ORBITAL ANOMALIES IN GODDARD SPACECRAFT

FOR

CY 1990

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ASSURANCE REQUIREMENTS OFFICE

OFFICE OF FLIGHT ASSURANCE '

NASA/GODDARD SPACE FLIGHT CENTER

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TO: Distribution

FROM: 302/Assurance Requirements Office

SUBJECT: Correction to Reports, *Orbital Anomalies in Goddard Spacecraft for CY1987, 1988, 1989 & 1990*

The purpose of this memorandum is to advise recipients of any of the four subject reports that some of the textual information, in the body of the report and Appendix A, concerning the Landsat-5 Ku Band is in error. The Ku Band subsystem in the spacecraft is functioning satisfactorily (presently using the redundant unit) and it is regularly used to send data from the Thematic Mapper (TM) to the ground via the TDRSS.

William G. Elsen

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 1990. 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 20 years 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 and yearly reports since, all published by the Office of Flight Assurance. The current report updates the record through 1990.

Spacecraft Activity Schedule

At the beginning of this reporting period, on January 1 1990, 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 and five of the GOES series; Landsat-4, and Landsat-5.

There were two new spacecraft launched during the year and one older spacecraft mission was terminated. In April two spacecraft were successfully launched. The PEGSAT Spacecraft was launched by a PEGASUS Launch Vehicle using a B-52 as a launch platform and the HST (Hubble Space Telescope) was launched on STS-31. Although the HST was not built under contract to GSFC (it was a MSFC program), it is listed in this report because flight operations and future refurbishment are assigned to GSFC. Two Goddard attached payloads were also launched: SSBUV (on STS41) in October and BBXRT (on STS-35) in December. The GOES-5 Spacecraft was deactivated in July because of depletion of its station-keeping fuel. The complete list of satellites active during all or part of 1990 is as follows:

NASA		NOAA
COBE		NOAA-9
DE-1	0	NOAA-10
ERBS	N	NOAA-11
IMP-8	G	GOES-2
ICE (ISEE-3)	0	GOES-3
IUE	I	GOES-5
NIMBUS-7	N	GOES-6
TDRS-1	G	GOES-7
TDRS-3		Landsat-4
TDRS-4		Landsat-5
HST	NEW	
PEGSAT		

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

Overall there were 71 anomalies, distributed over 13 different spacecraft, during the year. 29 of these were from HST. The distribution of these anomalies among the spacecraft is presented in Figure 1. (This compares with 50 anomalies distributed over 13 spacecraft in the previous year, 1989).

In addition, the distribution of these 71 anomalies among the spacecraft subsystems is shown graphically in Figure 2. This figure shows that most of the anomalies occurred in the Attitude Control Subsystem (ACS) and the Instruments.

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 in Table II.

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/NOA-A 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 originates 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, 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. The classification of each spacecraft, according to GMI 8010.2, is listed after the spacecraft name.

COBE (Cosmic Background Explorer) CLASS B

This spacecraft, launched in November 1989, continued to work well throughout the year. It continues to provide excellent scientific data. On 9/21/90 depletion of the liquid hydrogen (LH_2) in the dewar occurred. This was expected, but not as early as September. The temperature rose swiftly after depletion and this ended the operation of FIRAS (Far Infra-Red Absolute Spectrophotometer) which depends on cryogenic temperatures. This also decreases the output of the DIRBE (Diffuse Infra-Red Background Experiment) ; the four shortest wavelengths (near infra-red bands) continue to supply useful data. The DMR (Differential Microwave Radiometer) does not require cryogenic temperatures and it continues to supply data. A number of minor anomalies occurred during the year and they are listed in Table II. None of these have appreciably affected operations.

DE-1 (Dvnamic Explorer) UNCLASSIFIED

This spacecraft took part in various joint scientific endeavors early in the year: with ACTIVE, Russian spacecraft, WIPP campaign, and viewing of Comet Austin. In mid-year it was decided that the DE-1 mission would be terminated after the 1990-91 winter. The spacecraft continued to periodically experience high temperatures in the batteries and tape recorders which called for caution. In late October there was a spacecraft emergency called because the spacecraft stopped accepting ground commands of any kind. Telemetry transmissions from the spacecraft were normal. After some hours commands were again being accepted by the spacecraft and everything seemed normal again.

It was suspected that high temperatures were the cause. Shortly after this, at a science meeting, it was decided to terminate the mission on February 28, 1991. On November 17 the spacecraft again stopped accepting all commands. (The spacecraft was in a safe mode with all instruments off.) This condition continued until December **17.** [This problem kept re-appearing after January 1, 1991, and the mission was terminated on 3/3/91.]

ERBS (Earth Radiation Budget Satellite) UNCLASSIFIED

On February 28 the ERBE-Scanner Instrument failed abruptly, without any warning. Similar instruments in two NOAA spacecraft had failed earlier in the same manner. This leaves ERBS with two instruments; ERBE-Non-scanner and the SAGE. These continue to operate well providing good data. In the spring symptoms of battery aging continued to manifest itself. Various operational changes were made during the year to make life easier on the batteries. The two batteries are not charging up in a like manner with as much as two amps difference. The battery behavior improved later in the year due to conservation measures. In early July the second X-gyro failed leaving the spacecraft with only two redundant Z-gyros left. Shortly thereafter the first 180° yaw turn was performed using the new "Z only" procedure. It worked OK but produced high roll errors (35°). Subsequent yaw turns reduced the errors in roll and pitch. On September 17 the ERBS reached six years on orbit.

GOES (Geostationary operational Environmental Satellite **CLASS A**

GOES-5: This spacecraft depleted its station-keeping hydrazine fuel in December 1989, and is drifting westward from 60° West Longitude on January 10. At the beginning of the year it was the designated EAST S/C providing AAA VAS (from GOES-7), East WEFAX and DCS. In late April Mode AAA VAS and EAST WEFAX were transferred to GOES-2 and in early July the East DCS function was transferred to GOES-7 (DCPR) and GOES-2 (DCFI). On July 18 the spacecraft was

deactivated by configuring all subsystems to survival mode and all communications commanded off. This spacecraft served for nine years and produced approximately 60,000 images.

