ORBITAL ANOMALIES IN GODDARD SPACECRAFT

for

CY 1986

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APRIL 1987

ASSURANCE REQUIREMENTS OFFICE

OFFICE OF FLIGHT ASSURANCE

NASA/GODDARD SPACE FLIGHT CENTER

Summary

This report presents a summary of the in-orbit reliability performance of spacecraft built under the management of the Goddard Space Flight Center that were active during calendar year 1986. It is one of a series of such reports that collectively form a continuous published record of this performance. The major feature of these reports is a log of all anomalies occurring during the report period which provides a description of the anomaly and its time of occurrence. Each anomaly is classified according to criticality, type, subsystem, and other relevant criteria. Although some statistical analysis and comparisons are given, the purpose of the report is primarily documentary, with more extensive statistical treatment to be presented elsewhere.

Introduction

Since the earliest days of the Center, attempts have been made to record the performance of Goddard-managed spacecraft. Although statistical summaries exist, until the last decade or so the actual raw data was considered sensitive and was not published. This is unfortunate, since over the years it has been observed that the potential uses for this data are open-ended and cannot be predicted in advance. Hence, any pre-digested data is likely not to be what is needed in many instances.

The first report to contain specific anomaly data was the contractor report Analysis of Spacecraft On-Orbit Anomalies and Lifetimes, PRC R-3579, dated 10 February 1983, which covers roughly the period from 1978 to mid-1982, and includes JPL as well as GSFC spacecraft. This was followed by Orbital Anomalies in Goddard Spacecraft 1982-1983, Orbital Anomalies in Goddard Spacecraft 1984, and Orbital Anomalies in Goddard Spacecraft 1985 published by the Office of Flight Assurance. The current report updates the record through 1986.

Spacecraft Activity Schedule

At the beginning of this reporting period, on January 1, 1986, there were a total of 20 GSFC spacecraft in full or partial service. This number includes 8 meteorological spacecraft operated by NOAA consisting of three of the TIROS/NOAA series, five of the GOES series, Landsat-4, and Landsat-5.

There were two new spacecraft/missions launched during the year. In January, SPOC (or HITCHHIKER) and GAS Bridge, attached payloads, flew on STS mission 61-C. They operated successfully. In mid-September NOAA-G was launched successfully and was designated NOAA-10. The second TDRS spacecraft and SPARTAN-HALLEY were destroyed in the explosion of the Challenger STS on January 28. On May 3 the GOES-G spacecraft was also lost during launch when the Delta went out of control. The complete list of satellites active during all or part of 1986 is as follows:

NASA		NOAA
AMPTE/CCE		NOAA-6
DE-1	O	NOAA-7
ERBS	N	NOAA-9
IMP-8	G	GOES-2
ISEE-1	O	GOES-3
ICE (ISEE-3)	I	GOES-4
IUE	N	GOES-5
Nimbus-7	G	GOES-6
SMM		Landsat-4
TDRS-1		Landsat-5
SPOC(HITCHHIKER)/ GAS Bridge	NEW	NOAA-10

Details are shown in the Spacecraft Lifetime Data in Appendix A, which includes virtually all GSFC launches since 1960, excluding a number of international missions Goddard participated in but is not considered to have been responsible for and minor GAS (Get Away Special) experiments.

Overall, there were 37 anomalies, distributed over 22 different spacecraft, during the year. This compares with 56 anomalies distributed over 23 spacecraft in the previous year (1985).

In the following sections, each mission and its overall performance is discussed in more detail . A complete log of anomalies appears at the end of the report.

Data Sources

The data reported herein are taken primarily from three sources. For NASA spacecraft, the main source is the Spacecraft Orbital Anomaly Reports (SOAR). For TIROS/NOAA spacecraft the TIROS Orbital Anomaly Reports (TOAR) are used, and the GOES Anomaly Reports (GAR) cover the GOES series. These data bases are maintained by the Assurance Requirements Office, in the case of SOAR, and the Metsat Office in the case of TOAR and GAR. The information contained in these reports is originated in the corresponding spacecraft operations control centers. Supplementary information is obtained through miscellaneous written reports, attendance of the regular meetings of the Orbiting Satellites Project, and other verbal contacts. Additional backup information on many of these anomalies is available through this office. In some cases the classifications are not necessarily based on the judgments of this office, and are subject to revision. This applies particularly to "open" anomalies.

Spacecraft Performance Summary

The following provides a summary of the condition and performance of the active spacecraft covered by this report:

AMPTE/CCE

This spacecraft continued to obtain scientific data through the year. No anomaly reports were written on the spacecraft during the year. In May of this year the first indications of normal solar array degradation began to show up as decreased solar array output. As a precaution, in June, operational procedures were changed to turn off the spacecraft transmitter between data-taking passes to conserve power. In the early Fall the spacecraft successfully survived an eclipse season with some eclipses lasting over 2 1/2 hours. For these eclipses the instruments were turned off and all non-essential systems were powered down. The battery voltage never went below 26 volts.

