SMC-TR-00-10

AEROSPACE REPORT NO.
TR-99(1670)-1

The Impact of the Space Environment on Space Systems

20 July 1999

Prepared by

H. C. KOONS, J. E. MAZUR, R. S. SELESNICK, J. B. BLAKE,
J. F. FENNELL, J. L. ROEDER, and P. C. ANDERSON
Space and Environment Technology Center
Technology Operations

Prepared for

SPACE AND MISSILE SYSTEMS CENTER
AIR FORCE MATERIEL COMMAND
2430 E. El Segundo Boulevard
Los Angeles Air Force Base, CA 90245

Engineering and Technology Group

20000509 112

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED

DTIC QUALITY INSPECTED 2

This report was submitted by The Aerospace Corporation, El Segundo, CA 90245-4691, under Contract No. F04701-93-C-0094 with the Space and Missile Systems Center, 2430 E. El Segundo Blvd., Los Angeles Air Force Base, CA 90245. It was reviewed and approved for The Aerospace Corporation by A. B. Christensen Principal Director, Space and Environment Technology Center. Col. Hal Hagemeier was the project officer for the program.

This report has been reviewed by the Public Affairs Office (PAS) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nationals.

This technical report has been reviewed and is approved for publication. Publication of this report does not constitute Air Force approval of the report's findings or conclusions. It is published only for the exchange and stimulation of ideas.

Hal Hagemeier

Col. Hal Hagemeier, Chief
Integration Division
National Security Space Architect

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.

1. AGENCY USE ONLY (*Leave blank*)

2. REPORT DATE
20 July 1999

3. REPORT TYPE AND DATES COVERED

4. TITLE AND SUBTITLE
The Impact of the Space Environment on Space Systems

5. FUNDING NUMBERS
F04701-93-C-0094

6. AUTHOR(S)
H. C. Koons, J. E. Mazur, R. S. Selesnick, J. B. Blake, J. R. Fennell, J. L. Roeder, and P. C. Anderson

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
The Aerospace Corporation
Technology Operations
El Segundo, CA 90245-4691

8. PERFORMING ORGANIZATION REPORT NUMBER
TR-99(1670)-1

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Space and Missile Systems Center
Air Force Materiel Command
2430 E. El Segundo Boulevard
Los Angeles Air Force Base, CA 90245

National Security Space Architect
2461 Eisenhower Ave., Ste 164
Alexandria, VA 22331-0900

10. SPONSORING/MONITORING AGENCY REPORT NUMBER
SMC-TR-00-10

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

12b. DISTRIBUTION CODE

13. ABSTRACT (*Maximum 200 words*)

We have undertaken a study to determine the impact of the space environment on space systems. Known impacts include mission outages, mission degradation and mission failure, launch delays, redesign and retest, anomaly analyses, and the ultimate cost for each of the preceding. We are attempting to quantify these impacts whenever possible. This task is made difficult because impacts are rarely formally documented. We reviewed a variety of sources for anomaly impact information. These sources include anomaly reports from the archives of the Space Sciences Department of The Aerospace Corporation and other organizations, written and oral information from other staff members of The Aerospace Corporation, and contractor reports and published documents relating to spacecraft anomalies. The study provides a good indication of the quality and quantity of the data available. It also shows the degree to which it is possible to obtain impact information for historical anomalies. We summarize the results of the study, and emphasize those causes for which it may be possible to provide predictive information such as surface charging, internal charging, and the single-event upsets that accompany solar proton events.

14. SUBJECT TERMS
Space environment, Spacecraft anomalies, Spacecraft charging, Single-event upsets

15. NUMBER OF PAGES
200

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	

Acknowledgments

We thank J. H. Allen and D. C. Wilkinson of NOAA/NGDC, Boulder Colorado for allowing us to review their spacecraft anomaly files. We also thank the members of the 55th Space Weather Squadron, Schriever AFB, Colorado for preparing Space Environment Impact Records from the information contained in their anomaly database. This work was supported by the National Security Space Architect as part of the Space Weather Architecture Study, and the Space and Missile Systems Center, Air Force Materiel Command under contract F04701-93-C-0094.

Preceding Pages Blank

Contents

1. Introduction 1
2. Sources of Data 3
3. Approach Used for this Study 5
4. Results 7
   - 4.1 Anomaly Diagnosis 7
   - 4.2 Impacts 8
   - 4.3 Mission Loss 9
5. Space Weather Forecasting 11
6. Recommendations 13

References 15

Appendix A—Space Environment Impact Database ..... page 1 of 172

Appendix B—Space Environment Impact Database References B-1

Tables

1. Distribution of Records in the Space Environment Impact Database by Affiliation 7
2. Distribution of Records by Anomaly Diagnosis 8
3. Distribution of Records by Impact Duration 9
4. Other Impacts 9
5. Missions Lost or Terminated Due to the Space Environment 10

1. Introduction

We have undertaken a study to determine the impact of the space environment on space systems. We have included all types of spacecraft for which we have been able to find data. These include commercial, scientific, and military—both US domestic and foreign.

Known impacts include service outages, mission degradation and mission failure, data loss, sensor degradation, subsystem failure, launch delays, redesign and retest, anomaly analyses, and the ultimate cost for each of the preceding. We have attempted to quantify these impacts whenever possible. This task is made difficult because impacts are rarely formally documented.

2. Sources of Data

A variety of databases were used to determine those spacecraft anomalies that have been attributed to the space environment. The following comprehensive databases were utilized:

(1) Spacecraft Anomaly Manager (SAM). This database was maintained until recently by NOAA/NGDC in Boulder, Colorado. This database primarily contains anomalies that are believed to have been caused by the space environment.

(2) The Orbital Data Acquisition Program (ODAP). This database was developed by The Aerospace Corporation. It is no longer maintained. It contains anomaly information on 15 US Air Force and 91 non-Air Force programs. It was primarily developed to identify hardware reliability problems.

(3) NASA Anomaly Reports [*Bedingfield et al.,* 1996; *Leach and Alexander,* 1997].

(4) The anomaly database maintained by the US Air Force 55th Space Weather Squadron.

The are a number of serious difficulties with these existing anomaly databases. The databases were designed to determine the extent of spacecraft problems from the standpoint of the spacecraft designer. One of their main uses has been to identify unreliable parts across a variety of different spacecraft and manufacturers. Although in some cases they identify the environment as the cause of an anomaly, the spacecraft generally lack sensors to determine the state of the environment at the location of the spacecraft at the time of an anomaly. Since the appropriate environmental data were not available at the spacecraft, it was often difficult to make a diagnosis with high confidence that an anomaly was caused by the space environment. The assessments that have been incorporated into the data records have been made by a large number of people, some of whom are experts in environmental anomaly diagnosis, and some of whom have little knowledge or training in this area. Thus, there is a great deal of variability in the quality of the assessments that have been made.

The databases are also poorly maintained. There is no formal mechanism for collecting or submitting data to the organizations that maintain the databases. Often after an anomaly is understood it is no longer considered an anomaly and may no longer be recorded in the database. In the case of ODAP, later instances of an anomaly type on the same vehicle were often listed in the comment field of the first instance. Thus, there is no way to accurately count or even estimate the number of occurrences of a given type of anomaly on even a single spacecraft from the existing databases.

Finally, the databases were found to be completely inadequate to perform this study because they contain virtually no information on the impact of the anomalies in the sense that we are studying them. For both technical and insurance reasons the problems and impacts associated with anomalies are often closely held by the responsible organizations and are not normally released to the public.