GOES-6: This spacecraft started the year with only about 6 lbs. of station-keeping fuel left. It is located at 135° West Longitude being used for DCS, SEM and METSAT data relay. One station-keeping (East-West) maneuver was performed in late August to prevent excess drift along orbital track.

GOES-7. At the beginning of the year this spacecraft was located at 108° West Longitude and served as the PRIME spacecraft and the only GOES with imaging capability. Its performance is nominal and it is estimated to have 75 lbs. of hydrazine remaining. In July the spacecraft was situated at 98° West Longitude to support east coast hurricane watch season. Then in the fall it was slowly moved back to 108° West Longitude for the winter-spring storm watch operations. Some very minor anomalies were written up during the year that had a negligible effect on operations. At the end of the year everything was functioning very well.

HST (Hubble Space Telescope) CLASS B

The HST was launched on STS-31 on April 24 and deployed from the Shuttle on April 25. A number of very minor anomalies were written up in the first days of the mission. The first slightly more serious anomaly was noted first on May 1 when a vehicle low frequency vibration manifested itself that seemed to be thermally induced involving the solar array and transition from day to night and night to day. This anomaly affects gyro operation and takes time to damp out. Operational software has helped to compensate for this continuing problem. On June 26 it was discovered that the primary mirror had a spherical aberration problem. This has somewhat compromised the planned capability of the optical viewing but the mission can still meet many of its objectives. The other important anomaly occurred in December when one of the six gyros (No. 6) failed and a redundant gyro (No. 2) was brought on line.

ICE (International Cometary Explorer) UNCLASSIFIED
(originally ISEE-3)

This 12-year old spacecraft continued to operate successfully throughout the year without any reported anomalies. Science taking continued to be low due to conflict on the Deep Space Network with higher priority missions, such as Magellan and Galileo. In September a new PC system was set up and checked out to replace the large computers in the control center to be used for spacecraft control.

IUE (International Ultraviolet Explorer). UNCLASSIFIED

This spacecraft continued to obtain valuable scientific data throughout this year. During most of the year gyro No. 5 continued to show increased drift rates and, although getting worse, it continued to do its job. Batteries 1 and 2 occasionally mis-behave but considering their age they are in pretty good shape. Various power conservation methods were implemented during the year. Starting in May the spacecraft was used to view Comet Austin and this was repeated into October.

Provisions for 1-gyro operation have been made and some tests have been run. No anomalies were reported during the year

Landsat-4 UNCLASSIFIED

There were no anomalies reported in 1990 and the MSS (Multi-Spectral Scanner) and TM (Thematic Mapper) continue to produce images utilizing clever power management procedures (power system severely degraded). This spacecraft reached eight years on orbit this year.

Landsat-5 UNCLASSIFIED

This spacecraft (now six years old) continues to provide TM and MSS images. In April an intermittent problem developed in that an RF switch would fail to cycle between position 1 and 3, when commanded. Spacecraft operations were modified to eliminate further switching of this switch. This limits the spacecraft to using the TDRS for communication with the ground.

Nimbus-7. UNCLASSIFIED

This old-timer attained 12 years on-orbit in October.

Three instruments are still operating: SAM II (Stratospheric Aerosol Measurement), SBUV/TOMS (Solar Backscatter Ultraviolet/Total Ozone Mapping Spectrometer) and ERB (Earth Radiation Budget). Only five insignificant anomalies were reported during the year.

NOAA-9 CLASS B

This spacecraft has remained in standby status all year. However, the ERBE-NS and SBUV data are still being recovered and processed by NOAA for use by the scientific community. No anomalies were reported.

NOA-A-10 CLASS B

This was the operational "Morning" polar satellite. All instruments are operational except SARP (Search and Rescue Processor) and the ERBE-S (Earth Radiation Budget Experiment-Scanner), which both have failed. The Power Subsystem is severely degraded but it is able to support the normal load with careful management and operation.

NOA-A-11 CLASS B

At the beginning of the year this was the operational "afternoon" polar satellite. All instruments are performing well and all the subsystems are nominal except for the failed Digital Tape Recorder No. 5 and the failed Y-gyro in the IMU. While these failures do reduce redundancy, they do not affect current mission capability. A number of "negligible" anomaly reports were written during the year (see Table II). The pitch (Z) gyro became intermittent in mid-year and in September it dropped out of synchronous operation and could not be brought back to normal operation. New software, which had been developed earlier, took over control and maintained the proper attitude control. Operations and data products were not affected.

PEGSAT (Pegasus Satellite) UNCLASSIFIED

This small satellite was launched on a Pegasus launch vehicle on April 5. This was the first launch of this vehicle which is air-launched from the wing of a B-52 at high altitude. The launch was successful and the Pegsat had a malfunction-free mission with no SOARs required.

The mission was finally terminated when the batteries on the spacecraft were exhausted. There were no solar cells on this spacecraft.

SSBUV (Shuttle Solar Backscatter Ultra-Violet) CLASS D

This attached payload flew on the STS-41 mission, which launched the Ulysses spacecraft, in October (6 to 10).

TDRS (Tracking and Data Relay Satellite) CLASS A

TDRS-1: This spacecraft was in a standby mode for the entire year. There was only one anomaly reported which was of a negligible nature.

TDRS-3: This spacecraft continued throughout the year in its assignment as TDRS-WEST. It experienced relatively few anomalies. From mid-January to Mid-March the polarization switch for SA-2 (forward and return) became stuck in Right Hand Circular Polarization Mode. This limited the service somewhat. In early March there was a failure in the heater circuit of Fine Sun Sensor-A (FSS). This will lead to failure of the FSS itself. A switch will be made to the redundant FSS-B.

TDRS-4: This spacecraft launched in March 1989, served as TDRS-EAST all year. It carried out its assignment with very few problems. Several negligible anomalies occurred through the year (Table II).

Anomaly Data: Classification and Description

In the table of anomalies (Table II), 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 the 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 nine subsystems. These are:

    1. Attitude Control and Stabilization (ACS)
    2. Power
    3. Propulsion
    4. Structure
    5. Telemetry & Data Handling (TLM & DH)
    6. Thermal
    7. Timing, Control & 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	(0 - 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
Anomaly Effect:	1	Spacecraft failure
	2	Subsystem/instrument failure
	3	Component failure
	4	Assembly failure
	5	Part failure
	6	Subsystem/instrument degradation
	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
	6	Normal/Expected Operation

These classifications for the 1990 anomalies are given in Table I.

