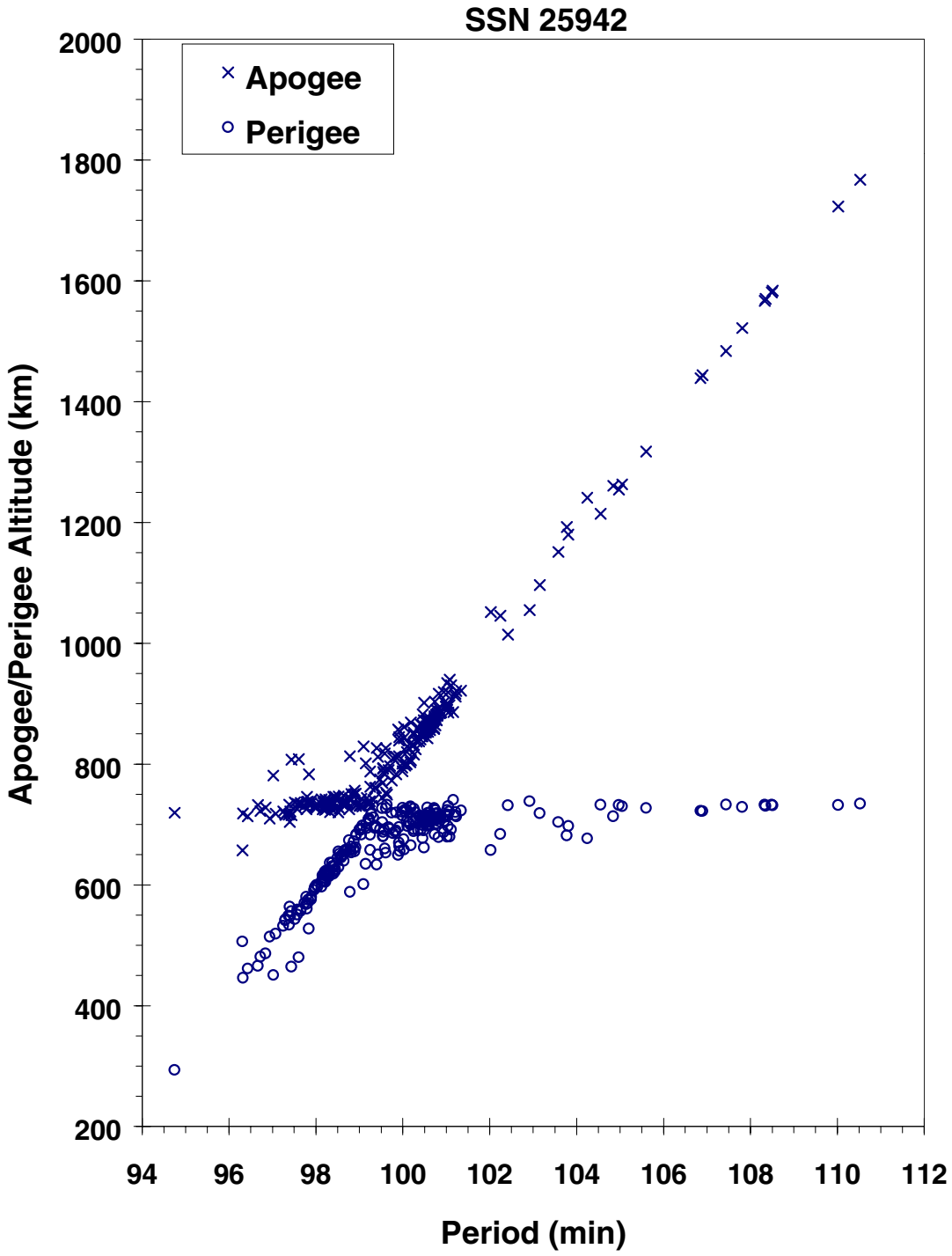
MAXIMUM ΔP:	10.985 min
MAXIMUM ΔI:	0.99 deg

COMMENTS

This is the second Long March 4 to breakup in only four missions. The first breakup (flight 2) occurred on 4 Oct 1990, one month after launch. Long March 4 missions did not resume until 1999, when two more were flown. This breakup involved the second 1999 mission (flight 4) and occurred five months after launch. This event has created more trackable debris than the 1990 breakup, with more than 300 pieces tracked by the SSN. Chinese officials were aware of the international concern following the 1990 breakup and had pledged to adopt countermeasures before the 1999 missions. Passivation of this vehicle may have been attempted.