A new database, known as the Space Systems Engineering Database (SSED), is being developed by The Aerospace Corporation. It is essentially a modern replacement for ODAP and addresses many of the problems found in the earlier databases. It currently contains data for several hundred vehicles.

3. Approach Used for this Study

We have augmented the databases above with a number of other sources for this study. We have reviewed the anomaly reports from the archives of the Space Sciences Department of The Aerospace Corporation to summarize the anomaly investigations that have been undertaken by the members of the department. In some cases, the original source material mentions the impacts the anomalies have had, especially if they have led to a redesign of a spacecraft subsystem. We have also contacted people whom we have worked with on anomaly analyses to obtain written and oral information regarding those studies. Contractor reports, published journal articles, newspaper articles, and memos have also been reviewed to identify anomaly investigations and impacts. We also visited NOAA/NGDC and reviewed their anomaly files for anomaly impacts.

We have summarized the data collected for this study in a Space Environment Impact Database. Each record contains the information for one class of anomalies for one vehicle. An anomaly class is a set of anomalies with essentially similar observables. This data collection can not and should not be used as an anomaly database for counting the individual occurrences of anomalies because each anomaly is not documented in a unique record. One record may document one anomaly or, in the extreme case, 617 anomalies for the main-bus, under-voltage, and phantom commands caused by surface electrostatic discharges on the MARECS-A spacecraft. The Space Environment Impact Database contains a description of the anomaly class, the diagnosis (i.e., the environmental cause), an indication as to whether or not the diagnosis was supported by the material in the references (on a scale from 3 meaning the diagnosis was well supported to 0 meaning there was no information to support the diagnosis), a description of the impact, any relevant comments from the references or the compiler, and a list of the references from which the information was obtained. The data have been entered into a Microsoft Access database to facilitate gathering statistics for this report. The complete database is included in Appendix A. The references for the source material for the database are given in Appendix B.

4. Results

The Space Environment Impact Database for this study contains 326 records. The number of records by spacecraft affiliation is given in Table 1. The total count in that table is greater than 326 because some of the spacecraft fall under more than one affiliation, such as foreign, commercial, communication satellites. 299 of the records contain anomalies that have the cause diagnosed as the space environment. Of these 299, only 155 have impacts obtained from the referenced documents.

Virtually none of the impacts are quantified in terms of their cost. Nor are their descriptions of the effects on the ultimate user of the space system. This is understandable because none of the information was provided by the ultimate user. Most of the information in the available sources was provided by the operators and the vehicle manufacturers. Hence, it tends to be related to operator impacts such as time required to restore the vehicle to normal operation or to technical impacts such as the testing and redesign required to "fix" the next generation of vehicles.

Table 1. Distribution of Records in the Space Environment Impact Database by Affiliation

Affiliation	Number of Records
DoD	87
Foreign	63
NASA, NOAA	58
Scientific	57
Classified/Other	52
Commercial	51

4.1 Anomaly Diagnosis

The distribution of records by anomaly diagnosis is given in Table 2. The first group is electrostatic discharges (ESD) and charging. The ESD anomalies group contains the largest number of records: 162. Virtually all of the anomalies in this area result from discharges. Only one was caused by the voltage changes on the surface of the vehicle. The uncategorized ESD anomalies refer to those that were not identified as either internal discharges or surface discharges in the references.

The second largest number of records, 85, falls in the Single-Event Upsets (SEU) group, also shown in Table 2. It contains less than half the number of records as the ESD group. The uncategorized SEU anomalies refer to those that were not related to cosmic rays, solar proton events, or the South Atlantic Anomaly in the references. Of these, the largest class is probably due to cosmic rays, and the smallest to solar proton events.

A distant third, with 16 records, is the radiation damage group. The largest member of this group is solar-array degradation, which is only reported as a anomaly when an unusually large degradation occurs during a solar proton event. Total radiation dose anomalies are surprisingly infrequent, repre-

Table 2. Distribution of Records by Anomaly Diagnosis

Diagnosis	Number of Records
ESD - Internal Charging	74
ESD - Surface Charging	59
ESD - Uncategorized	28
Surface Charging	1
Total ESD & Charging	162
SEU - Cosmic Ray	15
SEU - Solar Particle Event	9
SEU - South Atlantic Anomaly	20
SEU - Uncategorized	41
Total SEU	85
Solar Array—Solar Proton Event	9
Total Radiation Dose	3
Materials Damage	3
South Atlantic Anomaly	1
Total Radiation Damage	16
Micrometeoroid/Debris Impact	10
Solar Proton Event—Uncategorized	9
Magnetic Field Variability	5
Plasma Effects	4
Atomic Oxygen Erosion	1
Atmospheric Drag	1
Sunlight	1
IR background	1
Ionospheric Scintillation	1
Energetic Electrons	1
Other	2
Total Miscellaneous	36

senting only 1% of the records. This probably reflects the conservative limits defined in the radiation models and the conservative approach applied by designers when specifying shielding limits for electronic components.

Twelve other miscellaneous causes amounted to only 36 records.

4.2 Impacts

The only impact that could be readily quantified is the time required for the operators to recover from an anomaly. This may be taken as the duration of the impact on the user. This impact usually represented complete loss of data or service for the duration. The durations shown in Table 3 are the lengths of time that were required to restore service to the users. It is interesting to note that it is trimodal with peaks at *Minimal*, *One Hour to One Day*, and *More Than One Week*.

Table 3. Distribution of Records by Impact Duration

Duration of Impact	Number of Records
Minimal	13
Less than 10 min	8
10 min to 1 hr	14
1 hr to 1 day	54
1 day to 1 wk	7
More than 1 wk	68
Mission loss	9
Unknown	153

A *Minimal* duration anomaly has essentially no impact on the users. Some anomalies caused by SEUs are in this category because many spacecraft are designed to detect such anomalies and perform an automatic recovery. Anomalies in housekeeping functions, such as temperature sensors, are also in this category because they have no impact on the user.

One hour to One day represents the time it takes to recover, for example, when a vehicle suffers an attitude-control anomaly or enters a safe-hold condition. *More Than One Week* includes permanent damage and failures.

Table 4 lists other identifiable impacts that have happened on a number of systems. The largest number of records is 70 for *Phantom Commands*. The most serious is the *System or Part Failure* category, which occurs in 53 or 16% of the cases.

Table 4. Other Impacts

Impact	Number of Records
Phantom Command	70
Degraded Performance	55
System or Part Failure	53
Upsets	47
Other or Unknown	47
Spurious Signal	24
Solar array Degradation	14

Solar Array Degradation refers to the loss of solar array power capability primarily due to radiation damage of the solar arrays during a solar proton event. In most cases, the impact given in the source material was the potential loss of mission lifetime. However, there was no follow up to determine whether this shortening of the mission actually occurred. Thus, it was not possible to determine whether this impact was ultimately real or only predicted.

4.3 Mission Loss

Table 5 lists those missions that were listed as mission losses in the reference material and for which the diagnosis was environmental. Because of the impossibility of making a definitive diagnosis remotely and the serious repercussions of a mission loss, there is usually considerable controversy

Table 5. Missions Lost or Terminated Due to the Space Environment

Vehicle	Date	Diagnosis
DSCS II (9431)	Feb 73	Surface ESD
GOES 4	Nov 82	Surface ESD
Feng Yun 1	Jun 88	ESD
MARECS A	Mar 91	Surface ESD
MSTI	Jan 93	Single Event Effect
Hipparcos*	Aug 93	Total Radiation Dose
Olympus	Aug 93	Micrometeoroid Impact
SEDS 2*	Mar 94	Micrometeoroid Impact
MSTI 2	Mar 94	Micrometeoroid Impact
IRON 9906	1997	Single Event Effect
INSAT 2D	Oct 97	Surface ESD

* Mission had been completed prior to termination

surrounding the cause of each mission loss. For the most part, the diagnoses listed have been identified as probable causes by experts on space environmental anomalies who have been involved in the analyses of anomalies on those vehicles.