Using the data in Table I, the 71 "1990 anomalies" can be summarized in various ways. These are presented, following Table I, in various tables and graphs.

TABLE I

CLASSIFICATION OF 1990 Anomalies

Spacecraft	A	B	C	D	E	F
COBE	5	5	1	9	5	1
	6	1	1	9	1	1
	7	1	1	9	1	1
	8	6	1	5	3	4
	9	8	1	9	1	1
	10	1	1	9	6	5
	11	7	1	9	6	4
	12	7	1	9	5	1
	13	8	1	9	6	4
DE-1	16	7	3	2	4	1
ERBS	14	8	3	2	1	1
	15	1	2	3	5	3
GOES-5	35	5	1	7	6	4
GOES-7	14	8	1	9	5	5
	15	5	1	9	6	4
	16	3	1	9	6	5
	17	8	1	9	6	5
HST	1	2	1	9	1	1
	2	2	1	9	1	1
	3	2	1	9	1	1
	4	2	1	6	5	2
	5	2	1	9	3	4
	6	6	1	9	3	2
	7	6	1	9	1	1
	8	5	1	6	1	1
	9	2	2	6	1	1
	10	6	1	9	3	2
	11	1	1	6	3	1
	12	4	1	9	4	1
	13	8	1	5	3	2
	14	8	1	9	1	1
	15	1	1	3	4	1
	16	8	1	9	5	1
	17	8	3	6	2	1
	18	1	1	6	2	1
	19	8	1	6	4	1
	20	5	1	9	1	1
	21	8	1	6	1	1
	22	8	1	9	1	1
	23	8	1	9	6	5

Spacecraft	A	B	C	D	E	F	
HST	24	8	1	6	1	1	
	25	8	1	5	3	1	
	26	2	2	4	1	1	
	27	1	1	9	5	5	
	28	5	1	6	5	4	
	29	1	2	3	3	2	
LANDSAT-5	10	5	2	4	5	5	
NIMBUS-7	59	7	1	7	6	5	
	60	5	1	7	6	5	
	61	5	1	7	6	5	
	62	8	1	9	6	5	
	63	8	1	9	6	5	
NOAA-10	21	8	1	9	4	5	
NOAA-11	12	8	1	9	5	5	
	13	8	1	9	6	5	
	14	8	1	9	5	5	
	15	8	2	9	6	4	
	16	1	1	9	6	5	
	17	1	1	9	6	4	
	18	1	1	9	6	5	
	19	1	1	9	6	5	
	20	1	2	3	6	4	
TDRS-1	60	8	1	9	6	5	
TDRS-3	13	8	2	6	6	4	
	14	1	2	4	6	4	
	15	8	1	9	6	4	
TDRS-4	[10	8	1	9	5	4]	< 1989 Anomaly
	11	8	1	9	6	5	
	12	8	1	9	6	4	
	13	8	1	9	6	4	
	14	1	1	9	6	5	

A = Index

B = Subsystem

C = Criticality (Mission Effect)

D = Anomaly Effect

E = Failure Category

F = Type of Anomaly

Criticality	No. of Anomalies
Negligible	59
Minor	9
Substantial (1/3 to 2/3 Mission Loss)	3
Major (2/3 to Nearly Total Loss)	0
Catastrophic (Total Loss)	0

[SEE FIGURE 3]

The three items listed above as "Substantial" are: (1) the DE-1 spacecraft not accepting ground commands, (2) failure of ERBE Scanner Instrument in ERBS spacecraft, and (3) HST spacecraft - spherical aberration in primary mirror.

Anomaly Effect	No. of Anomalies ('91)
1. S/C Failure	0
2. Subsys./Ins't Failure	2
3. Component Failure	4
4. Assembly Failure	3
5. Part Failure	3
6. Subsys./Ins't Degradation	11
7. Indeterminate	4
8. Loss of Redundancy	0
9. None	44

[SEE FIGURE 4]

Failure Category	No. of Anomalies ('91)
1. Design Problem	16
2. Workmanship Problem	2
3. Part Problem	8
4. Environmental Problem	5
5. Other (w/explan.)	12
6. Unknown	28

[SEE FIGURE 5]

Type of Anomaly	No. of Anomalies ('91)
1. Systematic	27
2. Random	5
3. Wearout	1
4. Indeterminate	16
5. Intermittent	22

[SEE FIGURE 6]