DE-1 (Dynamic Explorer)

This spacecraft has operated throughout the year without any anomalies. During regular periods through the year, when the sun illuminates the spacecraft at certain angles, it is necessary to exercise power management to prevent temperatures from exceeding critical values to prevent damage. During these periods science operation is somewhat limited.

ERBS (Earth Radiation Budget Satellite)

This spacecraft has continued to perform very well this year - all its scientific objectives were fulfilled. The bit-flip problem in the onboard command memory continued to be an annoyance for a major portion of the year. In August a similar problem (memory bit-flips) surfaced during laboratory testing of a similar memory being built for the COBE spacecraft. The problem appears to be caused by both the Normal and the Block memories being enabled simultaneously for a short period of time (20-30 nanoseconds) every time the logic switches between the Normal and Block memories. Using this information the ERBS memories were modified and operations adjusted. As a result the number of bit-flips greatly decreased.

Early in the year noise started to appear in the X-gyro rate signal. This gyro is contained in Inertial Reference Unit -A. This noise was present most of the time for several months until in mid-August the X-gyro stopped spinning. The noise was caused by degradation in the mechanical bearings and eventually increasing wear and friction caused bearing failure. Under normal operation these gyro outputs are only used for attitude determination and the noise did not interfere with science data collection. (This output is only used to control the spacecraft during the periodic yaw maneuvers). When the bearing failed the redundant IRU was turned on and it is functioning normally.

GOES (Geostationary Operational Environmental Satellite)

GOES-2: This spacecraft served as the "CENTRAL" operational spacecraft at 113° W during the whole year providing only CENTRAL WEFAX service. (VISSR is inoperable, power subsystem is degraded, and the SEM was not turned on, although it is operational.)

GOES-3: This spacecraft served as the "WEST" spacecraft at 135° W during all of 1986 providing only WEFAX and WEST DCS support. (VISSR is inoperable, power system is degraded, and the SEM was not used, although operational.)

GOES-4: This spacecraft was only used to provide ESA with DCS service during the entire year. It was located in orbit at 43° W. (VISSR/VAS is inoperable, the SEM is degraded and was not used operationally, and the DCPR (Data Collection Platform Report) Transmitter-1 failed early in the year. Redundant Transmitter-2 is being used for DCS operations.) North-South station-keeping is not being done because of low RCS fuel supply.

GOES-5: This spacecraft was operated as the "EAST" spacecraft at 75° W. It was used to provide WEFAX, DCS, and SEM support. In addition GOES-6 stretched VISSR data was relayed to users through GOES-5. (VISSR/VAS is inoperable and SEM is semi-operational due to degraded and failed channels.) Due to low fuel supply no more North-South station-keeping maneuvers will be permitted. One such manuever was performed in 1986.

GOES-6: This spacecraft, the only GOES with imaging capability, was designated the "PRIME" spacecraft, providing visible, IR and VAS imaging and soundings from two orbital positions. During the Summer/Fall period it was located at 98° W for better Atlantic Ocean coverage during the hurricane season and at 108° W during Winter/Spring to better monitor Pacific Ocean storms. Primary Scan Drive Encoder Lamp-2, in operation since August 1985, failed "open" in August 1986. (Redundant Scan Drive Encoder Lamp-2 had failed "open" in August 1985.) Redundant Scan Drive Encoder Lamp-1 was selected in August to replace Primary Drive Lamp-2. On September 27 a "transient event" occurred which caused the sudden loss of both visible and IR video data and switched the operational state of SEM units. This "event" was almost identical to the one occurring in August 1985 which shifted the VAS Earth view window 45° east, except this time the shift was 45° west. Commands were executed to re-enter the Earth in the window and normal operations resumed. The SEM is operational with the EPS E-1 channel degraded due to detector radiation damage.

ISEE-1 (International Sun-Earth Explorer)

No anomalies were reported on this spacecraft in 1986 and operations continued as reported in 1985. This spacecraft and ISEE-2 are expected to re-enter the Earth's atmosphere in October 1987 approximately 10 years after launch.

ICE (International Cometary Explorer)(formerly ISEE-3)

This 8-year old spacecraft continued to operate successfully throughout the year without any reported anomalies.

IUE (International [Jltraviolet Explorer)

This spacecraft continued to supply excellent science in UV astronomy. During the year IUE was utilized to view and obtain data on Halley's Comet. There were no reported anomalies during 1986.

Landsat-4

No anomalies were reported on this spacecraft during the year. The Multispectral Scanner (MSS) continues to supply data. The Thematic Mapper is not functional .

