

TABLE 2.1 HISTORY OF SATELLITE BREAKUPS BY LAUNCH DATE

SATELLITE NAME	INTERNATIONAL DESIGNATOR	US SATELLITE NUMBER	LAUNCH DATE	BREAKUP DATE	DEBRIS CATALOGED	DEBRIS ON-ORBIT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	ADDITIONAL INFORMATION
TRANSIT 4A R/B	1961-015C	118	29-Jun-61	29-Jun-61	296	172	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	8	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	18	1825	260	56.1	UNKNOWN	COSMOS SECOND STAGE
OV2-1/LCS 2 R/B	1965-082DM	1822	15-Oct-65	15-Oct-65	473	32	790	710	32.2	PROPULSION	TITAN TRANSTAGE
COSMOS 95	1965-088A	1706	4-Nov-65	15-Jan-66	1	0	300	180	48.4	UNKNOWN	
OV2-3/ et al. R/B	1965-108A	1863	21-Dec-65	21-Dec-65	108	101	33660	165	26.4	PROPULSION	TITAN TRANSTAGE
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	Jun-66	51	0	275	240	28.8	UNKNOWN	ATLAS CORE STAGE
PAGEOS	1966-056A	2253	24-Jun-66	12-Jul-75	79	1	5170	3200	85.3	UNKNOWN	INFLATABLE SPHERE
AS-203	1966-059A	2289	5-Jul-66	5-Jul-66	34	0	215	185	32.0	DELIBERATE	SATURN S-IVB STAGE
COSMOS U-1	1966-088A	2437	17-Sep-66	17-Sep-66	52	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 192	1967-116A	3047	23-Nov-67	30-Aug-69	4	1	715	710	74.0	UNKNOWN	
COSMOS 199	1968-003A	3099	16-Jan-68	24-Jan-68	3	0	355	200	65.6	DELIBERATE	SELF-DESTRUCT
APOLLO 6 R/B	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	29	29	35810	35100	11.9	PROPULSION	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	39	2165	490	62.3	DELIBERATE	SELF-DESTRUCT
COSMOS 252	1968-097A	3530	1-Nov-68	1-Nov-68	139	40	2140	535	62.3	DELIBERATE	SELF-DESTRUCT
ESSA 8 (TOS F) R/B	1968-114B	3616	15-Dec-68	15-Nov-73	18	18	1462	1413	101.6	PROPULSION	DELTA SECOND STAGE
OPS 0757 (TACSAT) R/B	1969-013B	3692	9-Feb-69	28-Feb-68	19	19	37257	35886	6.2	UNKNOWN	TITAN TRANSTAGE
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	22	0	5445	270	30.4	PROPULSION	TE 364-4 STAGE
OPS 7613 R/B	1969-082AB	4159	30-Sep-69	4-Oct-69	261	63	940	905	70.0	UNKNOWN	AGENA D STAGE
NIMBUS 4 R/B	1970-025C	4367	8-Apr-70	17-Oct-70	441	299	1085	1065	99.9	UNKNOWN	AGENA D STAGE
COSMOS 374	1970-089A	4594	23-Oct-70	23-Oct-70	99	20	2130	530	62.9	DELIBERATE	SELF-DESTRUCT
COSMOS 375	1970-091A	4598	30-Oct-70	30-Oct-70	47	15	2100	525	62.8	DELIBERATE	SELF-DESTRUCT
COSMOS 397	1971-015A	4964	25-Feb-71	25-Feb-71	116	44	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	244	47	910	635	98.3	PROPULSION	DELTA SECOND STAGE