Figure 2 - 1990 Anomalies Distribution Among Subsystems

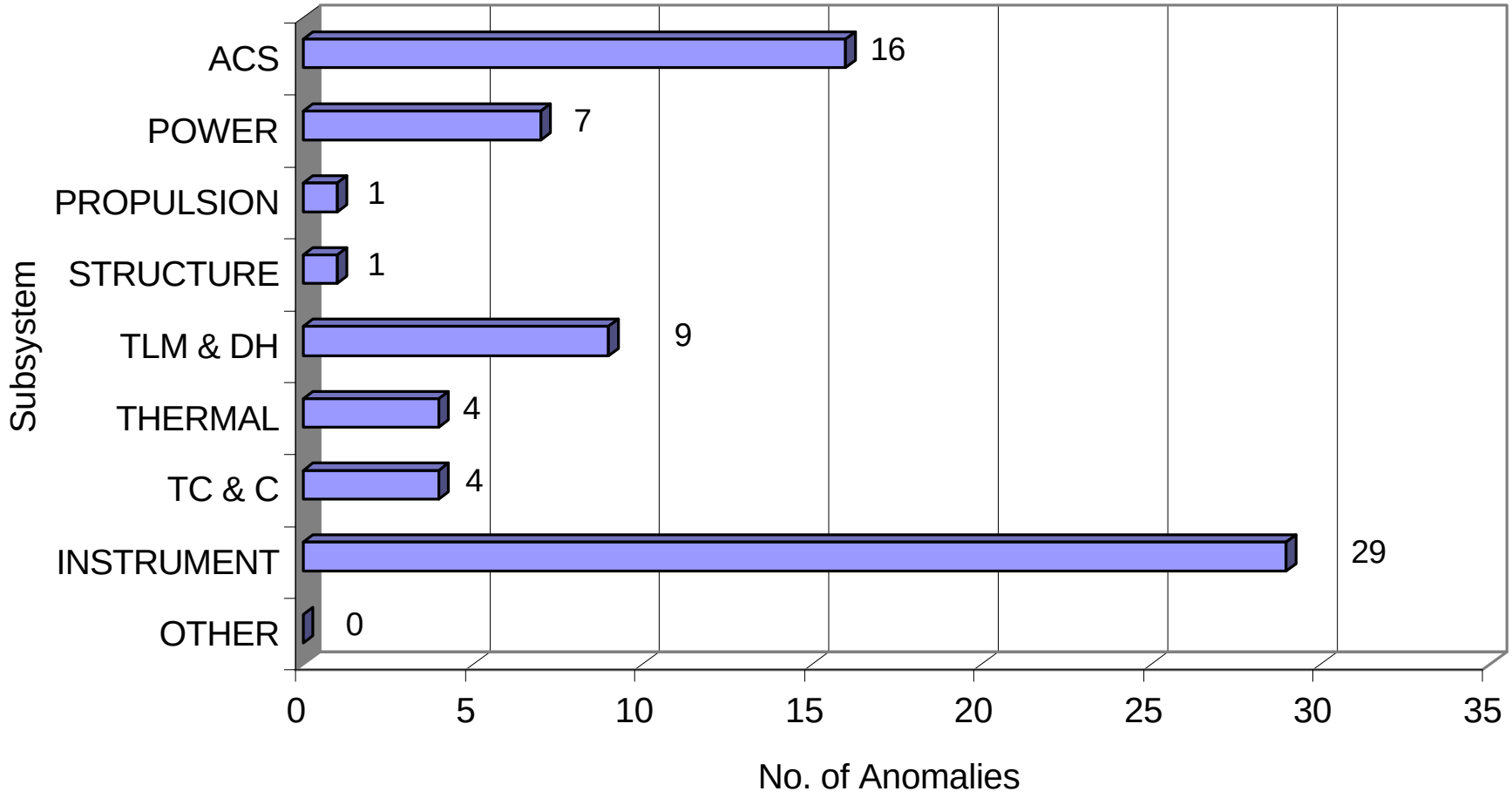
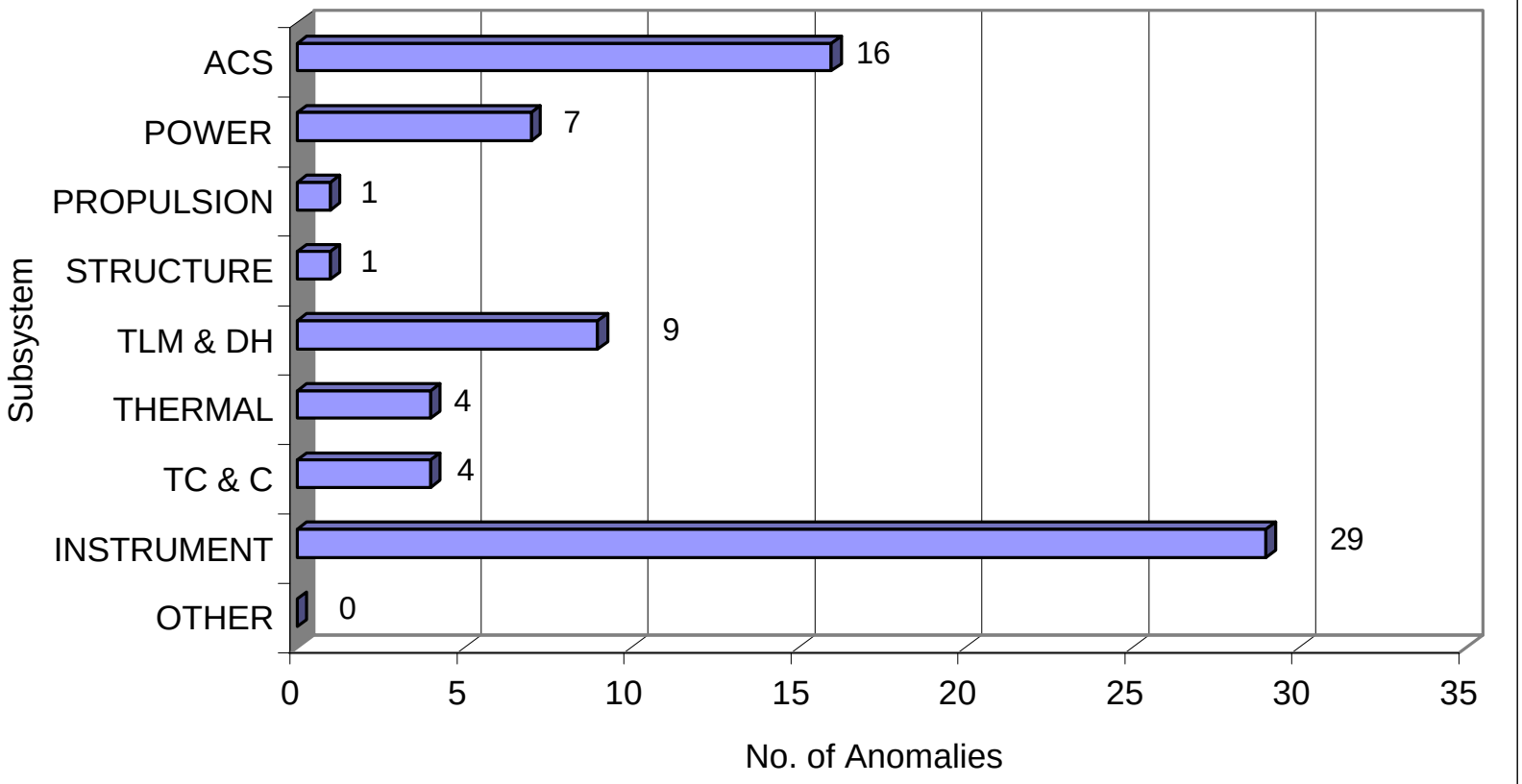