Landsat-5

Two minor anomalies were reported on this spacecraft during the year. In January, the prime Ku Band TWTA Helix Current increased causing a trip circuit to activate. A switch to redundant components was made. In June the high gain antenna deviated from normal track due to a momentary control loop problem - it was commanded back to normal. Data are still received from both the Thematic Mapper and the MSS.

Nimbus-7

This eight-year old spacecraft continued to provide data from the following instruments: ERB, SAM II, SBUV/TOMS, SMMR and CZCS. During the year the CZCS continued to degrade more and more with the increasing loss of synchronization on the Scan/Comp. motors. The CZCS was not operated for the latter half of the year and after unsuccessful start-up attempts in December, it was decided to permanently terminate CZCS operations. There were some other anomalies reported during the year on ERB and TOMS but they were of a minor nature and correctable.

NOAA-6

Although degraded in many areas, this spacecraft provided operational “morning orbit" data from available instruments in the earl part of the year. In June he AVHRR began experiencing scan motor sync. drop-outs which led to its becoming unusable. However, in late July, the instrument regained sync. and remained in sync. for awhile. Following launch and checkout of NOAA-10(G) in September, NOAA-6 was put ih standby status about the lst of December. Shortly before placement in standby, an anomaly was reported in the MSU involving failure of the reflector drive belt.

NOAA-7

In the early part of the year this spacecraft was in standby status. During eclipses in early June, however, the power system went out of regulation and the spacecraft went out of control. No recovery attempts were made and in late June the satellite was deactivated, after 5 years of service.

NOAA-8

As the year started NOAA-8 was tumbling and completely out of control. No more recovery attempts were made and, at the end of January, the spacecraft was deactivated.

NOAA-9

On January 30 the primary battery No. 2 charge regulator failed and the backup regulator was switched into operation. (In April 1985 the primary battery No. 1 charge regulator had failed in a similar way.) There were a couple of other minor anomalies on this satellite this year but they had no appreciable effect on operations. NOAA-9 is the prime afternoon ascending operational satellite of the NOAA spacecraft in orbit.

NOAA-10

This spacecraft (designated NOAA-G before launch) was successfully launched on September 17. Following chechout of various instruments, this spacecraft was handed over to NOAA on October 10. The spacecraft became fully operational on December 1. There were a number of anomalies reported in the first month of operation, although none seem to be serious. These minor anomalies involved the HIRS, SEM and AVHRR instruments and an unplanned control mode change.

SMM (Solar Maximum Mission)

In early January there were some "safe-holds" during spacecraft operation due to problems in the OBC (On-board Computer). Evidence indicates that 8K of memory (out of 48K total) has been lost due to "hard hits" (cosmic rays). By re-programming and not using the bad memory locations, operations have been normalized. In mid-February the HGAS (High Gain Antenna System), a pointable antenna used to communicate with the TDRS, locked up and can not be moved. It is thought that a failure in the control electronics caused the antenna to drive into the mechanical stops. Then attempts to move the antenna heated up mechanical bearings causing the lubricant to degrade resulting in "freeze-up" of the bearings. Now, to transmit to TDRS, the entire spacecraft must be rolled to point the HGAS at TDRS. Most operations now use STDN (ground) network. In early December Tape Recorder-C, used only for C/P (Coronagraph/Polarimeter) data, failed. It cannot be used to record data. Software is being re-written to record C/P data on another spacecraft recorder. The above anomalies have not really affected science operations that much during the year and a great deal of successful science was accomplished.

TDRS-1 (Tracking and Data Relay Satellite)

This satellite continued to provide tracking and data relay support to a number of Goddard missions during the year. At the end of November there was a power degradation in the forward single access link (SSA1) which rendered SSA1F service inoperable. This decreased user services seriously. The other anomalies that occurred in the year were minor in nature and correctable by ground commands.

Anomaly Data: Classification and Description

In the table of anomalies the following information is provided:

1. Index -- This is a chronological enumeration of the anomalies, beginning at launch. Numbers lower than the first number used in this report will be found in earlier reports of the series.

2. Date -- This is the date of occurrence of the anomaly, and in parentheses the number of days since launch is given, counting launch day as one.

3. Subsystem -- For the purposes of this data base, the spacecraft is divided into 9 subsystems. These are:

1. Attitude Control and Stabilization (ACS)
2. Power
3. Propulsion
4. Structure
5. Telemetry and Data Handling (TLM & DH)
6. Thermal
7. Timing, Control and Command (TC & C)
8. Instrument (payload)
9. Other (name to be entered)

4. Criticality -- This describes the impact of the anomaly on the mission, according to the following schedule:

1. Negligible	(O - 5% loss)
2. Non-negligible but small (Minor)	(5 - 33%)
3. 1/3 - 2/3 Mission Loss (Substantial)	(33 - 66%)
4. 2/3 to Nearly Total Loss (Major)	(66 - 95%)
5. Essentially Total Loss (Catastrophic)	(95 - 100%)

5. Description -- A brief description of the anomaly and its probable cause, if known.

6. Effect/Action -- The effect of the anomaly on the mission and corrective action, either for this mission or future missions, if any and if known.