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

SATELLITE NAME	INTERNATIONAL DESIGNATOR	US SATELLITE NUMBER	LAUNCH DATE	BREAKUP DATE	DEBRIS CATALOGED	DEBRIS ON-ORBIT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	ADDITIONAL INFORMATION
SALYUT 2 R/B	1973-017B	6399	3-Apr-73	3-Apr-73	25	0	245	195	51.5	PROPULSION	PROTON-K THIRD STAGE
COSMOS 554	1973-021A	6432	19-Apr-73	6-May-73	193	0	350	170	72.9	DELIBERATE	SELF-DESTRUCT
NOAA 3 R/B	1973-086B	6921	6-Nov-73	28-Dec-73	220	198	1510	1500	102.1	PROPULSION	DELTA SECOND STAGE
DMSP 5B F5 R/B	1974-015B	7219	16-Mar-74	17-Jan-05	7	7	885	775	99.1	COLLISION, ACCIDENTAL	HIT BY DEBRIS (26207)
NOAA 4 R/B	1974-089D	7532	15-Nov-74	20-Aug-75	185	160	1460	1445	101.7	PROPULSION	DELTA SECOND STAGE
COSMOS 699	1974-103A	7587	24-Dec-74	17-Apr-75	50	0	445	425	65.0	UNKNOWN	COSMOS 699 CLASS
LANDSAT 2 R/B	1975-004B	7616	22-Jan-75	9-Feb-76	207	32	915	740	97.8	PROPULSION	DELTA SECOND STAGE
NIMBUS 6 R/B	1975-052B	7946	12-Jun-75	1-May-91	307	231	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	65.0	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	70	68	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	184	174	1520	1505	102.0	PROPULSION	DELTA SECOND STAGE
COSMOS 862	1976-105A	9495	22-Oct-76	15-Mar-77	13	5	39645	765	63.2	DELIBERATE	SELF-DESTRUCT
COSMOS 880	1976-120A	9601	9-Dec-76	27-Nov-78	49	0	620	550	65.8	BATTERY	
COSMOS 884	1976-123A	9614	17-Dec-76	29-Dec-76	2	0	320	170	65.0	DELIBERATE	SELF-DESTRUCT
COSMOS 886	1976-126A	9634	27-Dec-76	27-Dec-76	76	58	2295	595	65.8	DELIBERATE	SELF-DESTRUCT
COSMOS 903	1977-027A	9911	11-Apr-77	8-Jun-78	6	3	39035	1325	63.2	DELIBERATE	SELF-DESTRUCT
COSMOS 917	1977-047A	10059	16-Jun-77	30-Mar-79	14	12	38725	1645	62.9	DELIBERATE	SELF-DESTRUCT
HIMAWARI 1 R/B	1977-065B	10144	14-Jul-77	14-Jul-77	177	59	2025	535	29.0	PROPULSION	DELTA SECOND STAGE
COSMOS 931	1977-068A	10150	20-Jul-77	24-Oct-77	6	5	39665	680	62.9	DELIBERATE	SELF-DESTRUCT
EKRAN 2	1977-092A	10365	20-Sep-77	23-Jun-78	5	5	35800	35785	0.1	BATTERY	
COSMOS 970	1977-121A	10531	21-Dec-77	21-Dec-77	70	64	1140	945	65.8	DELIBERATE	SELF-DESTRUCT
LANDSAT 3 R/B	1978-026C	10704	5-Mar-78	27-Jan-81	248	153	910	900	98.8	PROPULSION	DELTA SECOND STAGE
COSMOS 1030	1978-083A	11015	6-Sep-78	10-Oct-78	13	9	39760	665	62.8	DELIBERATE	SELF-DESTRUCT
NIMBUS 7 R/B	1978-098B	11081	24-Oct-78	26-Dec-81	2	1	955	935	99.3	PROPULSION	DELTA SECOND STAGE
COSMOS 1045 R/B	1978-100D	11087	26-Oct-78	9-May-88	42	32	1705	1685	82.6	PROPULSION	TSYKLON THIRD STAGE
P-78/SOLWIND	1979-017A	11278	24-Feb-79	13-Sep-85	285	0	545	515	97.6	COLLISION, DELIBERATE	HYPERVELOCITY IMPACT
COSMOS 1094	1979-033A	11333	18-Apr-79	17-Sep-79	1	0	405	380	65.0	UNKNOWN	COSMOS 699 CLASS
COSMOS 1109	1979-058A	11417	27-Jun-79	Feb-80	19	8	39425	960	63.3	DELIBERATE	SELF-DESTRUCT
COSMOS 1124	1979-077A	11509	28-Aug-79	9-Sep-79	5	5	39795	570	63.0	DELIBERATE	SELF-DESTRUCT
SATCOM 3	1979-101A	11635	7-Dec-79	11-Dec-79	21	21	35776	204	23.7	PROPULSION	AKM FAILURE
CAT R/B	1979-104B	11659	24-Dec-79	Apr-80	31	24	33140	180	17.9	PROPULSION	ARIANE 1 FINAL STAGE