Figure 2 - 1990 Anomalies Distribution Among Subsystems



Orbital Anomalies in Goddard Spacecraft
(CY 1990)

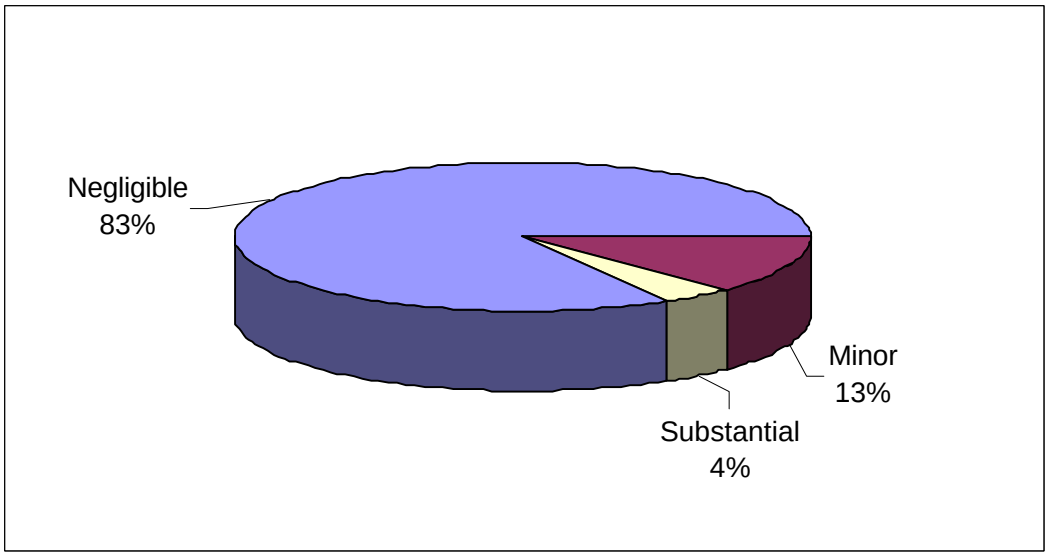


Figure 3 - Criticality

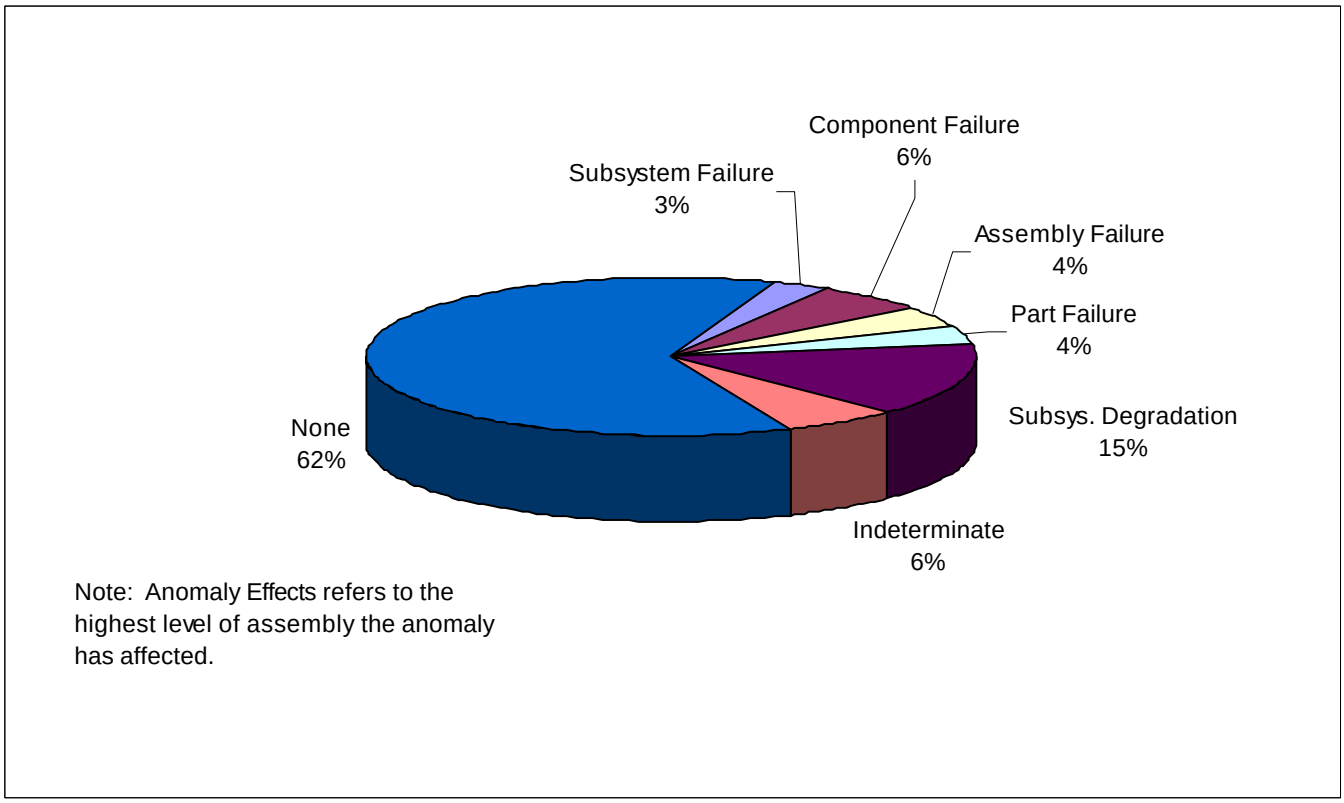


Figure 4 - Anomaly Effect

Orbital Anomalies in Goddard Spacecraft
(CY 1990)