The largest cause of mission failures related to the space environment is Surface ESD. In all cases, those vehicles were in geosynchronous orbit.

5. Space Weather Forecasting

Spacecraft charging ESD has caused by far the most environmentally related anomalies on spacecraft, and surface charging has caused the most serious anomalies, i.e., those that have resulted in the loss of the mission. Unfortunately, it is much more difficult to forecast the location and seriousness of spacecraft surface charging than it is to forecast the location and seriousness of internal charging.

Internal charging occurs one to a several days after a major magnetic storm. Hence, the storm itself is a warning that high levels of energetic electrons may be present in the radiation belts in the near future. Since these electrons primarily diffuse inward after the storm, their progress could be monitored, and flux levels reasonably well predicted one to two days in advance. Efforts to do this have been undertaken using linear prediction filters and neural networks [*Nagai,* 1988; *Baker et al.,* 1990; *Koons and Gorney,* 1991; 1993].

Surface charging is much more difficult to predict. It not only requires a prediction of a magnetic storm or substorm but also the electron distribution function as a function of location in the magnetosphere. Surface charging is not necessarily related to the absolute intensity of the flux of hot electrons around the spacecraft, but rather to the details of the electron distribution function. For example, the worst-case surface-charging event on the SCATHA spacecraft on 22 September 1982 occurred at a time when the electron distribution function at low energies (<1 keV) was below average, at middle energies (1 to 10 keV) was near the top of its average range, and at high energies (20 to 100 keV) was above its average range [*Koons et al.,* 1988; *Roeder,* 1994]. It is likely that the combination of high fluxes in the higher-energy range combined with a reduction in the secondary electrons from primaries in the low-energy range caused the extreme surface charging conditions on that day. Since surface charging occurs on a much faster time scale than internal charging, only an imminent forecast is probably possible, and it is unlikely that the location can be accurately identified without a significant number of sensors located across the tail of the magnetosphere.

Only the SEUs related to solar proton events can be forecast, and only an imminent solar proton event can be expected to be forecast in the foreseeable future. Since these SEUs represent only about 10% of the SEU Space Environment Impact Records, forecasts of solar proton events will not have a significant effect on impacts caused by SEUs.

Similarly, solar array degradation due to radiation damage of the arrays during a solar proton event will not have a significant effect on environmental impacts. This effect is further reduced because the time remaining in the mission is not necessarily related to this degradation, but is more often caused by some other failure on the vehicle.

Other causes make up a small portion of the environmentally related anomalies, and many, such as total radiation dose, atomic oxygen erosion, micrometeoroid impact, and debris impact, are inherently nonpredictable.

6. Recommendations

We recommend that significant efforts be made to better specify the electron distribution functions responsible for surface charging and internal charging. It is especially important to obtain the worst-case environments in the spirit of the 100-year storm used by civil engineers to design dams and flood control systems. With such specifications and with studies of the interactions of these environments with candidate spacecraft materials, the spacecraft designer will be better able to design spacecraft that are immune to the environment.

References

Baker, D. N., McPherron, R. L., Cayton, T. E., and Klebesadel, R., "Linear Prediction Filter Analysis of Relativistic Electron Properties at 6.6 R_E," *J. Geophys. Res., 95,* 15133–15140, 1990.,

Bedingfield, K. L., Leach, Richard D., and Alexander, M. B., "Spacecraft System Failures and Anomalies Attributed to the Natural Space Environment," *NASA Reference Publication 1390,* Marshall Space Flight Center, August, 1996.

Koons, H. C., Mizera, P. F., Roeder, J. L., and Fennell, J. F., "Severe Spacecraft-Charging Event on SCATHA in September 1982," *J. Spacecraft and Rockets, 25,* 239–243, 1988.

Koons, H. C., and Gorney, D. J., "A Neural Network Model of the Relativistic Electron Flux at Geosynchronous Orbit," *J. Geophys. Res., 96,* 5549–5556, 1991.

Koons, H. C., and Gorney, D. J., "Forecasting the Relativistic Electron Flux at Geosynchronous Orbit," in Solar-Terrestrial Predictions - IV, Proceedings of the Workshop at Ottawa, Canada, May 18–22, 1992. Edited by J. Hruska, M. A. Shea, D. F. Smart, and G. Heckman, Vol. 2., pp. 580–586, NOAA Environmental Research Laboratories, Boulder, CO, Sept. 1993.

Leach, Richard D., and Alexander, M. B., "Failures and Anomalies Attributed to Spacecraft Charging," *NASA Reference Publication 1375,* Marshall Space Flight Center, August, 1995.

Nagai, Tsugunobu, "Space Weather Forecast: Prediction of Relativistic Electron Intensity at Synchronous Orbit," *Geophys. Res. Letters, 15,* 425–428, 1988.

Roeder, J. L., Specification of the Plasma Environment at Geosynchronous Orbit in the Energy Range 87 eV to 288 keV, Aerospace Report No. TR-94(4940)-6, The Aerospace Corporation, El Segundo, California, 15 August 1994.

Appendix A
Space Environment Impact Database

Name:	A-1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	08 Mar 94				
Description:	Burnout of circuit				
Diagnosis:	ESD			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Random Part Failure				
Comments:	Satellite within Field Aligned currents combined with enhanced 51-1540 keV electrons before and during anomaly time				
References:	SWS1				

Name:	A-2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	03 Apr 94				
Description:	Bit flip in attitude control software				
Diagnosis:	SEU			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Other				
Comments:	Strong electron and proton disturbances near anomaly time				
References:	SWS1				

Name:	ADEOS 1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	24 Sept 1996				
Description:	Safehold; computer glitch				
Diagnosis:	SEU-Cosmic Ray			**Sure:**	0
Impact:	Based on description			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	None				
References:	JEM1, JHA22				

Name:	ALEXIS				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	?				
Description:	Autonomous attitude control system failed;				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Necessitated creation of a makeshift attitude control system. s/c operators need to upload a file each time a maneuver is desired			**Duration**	Unknown
Category:	System Failure				
Comments:	None				
References:	JHA23				

Name:	AMPTE/CCE				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	11 Sep 1984 on				
Description:	The magnetometer changed modes on 4 occasions				
Diagnosis:	SEU			**Sure:**	0
Impact:	Operating procedures had to be changed to remain operational			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	None				
References:	RSS51				

Name:	AMPTE/CCE				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	11 Nov 1984				
Description:	Lost data modulation due to phantom command				
Diagnosis:	ESD			**Sure:**	0
Impact:	Operating procedures had to be changed to remain operational			**Duration**	Unknown
Category:	Phantom commands				
Comments:	None				
References:	RSS13				

Name:	AMPTE/CCE				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Apr 1988				
Description:	The Command Processor system (CPS) No. 1 failed				
Diagnosis:	Total Radiation Dose			**Sure:**	0
Impact:	Switch to CPS No. 2 by the operators			**Duration**	Unknown
Category:	System Failure				
Comments:	Failure of CMOS PROM caused by cumulative radiation damage over 3.5 years in orbit				
References:	RSS50				