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

SATELLITE NAME	INTERNATIONAL DESIGNATOR	US SATELLITE NUMBER	LAUNCH DATE	BREAKUP DATE	DEBRIS CATALOGED	DEBRIS ON-ORBIT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	ADDITIONAL INFORMATION
COSMOS 1167	1980-021A	11729	14-Mar-80	15-Jul-81	12	0	450	355	65.0	UNKNOWN	COSMOS 699 CLASS
COSMOS 1174	1980-030A	11765	18-Apr-80	18-Apr-80	46	4	1660	380	66.1	DELIBERATE	SELF-DESTRUCT
COSMOS 1188	1980-050A	11844	14-Jun-80	26-Aug-80	8	6	39630	735	62.9	DELIBERATE	SELF-DESTRUCT
COSMOS 1191	1980-057A	11871	2-Jul-80	14-May-81	11	11	39255	1110	62.6	DELIBERATE	SELF-DESTRUCT
COSMOS 1217	1980-085A	12032	24-Oct-80	12-Feb-83	10	8	38830	1530	65.2	DELIBERATE	SELF-DESTRUCT
COSMOS 1220	1980-089A	12054	4-Nov-80	20-Jun-82	83	1	885	570	65.0	UNKNOWN	COSMOS 699 CLASS
COSMOS 1247	1981-016A	12303	19-Feb-81	20-Oct-81	7	6	39390	970	63.0	DELIBERATE	SELF-DESTRUCT
COSMOS 1260	1981-028A	12364	20-Mar-81	8-May-82	68	0	750	450	65.0	UNKNOWN	COSMOS 699 CLASS
COSMOS 1261	1981-031A	12376	31-Mar-81	Apr-81	10	10	39765	610	63.0	DELIBERATE	SELF-DESTRUCT
COSMOS 1275	1981-053A	12504	4-Jun-81	24-Jul-81	479	421	1015	960	83.0	BATTERY	
COSMOS 1278	1981-058A	12547	19-Jun-81	Dec-86	3	0	37690	2665	67.1	DELIBERATE	SELF-DESTRUCT
COSMOS 1285	1981-071A	12627	4-Aug-81	21-Nov-81	25	25	40100	720	63.1	DELIBERATE	SELF-DESTRUCT
COSMOS 1286	1981-072A	12631	4-Aug-81	29-Sep-82	2	0	325	300	65.0	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	11	11	39055	1315	62.8	DELIBERATE	SELF-DESTRUCT
METEOR 2-8	1982-025A	13113	25-Mar-82	29-May-99	53	53	960	935	82.5	UNKNOWN	
COSMOS 1348	1982-029A	13124	7-Apr-82	2-Sep-84	10	10	39200	1185	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	61	58	1000	990	65.8	BATTERY	
COSMOS 1405	1982-088A	13508	4-Sep-82	20-Dec-83	32	0	340	310	65.0	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	5	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	187	14	890	570	65.0	UNKNOWN	COSMOS 699 CLASS
COSMOS 1481	1983-070A	14182	8-Jul-83	9-Jul-83	7	7	39225	625	62.9	DELIBERATE	SELF-DESTRUCT
COSMOS 1484	1983-075A	14207	24-Jul-83	18-Oct-93	49	0	595	550	97.5	UNKNOWN	
COSMOS 1519-21 ULLAGE MOTOR	1983-127H	14608	29-Dec-83	4-Feb-91	8	3	18805	340	51.9	PROPULSION	PROTON-K BLOCK DM SOZ
PALAPA B2 R/B	1984-011E	14693	3-Feb-84	6-Feb-84	3	0	285	275	28.5	PROPULSION	PAM-D UPPER STAGE
WESTAR 6 R/B	1984-011F	14694	3-Feb-84	3-Feb-84	14	0	310	305	28.5	PROPULSION	PAM-D UPPER STAGE
COSMOS 1588	1984-083A	15167	7-Aug-84	23-Feb-86	45	0	440	410	65.0	UNKNOWN	COSMOS 699 CLASS
COSMOS 1603 ULLAGE MOTOR	1984-106F	15338	28-Sep-84	5-Sep-92	23	2	845	835	66.6	PROPULSION	PROTON-K BLOCK DM SOZ