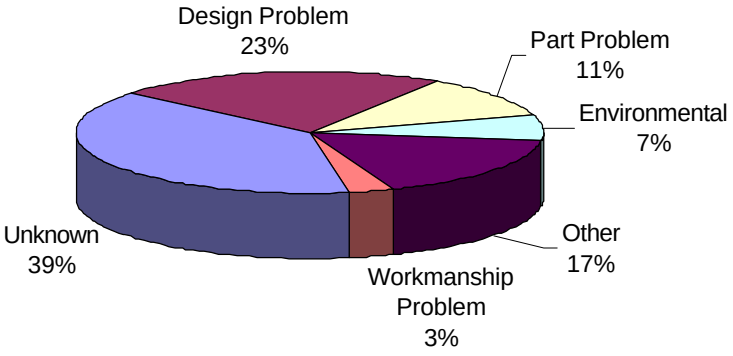


Figure 5 - Failure Category

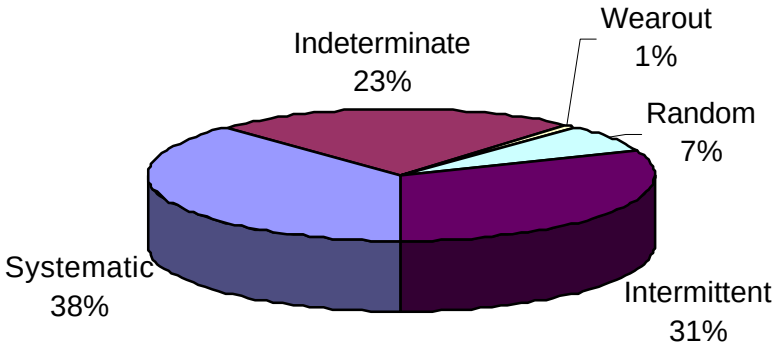


Figure 6 - Type of Anomalies

TABLE II

LOG OF 1990 ANOMALIES

TABLE II

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
				COBE		
5	1/7/90 (50)	TLM&DH	1	Tape recorders have larger than expected pressure loss (0.8 psi/month)	Negligible/None possible	A01273
6	3/2/90 (104)	ACS	1	ESA-A (Earth Sensor Ass'y) motor speed exceeded normal limit.	Negligible/None required	
7	4/10/90 (143)	ACS	1	ESA-B (Earth Sensor Ass'y) motor speed exceeded normal limit.	Negligible/None required	
8	5/12/90 (175)	Thermal	1	Temperature monitor on outer panel of solar array wing-A failed.	Other monitors available/None possible	
9	7/10/90 (234)	INST + DEWAR	1	Dewar outer and middle Vapor Cool Shield temperature limit violation - sun glint into Dewar is possible cause.	Negligible	
10	8/24/90 (279)	ACS	1	C-Axis Rate Meas. Ass'y (RMA) motor current exceeded limit value - decreased later.	Negligible/None	
11	10/11/90 (327)	TC&C	1	Command Storage Memory safety sequence (RTS999) inadvertently executed enabling Auto-Transmit Function (XMTR 1 and 2 enabled).	Negligible/ commanded off	
12	10/20/90 (336)	TC&C	1	Master Oscillator outer oven power reached a yellow limit of 6.14mv.	Negligible/ Oven limits modified in POCC data base.	
13	11/2/90 (349)	INST + DMR	1	DMR 31.5 B GHz antenna high output - decreased by itself.	Put out degraded science data for a few days.	

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
				DE-1		
16	10/22/90 (3367)	TC&C	3	XPNDR and command detector were falsely locked and command decoder was in confused state.	Real time commands could not be uplinked to S/C/ detector "lock" cleared itself.	A01138
				ERBS		
14	2/28/90 (1972)	INST + ERBE-S	3	This instrument abruptly stopped scanning.	Instrument failed/None possible	A01106
15	7/8/90 (2102)	ACS	2	X-Gyro in IRU-2 failed due to bearing wearout.	No immediate impact on S/C/ none possible	A01102
				GOES-5		
35	1/4/90 (3149)	TLM&DH	1	Battery 1 discharge current telemetry intermittently erratic.	None/None required	124
				GOES-7		
14	4/24/90 (1153)	INST + VAS	1	Phantom command: STEP SCAN ON (331)	No effect/Send proper command.	125
15	7/9/90 (1229)	TLM&DH	1	DCPR XMTRI 5 KHz off center frequency.		126
16	10/18/90 (1330)	Propulsion	1	RCS (Reaction Control Subsys.) post maneuver attitude deviated 86° in right ascension from predicted attitude.		127
17	11/1/90 (1344)	INST + SEM	1	EPS channels Al and Pl had excessively high output counts for several hours.		128

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
				HST		
1	4/25/90 (1)	POWER	1	When the-PDM (solar array) was deployed there was no indication that the motor had stopped.	None/none required	A01354
2	4/25/90 (1)	POWER	1	When the +PDM (solar array) was deployed there was no "deployed" indication and no motor "stop" indication.	None/Ground command stopped motor.	A01356
3	4/25/90 (1)	POWER	1	Same as SOAR's A01354 and A01356 except this was + SDM (Secondary Deployment Mechanism).	As above	A01357
4	4/25/90 (1)	POWER	1	Solar array section six current output five amps low - two cell strings are open circuit.	Reduced power output/none possible	A01358
5	4/25/90 (1)	POWER	1	Trouble was experienced deploying the -V2 solar array due to an intermittent open ground in tension sensor.	Slight deploy delay/tension circuit disabled.	A01360
6	4/25/90 (1)	THERMAL	1	Magnetic Sensing System (MSS)-2 temperature violates low temperature red limit due to possible failure of primary heater circuit.	Negligible/Red limit set points changed.	A01361
7	4/26/90 (2)	THERMAL	1	RWA bearing temperature of -19° has been observed- this is below red limit - cause not known.	Negligible/None required at present.	A01362
8	4/27/90 (3)	TLM&DH	1	TLM reported high torque on -V3 HGA, Y-gimbal due to mechanical interference.	Negligible/ Operational parameters changed to prevent interference.	A01363
9	5/1/90 (8)	POWER	2	Day/night change causes solar array to vibrate at 0.11 Hz and 0.6 Hz - affects gyro operation.	Gyros transition from low to high mode/ change ops to limit/damp vib.	A01364