Name:	Anik B				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	8 Feb 1986				
Description:	Roll error, occurred twice				
Diagnosis:	Magnetic Field Variability			**Sure:**	0
Impact:	Roll control was maintained, using thrusters if necessary			**Duration**	1 hr to 1 day
Category:	Other				
Comments:	Reaction of electromagnetic torquing control coils to a large geomagnetic disturbance				
References:	RSS38				

Name:	Anik B1				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	After Dec 1978				
Description:	One minor anomalous switching event. significant increase in operating temperature of various components. Thermal surfaces were degraded				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	Localized discharges when the satellite was in eclipse				
References:	RSS12				

Name:	Anik D2 (later ARABSAT 1D)				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	8 Mar 1985				
Description:	The despin control system malfunctioned and the platform on which the communications antenna was mounted began to spin, interrupting data transmission				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	Although the satellite was eventually brought under control, fuel was used to correct the resulting wobble and a year of station keeping was lost. Also, a greater than expected degradation to mirrored surfaces was attributed to surface discharges in the thermal blanket			**Duration**	More than 1 wk
Category:	Phantom commands				
Comments:	A large arc-discharge originating on the reflector at the back of the antenna or on the thermal shield at the front of the antenna				
References:	RSS12				

Name:	Anik E1				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	20 Jan 1994				
Description:	Momentum wheel control circuits failed causing satellite to point away from the Earth				
Diagnosis:	ESD Internal			**Sure:**	3
Impact:	Eight hour loss of service. 56 TV channels and data and telephone service in northwestern Ontario, northern Quebec, the Northwest Territories and the Yukon			**Duration**	1 hr to 1 day
Category:	System Failure				
Comments:	Internal discharges from an ungrounded spot shield. Full service was restored about 8 hours after the failure by successfully switching the momentum wheel control circuit to a backup on-board redundant circuit				
References:	HCK11, HCK12, HCK13, HCK14, HCK18, HCK28, RSS3, RSS4				

Name:	Anik E1				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	26 March 1996				
Description:	The 'south array' of solar power panels effectively disconnected from the battery charging system				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Anik was reduced to half its customary power supply. This resulted in immediate loss of transponder capability which could only be partially compensated by operators after some hours. Reduction by about two-thirds of its communication throughput capacity			**Duration**	Unknown
Category:	System Failure				
Comments:	'..., it appears very probable that the high fluence of energetic electrons was related to the failure.'				
References:	HCK9, JHA9				

Name:	Anik E2				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	20 January 1994				
Description:	Main momentum wheel energy transfer control circuit and secondary back-up failed during same event. Burnout of CD4047 Monostable/A stable Multivibrator from ungrounded spot shield				
Diagnosis:	ESD Internal			**Sure:**	3
Impact:	Canadian Press, the countries biggest news service wasn't able to transmit data for more than seven hours to more than 100 newspapers and 400 radio stations. TV and Radio relay of CBC broadcasts were eliminated by the failures. Satellite valued at US$228.8 million			**Duration**	1 hr to 1 day
Category:	System Failure				
Comments:	Engineers devised a ground based control system using the satellite's thruster motors to bring the satellite under control on 21 June and restore it to useful service in August. Five month effort and $15M loss to company. Service life of satellite shortened by 1 year				
References:	HCK11, HCK12, HCK13, HCK14, HCK16, HCK18, RSS3, RSS4, JHA21				

Name:	Arabsat 1A				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	15 Mar 1985, 1 Jun 1986				
Description:	On 15 March lost power, attitude control and orbit gyros. On 1 June loss of Earth lock in the attitude control system				
Diagnosis:	ESD			**Sure:**	0
Impact:	Manual North-South station keeping,			**Duration**	1 day to 1 wk
Category:	Other				
Comments:	Arab league communications satellite				
References:	RSS7,RSS11				

Name:	ATS 6				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	After May 1974				
Description:	The heat pipe gas reservoir ran hotter than normal due to degradation of the second surface mirrors (optical solar reflectors) that cover the reservoir's radiation				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Other				
Comments:	American Test Satellite				
References:	RSS38				

Name:	AUSSAT A1				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Jan 1986 to Jun 1989				
Description:	Anomalous phantom commands that changed modes in the telemetry system and the attitude control system. 19 such events occurred				
Diagnosis:	ESD			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	Australian Domestic Telecommunications Satellite				
References:	RSS7				

Name:	AUSSAT A2				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	May 1986 to Jun 1990				
Description:	Anomalous phantom commands that affected the telemetry subcommutator and attitude control system. 33 such events occurred				
Diagnosis:	ESD			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	Australian Domestic Telecommunications Satellite				
References:	RSS7				

Name:	AUSSAT A3				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Oct 1987 to Oct 1990				
Description:	Anomalous phantom commands that affected the telemetry subcommutator and attitude control system. 19 such events occurred				
Diagnosis:	ESD			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	Australian Domestic Telecommunications Satellite				
References:	RSS7				

Name:	AUSSAT K1				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	11 Nov 1985				
Description:	Bit flip in Encoder Device				
Diagnosis:	SEU			**Sure:**	1
Impact:	Loss of telemetry for a few seconds			**Duration**	Minimal
Category:	Other				
Comments:	None				
References:	DCW15, JEM3				

Name:	Brazilsat A1				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	13 Aug 89; 19 Oct 89; 29 Sept 89				
Description:	Degraded solar panel power generation				
Diagnosis:	Solar Proton Event			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Solar Array Degradati				
Comments:	None				
References:	DCW16, JEM4				

Name:	BS 3A				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	22-31 March 1991				
Description:	Lost power panel output. One-quarter of solar cells are unavailable				
Diagnosis:	Solar Proton Event			**Sure:**	2
Impact:	Forced reduction in the quantity of TV signals carried. Has severe power budget. Unable to continue its three-channel broadcasting from mid-May to mid-August			**Duration**	Unknown
Category:	Solar Array Degradati				
Comments:	Plan to reuse old BS 2B satellite for one channel until BS 3H is launched on April 19, 1991. (Japanese TV Satellite)				
References:	HCK33, JHA2				