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SATELLITE NAME	INTERNATIONAL DESIGNATOR	US SATELLITE NUMBER	LAUNCH DATE	BREAKUP DATE	DEBRIS CATALOGED	DEBRIS ON-ORBIT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	ADDITIONAL INFORMATION
SPACENET 2/MARECS B2 R/B	1984-114C	15388	10-Nov-84	20-Nov-84	3	2	35960	325	7.0	PROPULSION	ARIANE 3 FINAL STAGE
COSMOS 1646	1985-030A	15653	18-Apr-85	20-Nov-87	24	0	410	385	65.0	UNKNOWN	COSMOS 699 CLASS
COSMOS 1650-52 ULLAGE MOTOR	1985-037G	15714	17-May-85	29-Nov-98	4	2	18620	320	52.0	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	65.0	UNKNOWN	COSMOS 699 CLASS
COSMOS 1691 (1695)	1985-094B	16139	9-Oct-85	22-Nov-85	21	18	1415	1410	82.6	BATTERY	
COSMOS 1703 R/B	1985-108B	16263	22-Nov-85	4-May-06	50	2	640	610	82.5	PROPULSION	TSYKLON THIRD STAGE
COSMOS 1710-12 ULLAGE MOTOR	1985-118L	16446	24-Dec-85	29-Dec-91	17	10	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	71.0	PROPULSION	ZENIT SECOND STAGE
SPOT 1 R/B	1986-019C	16615	22-Feb-86	13-Nov-86	498	31	835	805	98.7	PROPULSION	ARIANE 1 FINAL STAGE
COSMOS 1769	1986-059A	16895	4-Aug-86	21-Sep-87	4	0	445	310	65.0	UNKNOWN	COSMOS 699 CLASS
USA 19	1986-069A	16937	5-Sep-86	5-Sep-86	13	0	745	210	39.1	COLLISION, DELIBERATE	HYPERVELOCITY IMPACT
USA 19 R/B	1986-069B	16938	5-Sep-86	5-Sep-86	5	0	610	220	22.8	COLLISION, DELIBERATE	HYPERVELOCITY IMPACT
COSMOS 1813	1987-004A	17297	15-Jan-87	29-Jan-87	195	0	415	360	72.8	DELIBERATE	SELF-DESTRUCT
COSMOS 1823	1987-020A	17535	20-Feb-87	17-Dec-87	150	76	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	1	635	605	83.0	UNKNOWN	
METEOR 2-16 R/B	1987-068B	18313	18-Aug-87	15-Feb-98	108	42	960	940	82.6	PROPULSION	TSYKLON THIRD STAGE
AUSSAT K3/ECS 4 R/B	1987-078C	18352	16-Sep-87	16-19 Sep-87	4	1	36515	245	6.9	PROPULSION	ARIANE 3 FINAL STAGE
COSMOS 1883-85 ULLAGE MOTOR	1987-079G	18374	16-Sep-87	1-Dec-96	14	11	19120	335	64.9	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 1883-85 ULLAGE MOTOR	1987-079H	18375	16-Sep-87	23-Apr-03	42	11	18540	755	65.2	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	0	22975	310	46.6	PROPULSION	PROTON-K BLOCK DM SOZ
METEOR 2-17	1988-005A	18820	30-Jan-88	21-Jun-05	45	45	960	930	82.5	UNKNOWN	
DMSP 5D-2 F9 (USA 29)	1988-006A	18822	3-Feb-88	14-17 Dec-12	10	3	810	800	98.8	UNKNOWN	
COSMOS 1916	1988-007A	18823	3-Feb-88	27-Feb-88	1	0	230	150	64.8	DELIBERATE	SELF-DESTRUCT
COSMOS 1934	1988-023A	18985	22-Mar-88	23-Dec-91	3	3	1010	950	83.0	COLLISION, ACCIDENTAL	HIT BY DEBRIS (13475)
INTELSAT 513 R/B	1988-040B	19122	17-May-88	9-Jul-02	8	8	35445	535	7.0	PROPULSION	ARIANE 2 R/B
COSMOS 1970-72 ULLAGE MOTOR	1988-085F	19535	16-Sep-88	4-Aug-03	79	10	18515	720	65.3	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 1970-72 ULLAGE MOTOR	1988-085G	19537	16-Sep-88	9-Mar-99	1	1	18950	300	64.6	PROPULSION	PROTON-K BLOCK DM SOZ