REFERENCE DOCUMENT

"Analyzing the Cause of LM-4 (A)'s Upper Stage's Disintegration and the Countermeasures", W. X. Zang and S. Y. Liao, 5th International Conference of Pacific Basin Societies, 6-9 Jun 1993, Shanghai.



CBERS-1 / SACI-1 long March 4 third stage debris cloud of 280 fragments within one day of the event as reconstructed from US SSN database.

3.0 SATELLITE ANOMALOUS EVENTS

This section describes the identified anomalous events compiled throughout the years of the Satellite Catalog and orbital debris analysis associated with this volume. No exhaustive search for anomalous events has yet been conducted, although the following compilation should represent the most significant events noted thus far.

3.1 Background and Status

As defined in the introduction of this volume, an **anomalous event** is the unplanned separation, usually at low velocity, of one or more detectable objects from a satellite which remains essentially intact. The assessment that the configuration of the parent satellite has not changed significantly is to a degree subjective and is often based on indirect parameters and not on detailed imagery.

Anomalous events can be caused by material deterioration of items such as thermal blankets, protective shields, or solar panels and by impacts of small debris, either natural or man-made. Other satellite deteriorations, e.g., paint debonding, are known to take place, but are undetectable with the sensors of the U.S. SSN. Interestingly, 24 of the 33 satellites in this section are U.S., 8 are C.I.S. and 1 is Japanese. Of the 33 satellites, 22 are payloads and 11 are rocket bodies. These events are summarized in Tables 3.1 and 3.2.

Because of the usually low velocity of debris ejection and the potential delay in detecting debris liberated in small numbers, the accuracy of the calculated time of separation is often degraded. Hence, only the month and year of each event are provided, although in some cases the time of the event has been narrowed to a shorter interval. As in the previous section, orbital altitudes are cited to the nearest 5 km based on a mean Earth radius and on the last element set prior to the assessed event date.

Anomalous event debris often exhibit unusually high decay rates which are indicative of high area-to-mass ratios. This feature, coupled with the normal small size of the debris, hinders official tracking and cataloging. Consequently, some debris are observed but are lost or decay before being assigned a permanent catalog number. The numbers of cataloged debris listed in this section are only from the anomalous events and do <u>not</u> include normal operational debris identified with the particular launch nor the parent itself.

Historically, anomalous events have often been confused with satellite breakups and have not been the subject of separate, extensive analyses. The list of events in this section is known to be incomplete. Several other satellites have been tentatively tagged as sources of anomalous events. Moreover, preliminary satellite catalog surveys suggest that additional anomalous events have occurred but remain unrecognized as such. Table 3.2 suggests a potential correlation of anomalous events with high solar activity. This section will be updated as future studies warrant.

4.0 OTHER SATELLITES ASSOCIATED WITH FRAGMENTATIONS

Satellite fragmentation lists compiled by other organizations, in particular by the National Security Council and NAVSPASUR, were carefully reviewed during the preparation of the fourth edition of the History of On-Orbit Satellite Fragmentations. However, due to the frequent exchange of information within the small orbital debris and space operations community and the long period during which satellite fragmentation lists have been maintained, no current list is completely independent from all others.

These reviews also revealed the need to define better the terms "satellite breakup" and "anomalous event" as discussed in Section 1.0. Many "breakup" lists have historically included entries related to normal launch and mission activities which resulted in numbers of debris in excess of the handful usually observed on these occasions. Some researchers have been misled by tracking difficulties and cataloging procedures which may cause late cataloging or misidentification of debris, superficially giving the appearance of fragmentations. A higher than average number of debris alone is not sufficient to assume a satellite fragmentation. Such pitfalls can generally be avoided by conducting analyses with complete satellite element set data rather than the limited orbital data available in the U.S. Satellite Catalog.

The following space missions, listed by international designator, have been examined in detail and have failed to qualify as either satellite breakup or anomalous event as set forth in Section 1.0. The source of debris associated with nearly all of these flights is of an operational nature. This list has not been updated since the fourth edition.

1965-73	1973-27	1984-08
1965-112	1973-75	1985-21
1967-01	1974-74	1985-75
1967-11	1976-12	1985-97
1967-24	1976-124	1986-24
1967-86	1977-42	1986-30
1968-117	1978-43	1986-52
1969-21	1979-08	1986-101
1970-05	1979-63	1988-19
1970-33	1980-83	1988-67
1970-65	1981-93	
1971-41	1982-06	
1972-78	1982-07	

5.0 SATELLITES NOT ASSOCIATED WITH BREAKUPS

The table below identifies specific SSN numbers of objects which possess the same International Designator year and number but are not associated with the indicated event. For example, 1961-015C was an Ablestar rocket body which broke up. The mission deployed two objects (Transit 4A and Solrad 3/Injun 1) which were not associated with the rocket body explosion. Those two objects are not counted in the 1961-015 totals, although they definitely are associated with the 1961-015 international designator.