Name:	BS 3A (Japanese Broadcasting satellite)				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	22 Feb 1994				
Description:	60-minute telemetry outage				
Diagnosis:	ESD			**Sure:**	0
Impact:	60-minute telemetry outage			**Duration**	10 min to 1 hr
Category:	Degraded Performanc				
Comments:	None				
References:	RSS2, RSS5, RSS6				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	30 March 1991				
Description:	DTU #1 failed during support. Switched to DTU #2 at next contact				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Loss of data until next contact (~2.5 hours)			**Duration**	1 hr to 1 day
Category:	System Failure				
Comments:	Period of high relativistic electron fluxes following large March 1991 magnetic storm				
References:	HCK22				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	17 May 1991				
Description:	Telemetry lost. Reselecting and power cycling DTU #2 did not restore telemetry. Switched back to DTU #1 and telemetry was restored				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	8000 seconds of data lost			**Duration**	1 hr to 1 day
Category:	System Failure				
Comments:	Reference contains interesting copies of Initial Anomaly Reports				
References:	HCK21				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	4 May 1991				
Description:	Telemetry lost. DTU #2 was reselected. This restored telemetry				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Temporary loss of data			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	None				
References:	HCK21				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	7 April 1991				
Description:	AFGL 701-8 was found misconfigured one time				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Loss of data until next contact (contacts were ~11 hours apart)			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Period of high relativistic electron fluxes following large March 1991 magnetic storm				
References:	HCK22				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	4 April 1991				
Description:	AFGL 701-11A High Voltage Power Supply was found at the wrong level				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Loss of data until next contact (contacts were ~11 hours apart)			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Period of high relativistic electron fluxes following large March 1991 magnetic storm				
References:	HCK22				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	3 April 1991				
Description:	AFGL 701-6 was found in wrong mode (Mode 0) one time				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Loss of data until next contact (contacts were ~11 hours apart)			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Period of high relativistic electron fluxes following large March 1991 magnetic storm				
References:	HCK22				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	31 March 1991				
Description:	CMOS time off by 15 seconds				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Loss of data until next contact (contacts were ~11 hours apart)			**Duration**	1 hr to 1 day
Category:	Degraded Performanc				
Comments:	Period of high relativistic electron fluxes following large March 1991 magnetic storm				
References:	HCK22				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	30 March 1991				
Description:	PCU status BAD. Sent processor reset and V/T = 6				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Loss of data until next contact (contacts were ~11 hours apart)			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Period of high relativistic electron fluxes following large March 1991 magnetic storm				
References:	HCK22				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	26 March to 10 April 1991				
Description:	AFGL 701-2 found in wrong mode (CAL MODE) three times				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Loss of data until next contact (contacts were ~11 hours apart)			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Period of high relativistic electron fluxes following large March 1991 magnetic storm				
References:	HCK22				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	26 March to 10 April 1991				
Description:	PCU Status was bad three times				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Loss of data until next contact (contacts were ~11 hours apart)			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Period of high relativistic electron fluxes following large March 1991 magnetic storm				
References:	HCK22				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	26 March to 10 April 1991				
Description:	ONR 307-3 found in improper mode (Load Mode) 21 times				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Loss of data until next contact (contacts were ~11 hours apart)			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Period of high relativistic electron fluxes following large March 1991 magnetic storm				
References:	HCK22				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	26 March to 10 April 1991				
Description:	AFGL 701-15 was found misconfigured two times				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Loss of data until next contact (contacts were ~11 hours apart)			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Period of high relativistic electron fluxes following large March 1991 magnetic storm				
References:	HCK22				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	26 March to 10 April 1991				
Description:	AFGL 701-14 found misconfigured 17 times				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Loss of data each time until next contact (contacts were ~11 hours apart)			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Period of high relativistic electron fluxes following large March 1991 magnetic storm				
References:	HCK22				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	26 March to 10 April 1991				
Description:	AFGL 701-2 was off three times				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Loss of data until next contact (contacts were ~11 hours apart)			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Period of high relativistic electron fluxes following large March 1991 magnetic storm				
References:	HCK22				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Jul 1990 TO Mar 1991				
Description:	Bit flips				
Diagnosis:	SEU			**Sure:**	3
Impact:	Unknown			**Duration**	Unknown
Category:	Other				
Comments:	Observed in each orbit with the 93422 and 931422 bipolar random access memories (RAM) being the most sensitive				
References:	RSS46				

Name:	CRRES				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	30 March 1991				
Description:	Tape Recorder #2 status unknown and readout commands nonfunctional				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	?? Loss of T/R 2 ??			**Duration**	Unknown
Category:	System Failure				
Comments:	Period of high relativistic electron fluxes following large March 1991 magnetic storm				
References:	HCK22				

Name:	CS 3B				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	17 Mar 1989				
Description:	Command Circuitry failed				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	Permanent lost of 1/2 of command circuitry on board			**Duration**	Unknown
Category:	System Failure				
Comments:	None				
References:	JHA13, JHA15				

Name:	CTS				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	After Nov 1977				
Description:	A transient event counter recorded 215 transient events in the wiring harnesses in the first year. A power diode failed causing a power bus burnout				
Diagnosis:	ESD			**Sure:**	3
Impact:	Unknown			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	(Hermes, Canadian-American Communications Technology Satellite				
References:	RSS26, RSS27				

Name:	DE 1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	After Aug 1981				
Description:	Unexplained 7 to 10 watt power increase on the spacecraft bus and apparent loss of microprocessor in the command and telemetry processor				
Diagnosis:	SEU			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	System Failure				
Comments:	Radiation 'hits' impinging on the spacecraft clock, etc. (Dynamics Explorer)				
References:	RSS38				

Name:	DE 1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	1982				
Description:	Failure of high voltage power supply on the High Altitude Plasma Indicator (HAPI)				
Diagnosis:	SEU			**Sure:**	0
Impact:	Spacecraft was operating in degraded mode			**Duration**	Unknown
Category:	System Failure				
Comments:	(Dynamics Explorer)				
References:	RSS56				

Name:	DFS 3				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Nov 95				
Description:	Suffered a complete breakdown and started drifting uncontrollably				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Mission Loss. Declared a total loss and conveyed to a graveyard orbit			**Duration**	Mission loss
Category:	Mission Loss				
Comments:	Deutsche Telekom				
References:	JHA 18				

Name:	DMSP				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Mar 89				
Description:	Had trouble unloading torque due to the large ambient magnetic field changes in orbit				
Diagnosis:	Magnetic Field Variability			**Sure:**	0
Impact:	Unknown			**Duration**	1 hr to 1 day
Category:	Other				
Comments:	Great magnetic storm				
References:	JHA 15				

Name:	DMSP				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	24 Jul 97				
Description:	Passive microwave sensor failure				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	Unknown			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	None				
References:	SWS1				

Name:	DMSP F-13				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	5 May 1995				
Description:	Latch-up of microwave imaging instrument (SSM/I) microprocessor. Required reset of instrument				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	Loss of data until spacecraft recommanded			**Duration**	1 hr to 1 day
Category:	Degraded Performanc				
Comments:	Diagnosed from SSJ/4 particle detector and RPA plasma measurements. Occurred in an intense auroral arc				
References:	PCA2				

Name:	DMSP F1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	9 Aug 1979				
Description:	OLS reset while using backup encoder pulses				
Diagnosis:	SEU-Solar Proton Event			**Sure:**	3
Impact:	Loss of data until recommanded			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Reset due to processor upset by proton event				
References:	PCA1				

Name:	DMSP F10				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	19 Apr 93				
Description:	Channel loss on the high gain analog amplifier.				
Diagnosis:	ESD Surface			**Sure:**	2
Impact:	Unknown			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	Increase in precipitating electron fluxes as the satellite traversed the auroral zone				
References:	SWS1				

Name:	DMSP F2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	1977				
Description:	SSIE data degraded due to inaccurate calibration. Caused by static buildup on spacecraft				
Diagnosis:	Surface Charging			**Sure:**	2
Impact:	Severe degradation of sensor data			**Duration**	More than 1 wk
Category:	Degraded Performanc				
Comments:	Fixed on F4 by isolating ion probe from ground				
References:	PCA1				

Name:	DMSP F2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	29 June 1977				
Description:	Celestial sensor (CSA) experienced false transits				
Diagnosis:	SEU			**Sure:**	3
Impact:	Loss of pointing accuracy. Important for imaging sensors. Honeywell designed CSA mod for F5			**Duration**	Unknown
Category:	Phantom commands				
Comments:	Proton hits outside South Atlantic Anomaly				
References:	PCA1				

Name:	DMSP F2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	22 Sept 1977				
Description:	Primary attitude sensor reset several times in South Atlantic Anomaly				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	3
Impact:	Loss of pointing accuracy. Important for imaging sensors			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	Incorporated software change to star fix				
References:	PCA1				

Name:	DMSP F2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	22 Dec 1978				
Description:	Spacecraft rose with main memory off and recorders and data transmitters not operating per the stored commands				
Diagnosis:	SEU			**Sure:**	1
Impact:	Loss of data until recommanded			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Probably due to proton stimulated processor error				
References:	PCA1				