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
10	5/1/90 (8)	THERMAL	1	CSS (Course Sun Sensor)-1 temperatures periodically violate low temp yellow limit due to possible failure of primary heater circuit (see SOAR A01361).	Negligible/ Yellow limit set points changed,	A01365
11	5/7/90 (14)	ACS	1	Bit flips in RAM of Fine Guidance Electronics when passing thru So. Atlantic Anomaly - affects guidance.	Failed guide star acquisitions/ onboard S/W modified to compensate.	A01366
12	5/11/90 (17)	STRUCTURE	1	Solar array drive mechanism temperatures occasionally violate high red limit-thermal predicts in error.	None/limits changed	A01367
13	5/13/90 (19)	INST + GHRS	1	Failure of detector 1 radiation diode 510.	Negligible/ other diode made primary in NSSC-1 tables.	A01368
14	5/15/90 (21)	INST + OTA	1	Anomalous telemetry indications for secondary mirror movement - indicated movement in opposite direction than commanded.	Mirror moved correctly/none	A01369
15	6/20/90 (57)	ACS	1	SAA causes high PMT counts in the fine guidance system resulting in guide star acquisition failures.	Operation affected/FGS use suspended in SAA.	A01370
16	6/22/90 (59)	INST+HSP	1	Responses from PMT rose than normal in short time - caused by operation at low voltages.	Negligible/ software changes made	A01372
17	6/26/90 (63)	INST+OTA	3	Spherical aberration in primary mirror of approx. 0.5 wave rms.	Substantial/ corrective optics for replacement mission.	A01373
18	6/28/90 (65)	ACS	1	FGS guide star acquisitions (both course track and fine lock) have exhibited high failure rate-cause is spherical aberration in primary mirror.	Negligible/ setting adjusted.	A01374
19	7/10/90 (77)	INST+WF/PC	1	Occurrences of spots around star images on PC exposures – cause possibly contamination on CCD windows.	Negligible/ periodically perform high temperature bakeout.	A01375

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
20	7/10/90 (77)	TLM&DH	1	Sometimes the MA XMTR monitor circuit sees operational PCM counts when the XMTRS are off - sneak circuit.	Negligible/ None-disregard anomaly.	A01376
21	7/16/90 (83)	INST+FOS	1	On occasion the FOS micro-processor has reset when blue side relay is commanded.	Negligible/ Change operations commanding.	A01377
22	7/16/90 (83)	INST+FOS	1	Intermittently the FOS micro-processor reset function executed improperly.	Causes FOS auto safing and payload safing/ happens seldom.	A01378
23	7/21/90 (88)	INST+FOS	1	One internal FOS observation during red-side SAA investigations resulted in a cal lamp turn-on 1.5 secs late.	Negligible/ None	A01379
24	7/23/90 (90)	INST+FOS	1	FOS red-side X and Y base appeared to move slowly 25 to 50 microns during X-pitch/y-pitch, focus	Negligible/ Make corrections using internal micro processor.	A01380
25	8/02/90 (100)	INST+WF/PC	1	Failure of part in RAM U48 (in TLM buffer) caused temperature indicator to toggle.	Negligible/ Can move to other RAM location.	A01381
26	8/4/90 (102)	POWER	2	Thermally induced (on solar array) low frequency vehicle oscillations at 0.11 Hz and 0.6 Hz.	Causes gyros to transition from low to high mode/trying to compensate with ACS.	A01382
27	8/13/90 (111)	ACS	1	Larger roll drift rates occur - many times caused by anomalous VI integral bias terms.	High roll drift errors/mods of control SIW.	A01383
28	8/22/90 (120)	TLM&DH	1	Two science data bits have been lost (2 occasions) causing slip of data stream.	Negligible/ recondition tape or modify playback procedure.	A01384
29	12/3/90 (223)	ACS	2	Failure of gyro No. 6 caused loss of lock, etc.	Failed to acquire TDRS and entered sunpoint mode/ switch to gyro No. 2.	A01385

ICE

NO ANOMALIES REPORTED IN 1990.

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
				IUE		
				NO ANOMALIES REPORTED IN 1990.		
				LANDSAT-4		
				NO ANOMALIES REPORTED IN 1990.		
				LANDSAT-5		
10	4/25/90 (2246)	TTM&DH	2	RF switch fails to cycle from position 1 to position 3 on command (intermittently).	Ass'y failed/no further switching of RF switch.	A01333
				NIMBUS-7		
59	2/4/90 (4121)	TC&C	1	Spurious execution of SAM-II sunrise command at time of 605 command and 605 command did not execute.	Retransmitted 605 command successfully.	A01245
60	4/9/90 (4185)	TLM&DH	1	Transponder-A failed to turn off after OFF command. Relay failed to latch into un-lock position.	XPDR stayed on/ next station pass turned XPNDR off.	A01246
61	5/2/90 (4208)	TLM&DH	1	Same as Index 60, above.	Same	A01247
62	7/15/90 (4282)	INST + ERB	1	After an ERB Electronics ON Command, solar channels were 100% saturated for 25 minutes.	Negligible/ none - Next pass everything normal.	A01249
63	8/8/90 (4306)	INST + ERB	1	An indication of Chopper Motor ON & PRP#1 OFF occurred. Digital A shows correct status.	Negligible/none	A01250
				NOAA-9		
				S/C IN STANDBY STATUS – NO ANOMALIES REPORTED IN 1990		

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
				NOAA-10		
21	4/17/90 (1308)	INST + SEM	1	TLM channels A222 & A27 showed zero volts for the bias of channeltron HV supply.	Temporary/ none required- went back to normal.	0297
				NOAA-11		
12	1/15/90 (478)	INST + SSU	1	SSU lost synchronization caused by noise spike on clock line.	Negligible/ Procedure to fix immediately in place.	0295
13	1/30/90 (493)	INST + AVHRR	1	Instrument has a once per orbit degradation in channel 3 black body video data (latitude 70-80° south)	Negligible/ None	0296
14	5/2/90 (585)	INST + SSU	1	SSU History File diagnostics indicate a scan pattern	Negligible/ None	0300
15	5/7/90 (590)	INST + SBUV/2	2	Sweep mode, grating drive anomaly in both encoder config's - Prime ozone retrieval data unharmed.	Minor/None possible	0299
16	5/25/90 (608)	ACS	1	ADACS control mode switched from normal to YGC on six occasions for no known reason.	Negligible/ ADACS commanded back to normal mode.	0298
17	7/19/90 (725)	ACS	1	The Z-axis gyro spin motor indicated a failed condition - later indicated normal.	Negligible/ Initiated auto restart sequence by logic switch	0301
18	7/19/90 (663)	ACS	1	AVHRR motor current and patch power telemetry readings changed coincident with anomalous IMU logic switching.	Negligible/ None possible - investigating.	0302
19	9/3/90 (709)	ACS	1	Large yaw update (-0.956 Deg.) occurred. No gryo anomalies with associated yaw bias filter resets.	Negligible/ None – Investigating.	0304