Occasionally it is not obvious whether an object should be included in a fragmentation event. In those cases historical research and historical Satellite Catalogs usually reveal whether an object should be included in the count. The list below represents the best summary of excluded objects. The parent object is always considered a fragment.

The list below is formatted as follows: Line one is the international designator and the number of objects to exclude. Line two is object no 1, object no 2, etc.

Note: If the number of objects to exclude = 0, then there is no line 2. Also, a blank line separates years.

<u>Int'l Designator</u>

1961-015 2
116 117

1962-057 0

1963-047 0

1964-006 28
746 748 750 14427 14428 15786 16544 16545 16546 16547 16548 18589
18686 18966 19010 19173 19990 19991 19992 19993 19994 19995 19996 19997
19998 20101 21621 25278
1964-070 1
920

1965-012 1
1095
1965-020 3
1267 1268 1269
1965-082 1
1624
1965-088 23
1707 1708 1740 1741 1784 1785 1786 1787 1788 1789 1790 1791
1792 1793 1794 1795 1796 1797 1798 1799 1800 1801 1802

1966-012 2
2012 2014
1966-046 3
2186 2189 2190
1966-056 3
2255 2256 2511
1966-059 1
2291
1966-088 0
1966-101 0

1968-003 1
3096
1968-025 1
3170
1968-081 5
3428 3429 3430 3431 5999
1968-090 0
1968-091 1
3505
1968-097 0

1969-029 1
3835
1969-064 1
4051
1969-082 10
4111 4132 4166 4168 4237 4247 4256 4257 4259 4295

1970-025 2
4362 4363
1970-089 1
4597
1970-091 0

1971-015 1
4965
1971-106 4
5650 5664 5665 5672

1972-058 1
6126

1973-017 1
6398
1973-021 2
6434 6436
1973-086 1
6920

1974-089 3
7529 7530 7531
1974-103 1
7588

1975-004 1
7615
1975-052 2
7924 7965
1975-080 1
8192
1975-102 1
8417

1976-063 1
8933

1976-067 2
9013 9016
1976-072 1
9048
1976-077 1
9057
1976-105 3
9496 9497 9506
1976-120 1
9604 9605
1976-123 4
9623 9624 9639 9640
1976-126 3
9643 9644 9645

1977-027 3
9912 9913 9921
1977-047 3
10060 10066 10089
1977-065 3
10143 10145 10156
1977-068 3
10151 10152 10167
1977-092 6
10366 10367 10368 10408 10484 11571
1977-121 1
10532

1978-026 2
10702 10703
1978-083 3
11016 11017 11076
1978-098 2
11080 18605
1978-100 4
11084 11085 11086 11177

1979-017 3
11279 11291 11322
1979-033 2
11334 11367
1979-058 3
11418 11423 11555
1979-077 3
11512 11513 11550
1979-104 3
11645 24754 25098

1980-021 1
11730
1980-028 4
11759 11760 11761 11762
1980-030 1
11766

1980-057 3
11872 11873 11888
1980-085 3
12033 12034 12035
1980-089 1
12055

1981-016 4
12304 12305 12306 12311
1981-028 1
12365
1981-031 3
12377 12378 12384
1981-053 1
12508
1981-054 4
12513 12514 12515 12519
1981-058 3
12548 12549 12561
1981-071 3
12629 12630 12680
1981-072 1
12632
1981-088 5
12818 12819 12820 12821 12822
1981-089 1
12829
1981-108 3
12934 12935 12940

1982-038 1
13151
1982-055 2
13260 13261
1982-088 1
13509
1982-115 4
13685 13686 13692 13693

1983-020 3
13901 13903 20413
1983-022 2
13924 14477
1983-038 6
14036 14037 14038 14041 14042 14043
1983-044 1
14065
1983-070 3
14183 14184 14191
1983-075 5
14208 14209 14229 14631 14928
1983-127 7
14590 14591 14592 14593 14594 14595 14607

1984-011 6
14681 14688 14689 14692 14695 14696
1984-083 1
15168
1984-106 6
15333 15334 15335 15336 15337 17358

1985-030 1
15654
1985-037 7
15697 15698 15699 15700 15701 15702 15715
1985-039 1
15735
1985-042 5
15755 15770 15771 15772 15774
1985-082 1
16055
1985-094 6
16138 16140 16141 16142 16143 16144
1985-118 10
16396 16397 16398 16399 16403 16404 16405 16406 16407 16445
1985-121 5
16434 16435 16436 16437 16438