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SKYNET 4B/ASTRA 1A R/B	1988-109C	19689	11-Dec-88	17-Feb-98	18	17	35875	435	7.3	PROPULSION	ARIANE 4 H10 FINAL STAGE
COSMOS 1987-89 ULLAGE MOTOR	1989-001G	19755	10-Jan-89	3-Aug-98	16	6	19055	340	64.9	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 1987-89 ULLAGE MOTOR	1989-001H	19856	10-Jan-89	13-Nov-03	1	1	18740	710	65.4	PROPULSION	PROTON-K BLOCK DM SOZ
GORIZONT 17 ULLAGE MOTOR	1989-004E	19771	26-Jan-89	17-Dec-92	1	0	17575	195	46.7	PROPULSION	PROTON-K BLOCK DM SOZ
INTELSAT 515 R/B	1989-006B	19773	27-Jan-89	1-Jan-01	87	86	35720	510	8.4	PROPULSION	ARIANE 2 R/B
COSMOS 2022-24 ULLAGE MOTOR	1989-039G	20081	31-May-89	10-Jun-06	120	43	18410	655	65.1	PROPULSION	PROTON-K BLOCK DM SOZ
GORIZONT 18 ULLAGE MOTOR	1989-052F	20116	5-Jul-89	12-Jan-93	2	0	36745	260	46.8	PROPULSION	PROTON-K BLOCK DM SOZ
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
COBE R/B	1989-089B	20323	18-Nov-89	3-Dec-06	26	1	790	685	97.1	UNKNOWN	DELTA SECOND STAGE
COSMOS 2053 R/B	1989-100B	20390	27-Dec-89	18-Apr-99	26	0	485	475	73.5	PROPULSION	TSYKLON THIRD STAGE
COSMOS 2054 ULLAGE MOTOR	1989-101E	20399	27-Dec-89	Jul-92	14	2	27650	345	47.1	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2079-81 ULLAGE MOTOR	1990-045F	20630	19-May-90	17-Nov-11	1	1	18620	420	65.0	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2079-81 ULLAGE MOTOR	1990-045G	20631	19-May-90	28-Mar-99	1	1	19065	405	64.8	PROPULSION	PROTON-K BLOCK DM SOZ
FENGYUN 1-2 R/B	1990-081D	20791	3-Sep-90	4-Oct-90	103	75	895	880	98.9	PROPULSION	CZ-4 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	29	1	850	610	98.9	PROPULSION	TE-M-364-15 UPPER STAGE
COSMOS 2109-11 ULLAGE MOTOR	1990-110G	21012	8-Dec-90	21-Feb-03	1	1	18805	645	65.4	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2109-11 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/EUTELSAT 2 F2 R/B	1991-003C	21057	15-Jan-91	Apr/May 96	15	12	30930	235	6.7	PROPULSION	ARIANE 4 H10 FINAL STAGE
COSMOS 2125-32 R/B	1991-009J	21108	12-Feb-91	5-Mar-91	112	112	1725	1460	74.0	PROPULSION	COSMOS SECOND STAGE
COSMOS 2133 ULLAGE MOTOR	1991-010D	21114	12-Feb-91	7-May-94	4	0	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	11	7	17630	205	6.8	PROPULSION	ARIANE 4 H10 FINAL STAGE
COSMOS 2139-41 ULLAGE MOTOR	1991-025F	21220	4-Apr-91	8-Mar-09	33	11	18535	465	64.9	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2139-41 ULLAGE MOTOR	1991-025G	21226	4-Apr-91	16-Jun-01	1	1	18960	300	64.5	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2157-62 R/B	1991-068G	21734	28-Sep-91	9-Oct-99	40	40	1485	1410	82.6	PROPULSION	TSYKLON THIRD STAGE
COSMOS 2163	1991-071A	21741	9-Oct-91	6-Dec-91	1	0	260	185	64.8	DELIBERATE	SELF-DESTRUCT
INTELSAT 601 R/B	1991-075B	21766	29-Oct-91	24-Dec-01	13	8	28505	230	7.2	PROPULSION	ARIANE 4 H10 FINAL STAGE
USA 73 (DMSP 5D2 F11)	1991-082A	21798	28-Nov-91	15-Apr-04	85	65	850	830	98.7	UNKNOWN	