7. Reference -- The number on the SOAR, TOAR, or GAR (if any) covering this particular incident.

Anomalies are also classified in various ways for the purpose of statistical analysis. SOAR calls for the following classifications:

ITEM	CODE	DESCRIPTION
Impact:	1	Spacecraft failed
	2	Subsystem or instrument failed
	3	Component failed
	4	Assembly failed
	5	Part failed
	6	Subsystem or instrument degraded
	7	Indeterminate
	8	Loss of redundancy
	9	None
Failure Category:	1	Design problem
	2	Workmanship problem
	3	Part problem.
	4	Environmental problem
	5	Other (w/explanation)
	6	Unknown
Type of Anomaly:	1	Systematic (would occur if identical equipment were operated under identical circumstances)
	2	Random
	3	Wearout (a special case of systematic)
	4	Indeterminate
	5	Intermittent

These classifications for the 1986 anomalies are given in Table I.

Using the data in Table 1, the 37 anomalies can be summarized as follows:

Type of Anomaly	No. of Anomalies
Systematic	2
Random	0
Wearout	6
Indeterminate	29
Intermittent	0

Criticality	No. of Anomalies
Negligible	10
Minor	26
1/3 to 2/3 Mission Loss	1
2/3 to Nearly Total Loss	0
Total Loss	0

If the Negligible and Minor criticality categories are eliminated, there was only one serious anomaly (1/3 to 2/3 Loss) that occurred during the year. This compares with 10 serious anomalies (1/3 to Total Loss) occurring in 1985. This serious anomaly, loss of SSA1F service on TDRS-1, caused a loss of redundancy and involved failure of a component. It is not presently known for certain which "Failure Category" or "Anomaly Type" this anomaly should be classed under.

TABLE I

CLASSIFICATION OF 1986 ANOMALIES

Spacecraft	A	B	C	D	E	F	G
ERBS	8	1	2	5	N	5	3
	9	1	2	2	Y	5	3
GOES-4	40	5	2	6	Y	6	4
GOES-5	32	7	1	9	N	6	4
	33	8	2	6	N	4	1
GOES-6	15	8	1	9	N	6	4
	16	8	2	5	Y	3	3
	17	8	2	6	N	6	4
LANDSAT-5	3	5	2	2	Y	6	4
	4	5	2	7	N	6	4
NIMBUS-7	36	8	2	6	N	5	3
	37	8	2	6	N	5	3
	38	8	2	7	N	6	4
	39	8	2	6	N	5	3
	40	7	1	9	N	6	4
	41	8	2	9	N	6	4
	42	7	2	7	N	6	4
NOAA-6	38	6	1	9	Y	6	4
	39	8	2	5	N	3	4
NOAA-9	17	2	2	6	Y	6	4
	18	1	1	9	N	6	4
	19	8	1	9	N	6	4
	20	8	1	6	N	6	4
NOAA-10	1	6	2	7	N	6	4
	2	5	2	7	N	6	4
	3	-	1	9	N	6	4
	4	8	2	6	N	6	4
	5	8	1	7	N	6	4
	6	8	2	9	N	6	4
	7	1	2	7	N	6	4
SMM	47	5	2	3	Y	6	4
	48	5	2	3	Y	6	4
TDRS-1	41	1	2	7	N	1	1
	42	6	2	7	N	6	4
	43	2	1	7	N	6	4
	44	7	2	7	N	6	4
	45	8	3	3	Y	6	4

A =Index

B = Subsystem

C = Criticality (Mission Effect)

D = Impact

E- = Loss of Redundancy

F = Failure Category

G = Type of Anomaly

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
				AMPTE/CCE		
				NO ANOMALIES REPORTED IN 1986		
				DE-1		
				NO ANOMALIES REPORTED IN 1986		
				ERBS		
8	2/20/86 (503)	ACS	2	X-gyro in IRU became noisy. Intermittent noise for six months	None	A01048
9	8/18/86 (682)	ACS	2	X-gyro in IRU stopped spinning – bearing failed.	Switched to back-up gyro	A01177
				GOES-1, -2, -3		
				NO ANOMALIES REPORTED IN 1986		
				GOES-4		
40	2/26/86 (1996)	TLM & DH	2	DCPR Transmitter-1 has frequency flucuations.	Unusable for DCS support/switch to Xmtr No. ?	97
				GOES-5		
32	7/10/86 (1875)	TC & C	1	SEU on CTU. Word 2-bit shift gave erroneous Cmd load verification.	Minor effect	99
33	9/15/86 (1942)	INST-SEM	2	SEM EPS E-1 & P-4 channels increasingly noisy & E-1 became unusable.	Degraded operation	102