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
20	9/21/90 (727)	ACS	2	The Z-gyro spin motor indicated a failed condition - will not restart.	Negligible/ops. Successfully done with reduced gyro software.	0303
				PEGSAT		
				NO ANOMALIES REPORTED DURING MISSION		
				TDRS-1		
60	3/20/90 (2542)	INST + Payload	1	KSA2E I parameter cautioned at 0.69ma. It returned to normal value (0.54ma) later.	Negligible/ None	(102)
				TDRS-3		
13	1/16/90 (474)	INST + Payload	2	KSA2F power reported to be non-existent and then KSA2R bacame unavailable also.	Lose of some service	(100)
14	3/7/90 (524)	ACS	2	Fine Sun Sensor (FSSA-A) heater circuit failure will lead to fine sun Sensor-A failure.	Minor/will switch to redundant Sun Sensor (B)	(101)
15	4/15/90 (563)	INST + Payload	1	Signal loss of 4 to 6dB in KSA2 Return link	Negligible/ None	(104)
				TDRS-4		
*10	[11/21/89] (253)	INST + Payload	1	Power level of KSA2-F (forward link) about 2dB below early post-launch tests in orbit.	Negligible/ PDAs adjusted on 3/12/90	(103)
11	3/2/90 (354)	INST + Payload	1	Telemetry parameter KSA 1W I (Helix current) briefly changed to an abnormal level (1.46 ma to 1.24 ma).	Negligible/ Monitor for further occurences.	(105)
12	11/5/90 (602)	INST + Payload	1	SGL level (composite return link) observed to be 3 to 6dB lower than levels established in post-launch test program.	Minimal/Gains adjusted	(106)

INDEX	DATE/(DAYS)	SUBSYSTEM	CRITICALITY	DESCRIPTION	EFFECT/ACTION	REF.
13	11/5/90 (602)	INST + Payload	1	SGL level in dedicated return links down 1.5 to 3 dB. (related to Index # 12, above)	Negligible/ Gains adjusted.	(107)
14	8/7/90 (512)	ACS	1	Several SA2 Pitch Gimbal Null Errors have occurred during null searches.	Negligible/ Null pot. Pointing S/W activated.	(108)

*Not discovered or report received until 1990.

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 1990; see text for update.

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.
IMP-1(C)	5/29/65	1.0	1.92	1.92	Reentered.

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
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.
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.

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
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.
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

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
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	9.93	9.93	S/C re-entered 9/26/87
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	7.89	VISSR degraded 9/80. Failed 5/6/81. S/C to standby 4/28/86.
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	7.75	S/C turned off 3/31/87
Magsat	10/30/79	0.4	.61	.61	Reentered as planned 6/11/80
SMM*	2/14/80	2.0	[0.83] +[5.62]	9.78	Lost fine pointing control 12/12/80, then repaired. Mission terminated 11/24/89: re-entered 12/2/89.
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	9.2	VAS failed 7/30/84. Loss of Station-keeping 12/89. De-activated 7/18/90. Out of station-keeping fuel.
NOAA-7(C)	6/23/81	2.0	3.62	4.92	Failed HIRS, degraded SSU, disabled power system.
DE-1(A)	8/3/81	1.0	9.57	9.57	Mission terminated (can't command S/C) 2/28/91.
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	Partial solar array loss.
NOAA-8(E)	3/28/83	2.0	1.25	1.25	Failed 7/1/84. Recovered May 1985. Failed again 1/86.
TDRS-1(A)	4/4/83	**	ACTIVE	ACTIVE	Some loss of capability. Orbital spare in early '89.
GOES-6(F)	4/28/83	7.0	5.73	ACTIVE	VAS failed 1/21/89..
Landsat-5(D')	3/1/84	3.0	ACTIVE	ACTIVE	
AMPTE/CCE	8/16/84	1.0	4.92	4.92	Some solar array degradation. Mission terminated 7/14/89.
ERBS	10/5/84	2.0	ACTIVE	ACTIVE	IRU-1/X-gyro failed (8/86), IRU-2/Y-gyro failed (7/88), IRU-1/Y gyro failed (11/89), ERBE-S failed (2/90), IRU-2/X gyro failed (7/90).

SPACECRAFT	LAUNCH DATE	DESIGN LIFE (YRS)	USEFUL LIFE (YRS)	ACTIVE LIFE (YRS)	REMARKS
NOAA-9(F)	12/12/84	2.0	3.92	ACTIVE	MSU & ERBE-S failure. Placed in standby 11/8/88.
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	Array shunts degraded. ERBE-S & SARP failed.
GOES-7(H)	2/26/87	7.0	ACTIVE	ACTIVE	
NOAA-11(H)	9/24/88	2.0	ACTIVE	ACTIVE	Y-gyro & DTR 5 A & B failed in late 1989.
TDRS-3(C)	9/29/88	**	ACTIVE	ACTIVE	
TDRS-4(D)	3/13/89	**	ACTIVE	ACTIVE	
COBE	11/18/89	0.83	ACTIVE	ACTIVE	Gyro failed.
PEGSAT	4/5/90	0.25	0.75	0.75	PEGASUS. Limited life mission.
HST	4/24/90	15***	ACTIVE	ACTIVE	Spherical aberration in primary mirror.
SSBUV	10/6/90	--	--	--	STS attached payload mission
BBXRT	12/2/90	--	--	--	STS attached payload mission

* Repaired by crew of shuttle flight 41-C on April 12, 1984.
** Complex warranty provisions call essentially for 10-year service from TDRSS system.
*** Based on periodic servicing in orbit. MSFC launched S/C; GSFC manages operational phase.