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

SATELLITE NAME	INTERNATIONAL DESIGNATOR	US SATELLITE NUMBER	LAUNCH DATE	BREAKUP DATE	DEBRIS CATALOGED	DEBRIS ON-ORBIT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	ADDITIONAL INFORMATION
TELECOM 2B/INMARSAT 2 R/B	1992-021C	21941	15-Apr-92	21-Apr-93	18	17	34080	235	4.0	PROPULSION	ARIANE 4 H10+ FINAL STAGE
INSAT 2A/EUTELSAT 2F4 R/B	1992-041C	22032	9-Jul-92	Feb-02	2	2	26550	250	7.0	PROPULSION	ARIANE 4 H10 FINAL STAGE
COSMOS 2204-06 ULLAGE MOTOR	1992-047G	22066	30-Jul-92	10-Jul-04	34	12	18820	415	64.9	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2204-06 ULLAGE MOTOR	1992-047H	22067	30-Jul-92	8-Nov-94	4	2	19035	480	64.8	PROPULSION	PROTON-K BLOCK DM SOZ
GORIZONT 27 ULLAGE MOTOR	1992-082F	22250	27-Nov-92	14-Jul-01	1	0	5340	145	46.5	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2224 ULLAGE MOTOR	1992-088F	22274	17-Dec-92	~22-Apr-05	1	0	21140	200	46.7	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	279	196	855	845	71.0	PROPULSION	ZENIT-2 SECOND STAGE
COSMOS 2237 R/B	1993-016B	22566	26-Mar-93	28-Mar-93	104	100	850	840	71.0	PROPULSION	ZENIT-2 SECOND STAGE
COSMOS 2238	1993-018A	22585	30-Mar-93	1-Dec-94	1	0	305	210	65.0	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 2251	1993-036A	22675	16-Jun-93	10-Feb-09	1668	1076	800	775	74.0	COLLISION, ACCIDENTAL	COLLIDED WITH IRIDIUM 33
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	1	0	295	170	64.9	DELIBERATE	SELF-DESTRUCT
GORIZONT 29 ULLAGE MOTOR	1993-072E	22925	18-Nov-93	6-Sep-00	1	0	11215	140	46.7	PROPULSION	PROTON-K BLOCK DM SOZ
CLEMENTINE R/B	1994-004B	22974	25-Jan-94	7-Feb-94	1	0	295	240	67.0	PROPULSION	
STEP II R/B	1994-029B	23106	19-May-94	3-Jun-96	754	82	820	585	82.0	PROPULSION	PEGASUS HAPS
COSMOS 2282 ULLAGE MOTOR	1994-038F	23174	6-Jul-94	21-Oct-95	2	0	34930	280	47.0	PROPULSION	PROTON-K BLOCK DM SOZ
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 2294-96 ULLAGE MOTOR	1994-076G	23402	20-Nov-94	7-Jun-14	2	2	18990	420	65.0	PROPULSION	PROTON-K BLOCK DM SOZ
RS-15 R/B	1994-085B	23440	26-Dec-94	26-Dec-94	26	23	2200	1880	64.8	UNKNOWN	ROKOT THIRD STAGE
USA 109 (DMSP 5D-2 F13)	1995-015A	23533	24-Mar-95	3-Feb-15	236	219	840	840	98.8	BATTERY	Operational at event time
COSMOS 2313	1995-028A	23596	8-Jun-95	26-Jun-97	13	0	325	210	65.0	UNKNOWN	COSMOS 699 CLASS
CERISE	1995-033B	23606	7-Jul-95	24-Jul-96	2	1	675	665	98.1	COLLISION, ACCIDENTAL	HIT BY DEBRIS (18208)
COSMOS 2316-18 ULLAGE MOTOR	1995-037K	23631	24-Jul-95	21-Nov-00	1	0	18085	150	64.4	PROPULSION	PROTON-K BLOCK DM SOZ
RADUGA 33 R/B	1996-010D	23797	19-Feb-96	19-Feb-96	1	0	36505	240	48.7	PROPULSION	PROTON-K BLOCK DM
GORIZONT 32 ULLAGE MOTOR	1996-034F	23887	25-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	65.0	DELIBERATE	SELF-DESTRUCT
IRIDIUM 33	1997-051C	24946	14-Sep-97	10-Feb-09	628	333	780	775	86.4	COLLISION, ACCIDENTAL	COLLIDED WITH COSMOS 2251
KUPON ULLAGE MOTOR	1997-070F	25054	12-Nov-97	14-Feb-07	7	4	14160	260	46.6	PROPULSION	PROTON-K BLOCK DM SOZ