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
				GOES-6		
15	3/17/86 (1054)	INST-SEM	1	X-RAY switched uncommanded from DATA to CAL & POSITION ELECT. from OFF to ON.	Sent corrective command	98
16	8/17/86 (1207)	INST-VAS	2	Primary Scan Drive Encoder Lamp 2 failed open circuit.	Switched to Redundant Encoder Lamp 1	100
17	9/27/86 (1248)	INST-VAS & SEM	2	Transient event shifted VAS Earth view window & changed mode of SEM units.	Restored by Cmd	101
				LANDSAT-4		
				NO ANOMALIES REPORTED IN 1986		
				LANDSAT-5		
3	1/4/86 (674)	TLM & DH	2	Prime Ku TWTA Helix Current increased causing trip circuit to activate.	Switched to rediindant components	A00803
4	6/24/86 (845)	TLM & DH	2	Control loop of High Gain Antenna went out of spec. causing antenna to deviate from normal track.	Commanded back to normal	A00806
				NIMBUS-7		
36	1/5/86 (2630)	INST-CZCS	2	Scan/Comp motors lost sync on 2 occasions. Due to degradation of photo diode & detector	Has happened before	A00823
37	1/22/86 (2647)	INST-CZCS	2	Same as index 36, above.		A00824
38	1/25/86 (2650)	INST-ERB	2	Reference channels 1 & 11 shutters failed to open on command.	Norm. operation 3 days later	A00827

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
39	1/28/86 (2653)	INST-CZCS	2	Same as index 36, above		A00825
40	1/30/86 (2655)	TC & C	1	Command, "CZCS Scan Drive On", failed to execute.	Re-transmitted Cmd & worked OK	A00826
41	2/24/86 (2680)	INST-TOMS	2	Chopper not sync'ed for 11 frames & motor current dropped.	Problem cleared in 3 minutes	A00828
42	11/2/86 (2931)	TC & C	2	Spurious execution of SAM-II sunset command during transmission of other commands	Did not re-occur	A01127
				NOAA-6		
38	1/18/86 (2397)	THERMAL	1	TCE #24 louver remains in active state all the time.	De-activate louver	00244
39	11/6/86 (2689)	INST-MSU	2	Spaceview values for MSU channels 1 & 2 increased to high counts. Reflector drive belt failed.	Degraded operation	00?58
				NOAA-7		
				NO ANOMALIES REPORTED IN 1986 (DEACTIVATED IN JIJNE 1986)		
				NOAA-8		
				DEACTIVATED IN JANUARY 1986		
				NOAA-9		
17	1/30/86 (414)	POWER	2	Battery #2 charge current dropped from taper charge level (1.7 a) to trickle charge level (0.65 a).	Switched to backup regulator	00245
18	4/26/86 (500)	ACS	1	Skew gyro dropped out of supermagneti-zation about 8 times in one week.	Nominal operations resumed 4/29	00246

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
19	7/30/86 (595)	INST-SBUV	1	Grating position lock indicator word is toggling 0 & 1.	Neglig./none	00248
20	11/2/86 (690)	INST-MSU	1	Spaceview values dropped considerably & chan. 3 intercept calibration coeff. drifted beyond limit.	No impact to mission	00257
				NOAA-10		
1	9/17/86 (1)	THERMAL	2	Heater on IMU X-face came on & stayed on. Set point on heater set too high.	Monitor into next eclipse	00250
2	9/24/86 (8)	TLM & DH	2	SATCU telemetry became very noisy. Happened again on 9/28	Noise decreased. Minor eff.	00251
3	10/7/86 (21)	----	1	Short circuit patch telemetry intermittently indicating minus 67 milliamps (0 counts)	Now quiet	00252
4	10/9/86 (23)	INST-HIRS	2	HIRS filter wheel motor current intermittent & loses sync	Under analysis	00253
5	10/9/86 (23)	INST-AVHRR	1	Avhrr ch's 1, *2* & 3 became noisy for about 350 scan lines, once per orbit in the Northern Hemisphere.	Under investigation	00?55
6	10/10/86 (24)	INST-SEM	2	SEM TED E & P Channeltron HV stepped from level 1 to 8. Data Mux mode changed from MOR to All proton.	Cmd'd to normal- OK so far	00254
7	10/19/86 (33)	ACS	2	ADACS control mode switched from nominal to YGC for no apparent reason-one time event	Cmd'd back to nominal	00256
				SMM		
47	2/15/86 (2193)	TLM & DH	2	Failure of High-Gain Antenna steering control electronics	Antenna can't be pointed at TDRS	A01017