Name:	DMSP F2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	31 May 1978				
Description:	Long OLS (Operational Linescan System) auto restart. Approx 2 min compared to normal 15 to 40 sec				
Diagnosis:	SEU			**Sure:**	1
Impact:	Minimal			**Duration**	Less than 10 min
Category:	Other				
Comments:	May be due to unusual pattern of proton effects. No indication of system failure				
References:	PCA1				

Name:	DMSP F3				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	17 Sept 1979				
Description:	OLS soft reset				
Diagnosis:	SEU			**Sure:**	3
Impact:	Minimal			**Duration**	Unknown
Category:	Other				
Comments:	None				
References:	PCA1				

Name:	DMSP F3				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	17 Sept 1979				
Description:	OLS reset, tape recorder PR3 turned off without command				
Diagnosis:	SEU			**Sure:**	3
Impact:	Loss of data until recommanded			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	None				
References:	PCA1				

Name:	DMSP F6				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	12 Oct 1983				
Description:	Spacecraft switched from PRADS to basic attitude mode				
Diagnosis:	SEU			**Sure:**	2
Impact:	Loss of pointing accuracy. Important for imaging sensors			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Proton activity				
References:	PCA1				

Name:	DMSP F6				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	7 Feb 1983				
Description:	OLS reset				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	3
Impact:	Data lost until spacecraft recommanded			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Consistently occurs in South Atlantic Anomaly				
References:	PCA1				

Name:	DMSP F6				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	7 Feb 1983				
Description:	OLS reset				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	3
Impact:	Data lost until spacecraft recommanded			**Duration**	1 hr to 1 day
Category:	Degraded Performanc				
Comments:	Consistently occurs in South Atlantic Anomaly				
References:	PCA1				

Name:	DMSP F6				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	27 Dec 1982				
Description:	Celestial sensor (CSA) producing false star transits				
Diagnosis:	SEU			**Sure:**	3
Impact:	Reduced pointing accuracy . Important for imaging sensors			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	CSA modified after similar anomalies on F2 and F3. Starfix module was enabled. Proton Activity				
References:	PCA1				

Name:	DMSP FLT 13				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	14 Aug 96				
Description:	Sensor package went off-line				
Diagnosis:	SEU			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	None				
References:	SWS1				

Name:	DMSP FLT 13				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	02 Dec 96				
Description:	Gyro fluctuations and erratic spinning of the SSMI microwave imager resulting in the SSMI going off line				
Diagnosis:	ESD Surface			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	None				
References:	SWS1				

Name:	DMSP FLT 8				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	15 Feb 94				
Description:	Microprocessor lock-up on the microwave imaging system				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Unknown			**Duration**	1 hr to 1 day
Category:	Degraded Performanc				
Comments:	Very large increase in 10-30 KeV electrons may have resulted in this anomaly				
References:	SWS1				

Name:	DRA Delta				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	June 1994 to 1995				
Description:	120 identical status switching anomalies; phantom commands disable logic in the Attitude Measurement Equipment				
Diagnosis:	ESD Internal			**Sure:**	3
Impact:	Little operational impact			**Duration**	Minimal
Category:	Phantom commands				
Comments:	GEO s/ c of Defense Research Aging, Farnburough, England				
References:	JEM5				

Name:	DSCC III FLT (B-10)				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	14 Mar 94				
Description:	Upset of attitude control system				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Other				
Comments:	Significantly enhanced energetic electron fluxes				
References:	SWS1				

Name:	DSCS A2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	23-25 September 1991				
Description:	CPU Failure				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	None				
References:	RSS7				

Name:	DSCS II				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	14 Sep 95				
Description:	Command Path-Electric Interface Assembly length checks and address check areas				
Diagnosis:	ESD Internal			**Sure:**	3
Impact:	None			**Duration**	Unknown
Category:	Other				
Comments:	>2 MeV electrons enhanced				
References:	SWS1				

Name:	DSCS II				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	08 Apr 95				
Description:	Anomalous NUDET detection				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	Significant >2 MeV electron enhancements				
References:	SWS1				

Name:	DSCS II (9431)				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	2 June 1973				
Description:	Satellite failed because power to its communications subsystem was suddenly interrupted				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	Mission Loss. Initiated joint NASA and Air Force spacecraft charging investigation. High energy discharge caused by spacecraft charging as a result of a geomagnetic substorm			**Duration**	Mission loss
Category:	Mission Loss				
Comments:	None				
References:	RSS31,RSS32				

Name:	DSCS II (9438)				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Nov and Dec 1986				
Description:	Low level logic glitches				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Other				
Comments:	None				
References:	RSS7				

Name:	DSCS II (9442)				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Nov 1986 and Mar 1987				
Description:	Low level logic glitches				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Other				
Comments:	None				
References:	RSS7				

Name:	DSCS II (9443)				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Mar and Jul 1987				
Description:	Low level logic glitches				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Other				
Comments:	None				
References:	RSS7				

Name:	DSCS II B7				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	26 March 1996				
Description:	Attitude Control Electronics failed				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	Unknown			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	Suggestive evidence that the anomaly could have been caused by surface charging. The surface of the vehicle as measured by an onboard sensor was charged to about 3 kV at the time of the anomaly				
References:	HCK3				

Name:	DSCS III				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	22 June 1994, 6 July 1994, 16 Oct 1994, 24				
Description:	NUDET event processing caused patch to disable				
Diagnosis:	ESD Internal			**Sure:**	3
Impact:	10/16/94 caused RAM patch to be disabled. RAM patch had to be restored. 10/24/94 EYC disabled. Support scheduled to execute 'EYC not -enabled' contingency			**Duration**	More than 1 wk
Category:	Degraded Performanc				
Comments:	Possible attitude loss of yaw control due to NUDET event processing				
References:	HCK5, HCK6				

Name:	DSCS III				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	10 Nov 95				
Description:	Software detected fault in the logic circuit caused shutdown of the RAM-PATCH module				
Diagnosis:	ESD Internal			**Sure:**	3
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	>2 MeV electrons significantly enhanced				
References:	SWS1				

Name:	DSCS III				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	09 Nov 95				
Description:	CPU cycle time over				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Other				
Comments:	>2 MeV electrons elevated				
References:	SWS1				

Name:	DSCS III (4524)				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Dec 1986 to Jan 1987				
Description:	Glitches in the tachometer system (10)				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Other				
Comments:	None				
References:	RSS7				

Name:	DSCS III (4524)				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	several from 16 Dec 1986 to 16 May 1987				
Description:	Tachometer problem				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Other				
Comments:	None				
References:	RSS7				

Name:	DSCS III B-7				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	26 Mar 96				
Description:	CPU error and altitude control excursion				
Diagnosis:	ESD Internal			**Sure:**	3
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	None				
References:	SWS1				

Name:	DSCS III B-9				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	24 mar 96 & 25 Mar 96				
Description:	Telemetry problems				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	Other satellites in close proximity experienced no injections, B-9 has been exposed to greater injections in the past with no problems experienced				
References:	SWS1				

Name:	DSCS III B4 & B9				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	30 Mar 1994, 15 May 1994, 11 Sept 1994, 3				
Description:	KI-31 autonomously switched from using the satellites master clock to its own internal oscillator				
Diagnosis:	SEU			**Sure:**	0
Impact:	Command access to vehicle lost on 9/11/94 until the KI-31 was commanded back(?!). On 10/3/94 had to use ACE mitigation plan to switch back to frequency standard			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Probably no user impact				
References:	HCK4				