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

SATELLITE NAME	INTERNATIONAL DESIGNATOR	US SATELLITE NUMBER	LAUNCH DATE	BREAKUP DATE	DEBRIS CATALOGED	DEBRIS ON-ORBIT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	ADDITIONAL INFORMATION
COSMOS 2347	1997-079A	25088	9-Dec-97	22-Nov-99	9	0	410	230	65.0	UNKNOWN	COSMOS 699 CLASS
ASIASAT 3 R/B	1997-086D	25129	24-Dec-97	25-Dec-97	1	0	35995	270	51.0	PROPULSION	PROTON-K BLOCK DM
COMETS R/B	1998-011B	25176	21-Feb-98	21-Feb-98	1	0	1880	245	30.0	PROPULSION	H-II SECOND STAGE
ARGOS/ORSTED/SUN SAT R/B	1999-008D	25637	23-Feb-99	28-Apr-14	8	1	840	635	96.5	UNKNOWN	DELTA 2 SECOND STAGE
FENGYUN 1C	1999-025A	25730	10-May-99	11-Jan-07	3442	2832	865	845	98.6	COLLISION, DELIBERATE	HYPERVELOCITY IMPACT
CBERS 1	1999-057A	25940	14-Oct-99	18-Feb-07	88	53	780	770	98.2	UNKNOWN	
CBERS 1/SACI 1 R/B	1999-057C	25942	14-Oct-99	11-Mar-00	344	150	745	725	98.5	PROPULSION	CZ-4 FINAL STAGE
COSMOS 2367	1999-072A	26040	26-Dec-99	21-Nov-01	17	0	415	405	65.0	UNKNOWN	COSMOS 699 CLASS
COSMOS 2371 ULLAGE MOTOR	2000-036E	26398	4-Jul-00	~1-Sep-06	1	0	21320	220	46.9	PROPULSION	PROTON-K BLOCK DM SOZ
NOAA 16	2000-055A	26536	21-Sep-00	25-Nov-15	458	458	858	842	98.9	UNKNOWN	
TES R/B	2001-049D	26960	22-Oct-01	19-Dec-01	372	72	675	550	97.9	PROPULSION	PSLV FINAL STAGE
COSMOS 2383	2001-057A	27053	21-Dec-01	28-Feb-04	14	0	400	220	65.0	UNKNOWN	COSMOS 699 CLASS
COSMOS 2392 ULLAGE MOTOR	2002-037E	27474	25-Jul-02	1-Jun-05	61	0	835	255	63.7	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2392 ULLAGE MOTOR	2002-037F	27475	25-Jul-02	29-Oct-04	1	0	840	235	63.6	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2399	2003-035A	27856	12-Aug-03	9-Dec-03	22	0	250	175	64.9	DELIBERATE	SELF-DESTRUCT
ALOS-1 R/B	2006-002B	28932	24-Jan-06	8-Aug-06	24	3	700	550	98.2	UNKNOWN	H-IIA SECOND STAGE
ARABSAT 4 BRIZ-M R/B	2006-006B	28944	28-Feb-06	19-Feb-07	102	92	14705	495	51.5	PROPULSION	PROTON-K BRIZ-M STAGE
YAOGAN 1	2006-015A	29092	26-Apr-06	4-Feb-10	8	2	630	625	97.9	UNKNOWN	
COSMOS 2421	2006-026A	29247	25-Jun-06	14-Mar-08	509	0	420	400	65.0	UNKNOWN	COSMOS 699 CLASS
IGS 3A R/B	2006-037B	29394	11-Sep-06	28-Dec-06	10	0	490	430	97.2	UNKNOWN	H-IIA SECOND STAGE
COSMOS 2423	2006-039A	29402	14-Sep-06	17-Nov-06	31	0	285	200	64.9	DELIBERATE	SELF-DESTRUCT
DMSP 5D-3 F17 R/B	2006-050B	29523	4-Nov-06	4-Nov-06	65	0	865	830	98.8	UNKNOWN	DELTA IV SECOND STAGE
USA 193	2006-057A	29651	14-Dec-06	21-Feb-08	175	0	255	245	58.5	COLLISION, DELIBERATE	HYPERVELOCITY IMPACT
COSMOS 2424-2426 ULLAGE MOTOR	2006-062G	29680	25-Dec-06	27-Jul-16	9	8	19088	426	64.8	PROPULSION	PROTON-K BLOCK DM SOZ
BEIDOU 1D R/B	2007-003B	30324	2-Feb-07	2-Feb-07	39	36	41900	235	25.0	UNKNOWN	CZ-3A FINAL STAGE
IGS 4A/4B R/B DEBRIS	2007-005E	30590	24-Feb-07	23-Dec-10	4	0	440	430	97.3	UNKNOWN	H-IIA DEBRIS
COSMOS 2428	2007-029A	31792	29-Jun-07	10-May-14	10	2	860	845	71.0	UNKNOWN	
COSMOS 2431-33 ULLAGE MOTOR	2007-052F	32280	26-Oct-07	13-Aug-14	25	25	18790	730	65.0	PROPULSION	PROTON-K BLOCK DM SOZ
USA 197 R/B	2007-054B	32288	11-Nov-07	11-Nov-07	32	32	1575	220	29.0	UNKNOWN	DELTA IV SECOND STAGE
COSMOS 2434-36 ULLAGE MOTOR	2007-065G	32399	25-Dec-07	18-Aug-11	1	1	18965	540	65.0	PROPULSION	PROTON-K BLOCK DM SOZ
AMC 14 BRIZ-M R/B	2008-011B	32709	14-Mar-08	13-Oct-10	116	115	26565	645	48.9	PROPULSION	PROTON-K BRIZ-M STAGE