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
48	12/7/86 (2488)	TLM & DH	2	Tape Recorder-C failed to respond to commands - remains in standby mode	Can't record C/P data	A01146
				TDRS-1		
41	1/7/86 (1009)	ACS	2	During CVU-A disabled & ETO, SGL roll gimbal & SA 1 roll & pitch gimbal moved positive further than commanded by ground software.	Corrected by new ground command	A01183
42	5/30/86 (1152)	THERMAL	2	Trend analysis of SA-1 & SA-2 antenna compartments indicates possible primary heater failure of SA-1 heater.	Minor/none	A01184
43	9/12/86 (1257)	POWER	1	Battery +Y Cl "cautioned" at 1.45 V for one up-date & then returned to normal.	No action req.	A01185
44	11/7/86	TC & C	2	Both CVU's went to disabled state. S/C would not process commands.	Reset CVIJ's	A01188
45	11/28/86 (1334)	INST-DATA RELAY	3	Forward power degradation to SSA1 occurred which rendered SSA1F inoperable	Decreases user services	A01189

APPENDIX A

SPACECRAFT LIFETIME DATA

Note: In the following table, the term "useful life" refers to the time during which the major mission objectives were met. Active life is the total lifetime during which the satellite remained in service. A blank space means the information was not available. Data is through 1986; see text for update.

SPACECRAFT LIFETIMES

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
TIROS	4/1/60	0.25	.24	.24	TV system useful for 77 days
Explorer VIII (S-30)	11/3/60	0.25	.15	.15	Last transmission 12/28/60
TIROS-II	11/23/60		.63	1.03	TV data useful to 7/12/61
Explorer XI (S-15)	4/27/61		.61	.61	Last transmission 12/7/61
TIROS-III	7/12/61	.25	.40	.63	TV data useful to 12/4/61. Lost tape recorders.
Explorer XII (S-3)	8/15/61	1.0	.31	.31	Transmission ceased abruptly
TIROS-IV	2/8/62	0.25	.36	.44	TV useful to 6/9/62. Lost tape recorders.
OSO-I	3/7/62	0.5	1.40	1.40	Lost tape recorder @ 2 mos. starfish incident degraded power system.
Ariel-I (S-51)	4/26/62	1.0	0.88		Degraded by starfish incident of 7/9/62.
TIROS-V	6/19/62	0.5	0.88	0.88	TV useful to 5/4/63. Camera filaments failed.
TIROS-VI	9/18/62	0.5	1.06	1.06	TV useful to 10/11/63. Filaments and focus out.
Explorer XIV (S-3a)	10/2/62		0.85	1.20	Last transmission 2/17/64
Explorer XV (S-3b)	10/27/62	0.17	0.26	0.55	Despin system failed. Last transmission 5/19/63.
Relay I	12/13/62	2.0	2.53	2.53	
Syncom I	2/14/63	2.0	0	0	Lost power, mission failure.
Explorer XVII (S-6)	4/3/63	0.25	.27	.27	Batteries degraded. No solar array.
TIROS-VII	6/19/63	0.5	4.33	4.96	Deactivated. Camera focus out 12/65.
Syncom II	7/26/63	2.0	N/A	N/A	
IMP-A	11/26/63	1.0	0.82		
TIROS-VIII	12/21/63	0.5	3.53	3.53	Deactivated.
Relay-II	1/21/64	1.0	1.68	3.50	
Ariel-II (S-52)	3/27/64	1.0	0.53		Had spin rate and attitude control problems.
Syncom III	8/19/64	3.0	N/A	N/A	
Explorer XX (S-48)	8/25/64		1.60	1.60	Based on last transmission 3/30/66.
Nimbus-I	8/28/64	0.5	0.07	0.07	Solar array drive failed.
OGO-1(A)	9/4/64	1.0	5.23	5.23	Mission failure. 3-axis stabilization not achieved.
IMP-B	10/3/64	1.0	0.50	1.25	Reentered. Placed in wrong orbit.
Explorer XXVI (S-3c)	12/21/64	1.0	2.10	2.10	Last transmission 1/21/67.
TIROS-IX	1/22/65	0.5	2.73	3.4	Deactivated. Camera contrast out 10/66.
OSO-II	2/3/65	0.5	0.75	0.75	Used up control gas.