Name:	DSCS III FLT 17				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	03 Oct 94				
Description:	K1-31 switch from the master clock to the internal oscillator				
Diagnosis:	ESD			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	Significantly enhanced geomagnetic and energetic particle environment				
References:	SWS1				

Name:	DSCS III FLT 21				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	08 Oct 96				
Description:	RAM patch disable				
Diagnosis:	ESD			**Sure:**	3
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	None				
References:	SWS1				

Name:	DSCS III FLT 23				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	24 Oct 94				
Description:	Enhanced Yaw Control Patch to Disable				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	Spacecraft charging or SEU				
References:	SWS1				

Name:	DSCS III FLT 23				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	24 Oct 94				
Description:	Enhanced Yaw Control Patch disabled (due to NUDET event processing)				
Diagnosis:	ESD			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	Significantly disturbed geomagnetic and energetic particle environment				
References:	SWS1				

Name:	DSCS III FLT 23				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	11 May 95				
Description:	Uncommanded internal oscillator swap				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	None				
References:	SWS1				

Name:	DSCS-III FLT 21				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	01 Oct 97				
Description:	Anomalous Nuclear Event Detector Trip				
Diagnosis:	ESD Internal			**Sure:**	3
Impact:	Unknown			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	Enhanced energetic particle environment. >2 MeV				
References:	SWS1				

Name:	DSP F?				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	?				
Description:	Sensor Temp Monitor Shift in Calibration				
Diagnosis:	ESD Surface			**Sure:**	1
Impact:	None			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	Anomalies correlate with occurrence of focal plane strobes which are thought to be caused by charging				
References:	JLR18				

Name:	DSP F1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	1 July 1971				
Description:	False trigger signals in MIIIB Control Counter Monitor				
Diagnosis:	ESD Surface			**Sure:**	2
Impact:	Only annoyance to spacecraft controllers			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	Correlation of many events with Ap index and local time occurrence in 2300-0600 sector				
References:	JLR1				

Name:	DSP F10				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	June 15, 1983				
Description:	Uncommanded Mode Switch				
Diagnosis:	ESD Surface			**Sure:**	2
Impact:	None			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	Onboard detectors saturated. Suggestive correlation of anomaly with electron data from other DSP satellites				
References:	JLR17				

Name:	DSP F2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	18 & 20 May 1971				
Description:	Digital Telemetry Unit subcom B calibration change (partial short)				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	Only annoyance to spacecraft controllers. Re-interpretation of housekeeping channels			**Duration**	More than 1 wk
Category:	Degraded Performanc				
Comments:	No engineering reason for short, so it must be the environment				
References:	JLR2				

Name:	DSP F2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Various				
Description:	Noise Strobes over Focal Plane				
Diagnosis:	ESD Surface			**Sure:**	1
Impact:	Bad data removed by ground processing			**Duration**	1 hr to 1 day
Category:	Spurious Signal				
Comments:	Local time distribution centers at midnight to dawn sector				
References:	JLR3				

Name:	DSP F2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	February 13-14, 1978				
Description:	Excessive Star Sensor Output				
Diagnosis:	Solar Proton Event			**Sure:**	3
Impact:	Intermittent loss of data totaling 900 s			**Duration**	10 min to 1 hr
Category:	Spurious Signal				
Comments:	Must use backup attitude processing algorithms instead of primary method				
References:	JLR4				

Name:	DSP F3				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	March 3, 1974				
Description:	Mission IIIB Sensor Degradation				
Diagnosis:	Total Radiation Dose			**Sure:**	0
Impact:	Loss of redundant sensor (one of three)			**Duration**	More than 1 wk
Category:	Random Part Failure				
Comments:	No coincident particle data but similar degradation observed during May and August 1972 particle events				
References:	JLR5				

Name:	DSP F3				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Various				
Description:	Noise Strobes over Focal Plane				
Diagnosis:	ESD Surface			**Sure:**	1
Impact:	Bad data removed by ground processing			**Duration**	1 hr to 1 day
Category:	Spurious Signal				
Comments:	Local time distribution centers at midnight to dawn sector				
References:	JLR3				

Name:	DSP F4				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Various				
Description:	Noise Strobes over Focal Plane				
Diagnosis:	ESD Surface			**Sure:**	1
Impact:	Bad data removed by ground processing			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	Local time distribution centers at midnight to dawn sector				
References:	JLR3				

Name:	DSP F4				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	July 6, 1973 0840 UT				
Description:	Focal Plane Heater Inadvertent Inhibit				
Diagnosis:	ESD Surface			**Sure:**	1
Impact:	Annoyance to ground controller			**Duration**	Unknown
Category:	Phantom commands				
Comments:	Poor correlation with Kp and ground magnetograms				
References:	JLR6				

Name:	DSP F4				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	June 4, 1974 0107 UT				
Description:	Star Sensor Threshold Level Uncommanded Change				
Diagnosis:	ESD Surface			**Sure:**	1
Impact:	None			**Duration**	Unknown
Category:	Phantom commands				
Comments:	No supporting particle data. Anomaly correlated with focal plane strobes thought to be caused by charging				
References:	JLR7				

Name:	DSP F4				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	July 3, 1973 0125 UT				
Description:	SRI QCM Inadvertently Turned Off				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	None			**Duration**	Unknown
Category:	Phantom commands				
Comments:	Local time occurrence of event in midnight sector				
References:	JLR8				

Name:	DSP F6				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	January 30, 1977				
Description:	IR Noise Bursts				
Diagnosis:	ESD Surface			**Sure:**	1
Impact:	Removed from data by ground processing			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	Local time distribution is midnight to dawn sector				
References:	JLR9				

Name:	DSP F6				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	March 28 , 1983				
Description:	Earth Sensor Assembly A Failure				
Diagnosis:	ESD Surface			**Sure:**	1
Impact:	Loss of Earth lock and data for 24 h. Loss of subsystem redundancy			**Duration**	1 hr to 1 day
Category:	System Failure				
Comments:	Coincident with end of eclipse interval. Weak correlation with electron data from other satellites				
References:	JLR10				

Name:	DSP F6				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Jan 8, 1985 1730-2030 UT				
Description:	Earth Sensor Assembly B Failure				
Diagnosis:	ESD Surface			**Sure:**	1
Impact:	Loss of attitude subsystem redundancy			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	Anomaly time uncertain within 3 hours. Two substorm electron injections during this interval from measurements on other satellites				
References:	JLR11				

Name:	DSP F6				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	February 13-14, 1978				
Description:	Excessive Star Sensor Output				
Diagnosis:	Solar Proton Event			**Sure:**	3
Impact:	Intermittent loss of data totaling 900 s			**Duration**	10 min to 1 hr
Category:	Spurious Signal				
Comments:	Must use backup attitude processing algorithms instead of primary method				
References:	JLR4				

Name:	DSP F7				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Jan 24, 1985				
Description:	Earth Sensor Assembly B Failure				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	Software changes required to continue mission			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	No supporting particle data but "similar" to previous Anomaly 1097 which was suspected as surface charging				
References:	JLR12				

Name:	DSP F7				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Dec 3, 1983				
Description:	Link 2 Quality Alarms, Intermittent Signal Strength				
Diagnosis:	ESD Surface			**Sure:**	1
Impact:	Degraded data quality for several hours			**Duration**	1 hr to 1 day
Category:	Degraded Performanc				
Comments:	Correlation between alarms and electron flux from onboard detector not very consistent				
References:	JLR14				