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

SATELLITE NAME	INTERNATIONAL DESIGNATOR	US SATELLITE NUMBER	LAUNCH DATE	BREAKUP DATE	DEBRIS CATALOGED	DEBRIS ON-ORBIT	APOGEE (KM)	PERIGEE (KM)	INCLINATION (DEG)	ASSESSED CAUSE	ADDITIONAL INFORMATION
COSMOS 2442-44 ULLAGE MOTOR	2008-046H	33385	25-Sep-08	20-May-14	11	10	18720	865	65.0	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2447-49 ULLAGE MOTOR	2008-067G	33472	25-Dec-08	26-Mar-16	4	4	18840	682	65.4	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2447-49 ULLAGE MOTOR	2008-067H	33473	25-Dec-08	1-Jun-16	12	12	18786	709	65.3		
BEIDOU G2	2009-018A	34779	14-Apr-09	29-Jun-16	1	1	36137	35384	4.7	UNKNOWN	
COSMOS 2459-61 ULLAGE MOTOR	2010-007G	36406	1-Mar-10	9-Jul-14	11	11	18750	770	65.0	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2459-61 ULLAGE MOTOR	2010-007H	36407	1-Mar-10	22-May-18	11	11	18929	602	65.1	PROPULSION	PROTON-K BLOCK DM SOZ
COSMOS 2464-2466 ULLAGE MOTOR	2010-041G	37143	2-Sep-10	3-Sep-17	10	10	18684	756	65.2	PROPULSION	PROTON-K BLOCK DM SOZ
CHINASAT 6A R/B	2010-042B	37151	4-Sep-10	4-Sep-10	30	29	41894	194	25.2	UNKNOWN	
BEIDOU G4 R/B	2010-057B	37211	1-Nov-10	1-Nov-10	57	55	35780	160	20.5	UNKNOWN	CZ-3C FINAL STAGE
SL-23 DEBRIS	2011-037B	37756	18-Jul-11	3/4-Aug-15	1	1	3649	428	51.4	UNKNOWN	Fregat-SB SBB propellant tank
NIGCOMSAT 1R R/B	2011-077B	38015	19-Dec-11	~21-Dec-11	39	39	41715	230	24.3	UNKNOWN	CZ-3B FINAL STAGE
BEIDOU G5 R/B	2012-008B	38092	24-Feb-12	26-Feb-12	38	37	35950	150	20.7	UNKNOWN	CZ-3C FINAL STAGE
NIMIQ 6 R/B	2012-026B	38343	17-May-12	23-Dec-15	11	11	34592	10408	12.0	UNKNOWN	Briz-M CORE
TELKOM 3 / EXPRESS MD2 BRIZ-M R/B	2012-044C	38746	6-Aug-12	16-Oct-12	113	20	5010	265	49.9	PROPULSION	PROTON-K BRIZ-M STAGE
CASSIOPE R/B	2013-055B	39266	29-Sep-13	29-Sep-13	16	1	1490	320	81.0	PROPULSION	FALCON 9 SECOND STAGE
SENTINEL 1A	2014-016A	39634	3-Apr-14	23-Aug-16	8	3	698	696	98.2	COLLISION, ACCIDENTAL	Solar array impact by small MMOD
PROGRESS-M 27M R/B	2015-024B	40620	28-Apr-15	28-Apr-15	21	0	181	169	51.7	UNKNOWN	Soyuz 2.1a (3); separation with PROGRESS M-27M
COSMOS 2513 R/B	2015-075B	41122	13-Dec-15	16-Jan-16	7	7	35777	33426	0.2	UNKNOWN	Briz-M CORE
ASTRO H (HITOMI)	2016-012A	41337	17-Feb-16	26-Mar-16	13	10	578	563	31.0	PROPULSION	likely structural failure mechanism
FREGAT DEB (TANK)	2017-086C	43089	26-Dec-17	12-Feb-18	5	2	4070	277	50.4	UNKNOWN	SL-23 Fregat SB SBB propellant tank

1. NA = NOT AVAILABLE

2. BREAKUP DATE AND ORBIT ARE FOR FIRST EVENT ONLY IF MULTIPLE EVENTS OCCURRED

3. DOES NOT INCLUDE SATELLITE BREAKUPS IF VEHICLE WAS ON REENTRY TRAJECTORY AT THE TIME OF THE EVENT