SPACECRAFT LIFETIMES

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
IMP-1(C)	5/29/65	1.0	1.92	1.92	Reentered.
TIROS-X	7/2/65	1.0	1.16	2.00	Deactivated.
OGO-2(C)	10/14/65	1.0	3.48		Mission failure: Horizon scanners did not maintain earth lock.
ESSA-I	2/3/66	1.0	2.36	2.36	Deactivated.
ESSA-II	2/28/66	1.0	4.64	4.64	Deactivated.
OAO-I	4/8/66	1.0	0	0	Mission failure: Lost power
Nimbus-II	5/16/66	0.5	2.67	2.67	ACS scanner failed.
AE-B	5/25/66	0.5	0.82		Higher than planned orbit. Two sensors did not work.
OGO-3(B)	6/6/66	1.0	2.04	3.5	Boom oscillation problem.
AIMP-2(D)	7/1/66	0.5	4.92		Failed to achieve lunar orbit.
ESSA-III	10/2/66	1.0	2.02	2.02	Deactivated. Cameras failed
ATS-I	12/6/66	3.0		ACTIVE	Gas expended. Limited service
ESSA-IV	1/26/67	1.0	0.41	1.27	Deactivated. One camera failed, one degraded.
OSO-III	3/8/67	0.5	3.0	3.0	Tape recorder failure at 18 mos. ACS controlled manually.
ESSA-V	4/20/67	1.0	2.83	2.83	Deactivated. IR failed, cameras gradually degraded.
IMP-3(F)	5/24/67	1.0	1.95	1.95	Reentered.
AIMP-4(E)	7/19/67		3.50	3.50	Lunar orbit. Subsequent period of intermittent operation.
OGO-4(D)	7/28/67	1.0	2.24	2.75	Thermal bending of antenna caused stabilization control problem.
OSO-IV	10/18/67	0.5	0.90		Tape recorder failure at 6 mos.
ATS-III	11/5/67	3.0		ACTIVE	Instruments no longer in use
ESSA-VI	11/10/67	1.0	2.09	2.09	Deactivated Cameras degraded
OGO-5(E)	3/4/68	1.0	3.60	3.60	Deactivated. Data glut
RAE-A	7/4/68	1.0	4.50	4.50	Deactivated. Data quality had become marginal.
ESSA-VII	8/16/68	1.0	0.92	1.56	Deactivated. Early camera and tape recorder failures
OAO-II	12/7/68	1.0	4.20	4.20	Prime instrument (WEP) failed.
ESSA-VIII	12/15/68	1.0	4.95	6.75	Deactivated. Camera problems
OSO-V	1/22/69	0.5	3.9	3.9	
ESSA-IX	2/26/69		4.1	4.1	Deactivated. Standby after 4/71.

SPACECRAFT LIFETIMES

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
Nimbus-3	4/19/69	0.5	2.67		ACS Scanner failed 1/72.
OGO-6 (F)	6/5/69	1.0	2.06	2.25	Deactivated. Data glut
IMP-5(G)	6/21/69		3.51	3.51	Reentered.
OSO-VI	8/9/69	0.5	3.30	3.30	
ATS V	8/12/69	3.0	14.84	14.84	Mission officially unsuccessful: Stabilization not achieved. Deorbited 3/20/84
TIROS-M	1/23/70	1.0	1.40	1.40	Momentum wheel assembly failed.
Nimbus-4	4/8/70	1.0	10.00	10.00	Deactivated.
NOAA-1 (ITOS-A)	12/11/70	1.0	.56	0.75	Deactivated. Momentum wheel assembly problems.
SAS-A	12/12/70	0.5	4.00	4.00	Transmitter failure terminated mission.
IMP-6(I)	3/13/71	1.0	3.56	3.56	Reentered.
OSO-VII	9/29/71	0.5	3.17	3.17	Reentered due to bad orbit
SSS-A	11/15/71	1.0	2.87	2.87	Deactivated. Battery unusable, as expected after 1 year.
Landsat-1 (ERTS-A)	7/23/72	1.0	5.58	5.58	Deactivated: Funding withdrawn
OAO-C	8/21/72	1.0	8.50	8.50	Deactivated: Funding withdrawn
IMP-7(H)	9/22/72	2.0	6.10	6.10	Power system failed.
NOAA-2 (ITOS-D)	10/15/72	1.0	2.25	2.40	Standby after 3/74. Some experiments failed.
SAS-B	11/16/72	0.5	.54	.54	Experiment low voltage power supply failed.
Nimbus-5	12/12/72	1.0	10.30	10.30	Deactivated 3/31/83. Second HDRSS failed 7/27/82.
RAE-B	6/10/73	1.0	3.75	3.75	Deactivated. Mission objectives achieved.
IMP-8(J)	10/25/73	2.0	ACTIVE	ACTIVE	All instruments operating.
NOAA-3 (ITOS-F)	11/6/73	1.0	2.84	2.84	Deactivated. Radiometer, VTPR, VHRR out
AE-C	12/16/73	1.0	5.00	5.00	Reentered.
SMS-1	5/17/74	2.0	1.60	6.70	Standby after 1/76. Deactivated 1/31/81.
ATS-6(F)	5/30/74	5.0	5.17	5.17	Deactivated.
NOAA-4 (ITOS-G)	11/15/74	1.0	4.00	4.00	Deactivated. Radiometer, VHRR's out.
Landsat-2	1/22/75	1.0	8.51	8.51	Yaw flywheel stopped 11/79, recovered 5/80. Permanently turned off July 27, 1983.
SMS-2(B)	2/6/75	2.0	6.50	7.50	Second encoder failed on 8/5/81.
SAS-C	5/7/75	1.0	4.92	4.92	Reentered.