1986-019 3
16613 16614 16616
1986-059 1
16896
1986-069 0

1987-004 1
17298
1987-020 1
17536
1987-059 2
18185 18186
1987-062 1
18215
1987-068 1
18312
1987-078 3
18350 18351 18353
1987-079 7
18355 18356 18357 18358 18359 18360 18375
1987-108 1
18714
1987-109 5
18715 18716 18717 18718 18722

1988-007 1
18824
1988-085 7
19501 19502 19503 19504 19505 19535 21751
1988-109 3
19687 19688 19690

1989-001 7
19749 19750 19751 19752 19753 19754 19756
1989-004 5
19765 19766 19767 19768 19776
1989-052 5
20107 20108 20109 20110 20115
1989-054 1
20125
1989-056 2
20137 20138
1989-094 2
20340 20341
1989-100 38
20389 20397 20398 20408 20467 20468 20515 20522 20531 20532 20637 20640
20802 20803 20821 20822 20823 20911 21020 21021 21022 21023 21042 21043
21064 21205 21206 21207 21537 21540 21767 21768 21769 21770 21771 21772
21773 21774
1989-101 6
20391 20392 20393 20394 20400 21648

1990-045 6
20619 20620 20621 20622 20623 20630
1990-081 7
20788 20789 20790 20792 20793 20797 20798
1990-087 1
20829
1990-102 5
20953 20954 20955 20958 21406
1990-105 1
20978
1990-110 7
21006 21007 21008 21009 21010 21011 21012

1991-003 3
21055 21056 21058
1991-009 8
21100 21101 21102 21103 21104 21105 21106 21107
1991-010 5
21111 21112 21113 21122 21129
1991-015 5
21139 21140 21141 21142 21904
1991-068 6
21728 21729 21730 21731 21732 21733
1991-071 1
21742

1992-021 3
21939 21940 21942
1992-047 7
22056 22057 22058 22059 22060 22061 22066
1992-091 1
22281
1992-093 5
22284 22290 22291 22292 22293

1993-016 3
22565 22575 22576
1993-018 1
22586
1993-028 1
22642
1993-045 1
22717
1993-057 3
22789 22790 22953

1994-004 3
22973 22974 22987
1994-029 1
23105
1994-038 5
23168 23169 23170 23171 23172
1994-056 2
23230 23248
1994-069 5
23327 23328 23329 23330 23339
1994-085 1
23439

1995-028 1
23597
1995-033 3
23605 23607 23608

1996-010 4
23794 23795 23796 23824
1996-034 5
23880 23881 23882 23883 23886

1997-024 1
24806
1997-079 1
25089
1997-086 3
25126 25127 25128

1998-011 1
25175

1999-057 2
25940 25941

6.0 SATELLITES NOT ASSOCIATED WITH ANOMALOUS EVENTS

The table below identifies specific SSN numbers of objects which possess the same International Designator year and number but are not associated with the indicated anomalous event. The list below represents the best summary of excluded objects. Parent object is not considered a fragment.

The list below is formatted as follows: Line one is the international designator and the number of objects to exclude. Line two is object no 1, object no 2, etc.

Note: If the number of objects to exclude = 0, then there is no line 2. Also, a blank line separates years.

Int'l Designator

1963-049 11
703 705 706 715 753 2432 2620 2930 4586 6182 6283

1964-026 4
805 806 809 2986
1964-053 1
876

1965-016 8
1208 1244 1245 1272 1291 1292 1293 1310
1965-027 2
1315 1316
1965-048 3
1425 1428 1435
1965-109 4
1865 2086 2226 2353

1966-005 5
1953 2140 214 2889 2989
1966-024 1
2120
1966-040 1
2174
1966-077 2
2411 2412

1967-034 3
2755 2777 2778
1967-048 1
2811
1967-092 3
2967 2994 3122

1968-019 1
3150

1970-067 4
4515 5036 5447 6372

1971-003 1
4849

1972-049 1
6079

1975-027 1
7734

1978-014 5
10665 12329 12330 12331 12406
1978-064 0
1978-094 1
11056
1978-096 2
11061 11062
1978-098 1
11080

1979-057 2
11419 11634

1981-043 2
12456 15769
1981-059 2
12559 12560

1985-066 5
15936 15938 15950 15951 16020

1988-032 1
19045

1989-089 1
20323

1991-039 2
21398 21842

1993-014 4
22562 22567 22568 22599

1995-041 2
23639 23641
1995-059 1
23710