SPACECRAFT LIFETIMES

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
Nimbus-6(F)	6/12/75	1.0	7.18	8.28	Yaw flywheel failed 8/14/82.
OSO-8(I)	6/21/75	1.0	3.40	3.40	Funding withdrawn
AE-D	10/6/75	1.0	0.42	0.42	Shorted diode in power supply electronics.
GOES-1(A)	10/16/75	3.0	9.3	9.4	VISSR failed 2/85
AE-E	11/20/75	1.0	5.56	5.56	Reentered 6/10/81
NOAA-5 (ITOS-H)	7/29/76	1.0	2.96	2.96	Failed 7/79
GOES-2 (B)	6/16/77	3.0	1.55	1.55	VISSR failed 1/79
ISEE-1(A)	10/22/77	2.0	ACTIVE	ACTIVE	Some instrument losses
IUE	1/26/78	3.0	ACTIVE	ACTIVE	Fully operational. Some problems w/ computer "HALTS"
Landsat-3(C)	3/5/78	3.0	5.07	5.51	Problems with MSS instrument
AEM-A (HCMM)	4/26/78	1.0	2.40	2.40	Deactivated. Battery degraded 9/14/80.
GOES-3(C)	6/16/78	3.0	2.21	ACTIVE	VISSR degraded 9/80. Failed 5/6/81.
ISEE-3(C) [ICE]	8/12/78	2.0	ACTIVE	ACTIVE	Some instrument losses.
TIROS-N	10/13/78	2.0	2.38	2.38	ACS failed 2/27/81.
Nimbus-7(G)	10/24/78	1.0	ACTIVE	ACTIVE	Solar array power and some instruments degraded.
AEM-B (SAGE)	2/18/79	1.0	2.75	2.75	Battery degraded. Failed 11/18/81.
NOAA-6(A)	6/27/79	2.0	7.39	--	Much degraded. Standby 11/86
Magsat	10/30/79	0.4	.61	.61	Reentered as planned 6/11/80
SMM	2/14/80	2.0	0.83*	ACTIVE	Lost fine pointing control 12/12/80.
GOES-4(D)	9/9/80	7.0	2.21	6.66	VAS failed 11/25/82.
GOES-5(E)	5/22/81	7.0	3.19	ACTIVE	VISSR inoperable
NOAA-7(C)	6/23/81	2.0	3.62	--	Failed HIRS, degraded SSU, disabled power system.
DE-1(A)	8/3/81	1.0	ACTIVE	ACTIVE	
DE-2(B)	8/3/81	1.0	1.54	1.54	Reentered as expected 2/19/83.
OSS-1	3/22/82	--	--	--	Shuttle attached payload mission.
Landsat-4(D)	7/16/82	3.0	ACTIVE	ACTIVE	
NOAA-8(E)	3/28/83	2.0	--	--	Failed 7/1/84. Recovered May 1985. Failed again 1/86.
TDRS-1(A)	4/4/83	**	ACTIVE	ACTIVE	Some loss of capability.
GOES-6(F)	4/28/83	7.0	ACTIVE	ACTIVE	

SPACECRAFT LIFETIMES

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
Landsat-5(D')	3/1/84	3.0	ACTIVE	ACTIVE	
AMPTE/CCE	8/16/84	1.0	ACTIVE	ACTIVE	
ERBS	10/5/84	2.0	ACTIVE	ACTIVE	
NOAA-9(F)	12/12/84	2.0	ACTIVE	ACTIVE	
SPARTAN-1	6/20/85	--	--	--	STS attached payload mission
SPOC/HITCHHIKER	1/12/86	--	--	--	STS attached payload mission
NOAA-10(G)	9/17/86	2.0	ACTIVE	ACTIVE	
GOES-7(H)	2/26/87	7.0	ACTIVE	ACTIVE	

* Repaired by crew of shuttle flight 41-C on April 12, 1984.
** Complex warranty provisions call essentially for 10-year service from TDRSS system.