Name:	DSP F7				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	February 13-14, 1978				
Description:	Excessive Star Sensor Output				
Diagnosis:	Solar Proton Event			**Sure:**	3
Impact:	Intermittent loss of data totaling 900 s			**Duration**	10 min to 1 hr
Category:	Spurious Signal				
Comments:	Must use backup attitude processing algorithms instead of primary method				
References:	JLR4				

Name:	DSP F7				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Nov 9-10, 1983				
Description:	Earth Sensor Assembly A Failure				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	Loss of Earth lock and data for 1800 s			**Duration**	10 min to 1 hr
Category:	System Failure				
Comments:	Correlation of two events with peaks in electron flux from onboard detector good within several minutes				
References:	JLR13				

Name:	DSP F9				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Feb 10 , 1983 1200 UT				
Description:	Crypto Power Supply KPP-29A-A Anomalous Turn-on and Failure				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	Loss of command subsystem redundancy			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	Strong correlation of two anomaly events with electron flux peak from on-board detector				
References:	JLR15				

Name:	DSP F9				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	October 7, 1982				
Description:	Crypto Power Supply KPP-29A-B Failure				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	Loss of command subsystem redundancy			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	Strong correlation of failure with electron flux peak from on-board detector				
References:	JLR16				

Name:	DSP PAR 4				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	14 Sep 95				
Description:	Current spike on primary bus current				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	Injection 51-107 KeV and 107-315 KeV electrons				
References:	SWS1				

Name:	ERBS				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	1 Nov 1984				
Description:	Bit changes in block (delta time) section of both command memories. There were 142 'hits' recorded to date				
Diagnosis:	SEU			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	Earth Radiation Budget Satellite				
References:	RSS51				

Name:	ERBS				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	7 Oct 1993				
Description:	Anomalous changes in chips located in the Command Storage Memory				
Diagnosis:	Unknown			**Sure:**	0
Impact:	CSM-2 unreliable and time tags changed. Stop use of CSM-2 and use only CSM-1			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	Noise and radiation. (Earth Radiation budget Satellite)				
References:	RSS33				

Name:	ERS-1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	After Jul 1991				
Description:	A Precision Range Rate Equipment (PRARE) instrument failed following a transient high current event				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	0
Impact:	Unknown			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	(European Space Agency Remote Sensing satellite)				
References:	RSS45				

Name:	ETS-6 (Japanese Engineering Test Satellite				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	11 Jul 1979				
Description:	Reduced effectiveness of solar panels				
Diagnosis:	Radiation Damage			**Sure:**	3
Impact:	Satellite lifetime reduced			**Duration**	More than 1 wk
Category:	Solar Array Degradati				
Comments:	Satellite failed to reach geostationary orbit and high Van Allen Belt radiation levels quickly eroded the efficiency of the solar panels				
References:	RSS42				

Name:	EUVE				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Nov 1993				
Description:	'Clam-up' (all detector doors shut). Payload put into pre-launch mode				
Diagnosis:	SEU			**Sure:**	0
Impact:	System restored to normal on day of each anomaly with no damage			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	(Extreme Ultraviolet Explorer)				
References:	RSS33				

Name:	F2, F3, F4				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	8,9,10 September 1984				
Description:	Observed in telemetry				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Other				
Comments:	Period of unusually high solar and geomagnetic activity				
References:	HCK19				

Name:	FLTSATCOM				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	2/11/87, 3/3/87, 5/10/87, 6/12/87, 6/20/87				
Description:	Low level logic problems				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	None				
References:	RSS7				

Name:	FLTSATCOM 6071				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Mar to Jun 1987				
Description:	Low level logic anomalies				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	System restored to normal on day of each anomaly with no damage			**Duration**	1 hr to 1 day
Category:	Spurious Signal				
Comments:	Five deep dielectric charging events				
References:	RSS7				

Name:	FLTSATCOM-1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	12 May 95				
Description:	Relay flip switch				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	>2 MeV electrons enhanced for 9 days prior to anomaly				
References:	SWS1				

Name:	FY-1				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	15 Oct 1988				
Description:	Failure of attitude control system				
Diagnosis:	ESD			**Sure:**	0
Impact:	Mission Loss			**Duration**	Mission loss
Category:	Mission Loss				
Comments:	Fengyun-1, Chinese experimental weather satellite				
References:	HCK36, RSS7				

Name:	GEO spacecraft (13 commercial)				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	29-30 September 1989				
Description:	SEUs				
Diagnosis:	SEU-Solar Proton Event			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	None				
References:	HCK33				

Name:	GEO spacecraft (7 commercial)				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	13-14 Mar 89				
Description:	Problems maintaining operational attitude orientation within specified ranges				
Diagnosis:	Magnetic Field Variability			**Sure:**	0
Impact:	Required 177 manual operator interventions to make thruster adjustments in orbit to maintain the required attitude			**Duration**	1 hr to 1 day
Category:	Degraded Performanc				
Comments:	More than is normally required of controllers during a year of routine observations				
References:	JHA15				

Name:	GEO spacecraft (commercial)				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	22-31 March 1991				
Description:	L-band amplifier failed				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	None				
References:	HCK33				

Name:	GEO spacecraft (commercial)				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	22-30 May 1991				
Description:	L-band amplifier loss				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	None				
References:	JHA20				

Name:	GEO spacecraft (various commercial)				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	19-29 October 1989				
Description:	Pitch glitches and SEUs				
Diagnosis:	SEU-Solar Proton Event			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	None				
References:	HCK33				

Name:	GMS-3				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:					
Description:	Severe scintillation				
Diagnosis:	Ionospheric Scintillations			**Sure:**	0
Impact:	Data transmissions were lost for 1 hour			**Duration**	10 min to 1 hr
Category:	Degraded Performanc				
Comments:	None				
References:	JHA15 (?)				

Name:	GMS-3				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Sept 1984-Jan 1989				
Description:	phantom commands				
Diagnosis:	ESD Surface			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	None				
References:	JEM7				

Name:	GMS-3				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Dec 1984 to Aug 1985				
Description:	Multiple anomalous switching events in the accelerometer. Anomalous gain level stepping the Visible Infrared Spin Scan Radiometer				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	(Japanese Geostationary Meteorological Satellite , Himawari 3)				
References:	RSS7, DCW4				

Name:	GMS-4				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Jan and Jul 1991				
Description:	The Visible Infrared Spin Scan Radiometer gain setting experienced an anomalous change in state				
Diagnosis:	ESD			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	(Japanese Meteorological Satellite, Himawari 4)				
References:	RSS7				

Name:	GOES -8				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	18 & 20 Apr 94				
Description:	Attitude orbital control system experienced uncommanded thruster burns				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	Uncommanded thruster burns while in transfer orbit. C.F. Falcon AFB assessment 5/17/94 & attached reference				
References:	SWS1				

Name:	GOES-4				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	29 Mar 1981 to 26 Nov 1982				
Description:	The mirror used with the visible Spin Scan Radiometer Atmospheric Sounder, the principle (VISSR) instrument on the spacecraft, suffered phantom commands that begun a sudden, undesired repositioning. Eventually it failed completely on 11/26/82				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	New commands were issued by controllers on Earth. Finally taken out of service. The ungrounded radiator was redesigned on GOES-5 before its launch			**Duration**	Mission loss
Category:	Mission Loss				
Comments:	Mission Loss. Led to the development of the spacecraft anomaly database at NOAA. A portion of the VAS second stage radiation cooler was ungrounded and built up potential from the surrounding plasma until it discharged, creating a large electromagnetic pulse (Geostationary Operational Environmental Satellite)				
References:	RSS20, RSS21				

Name:	GOES-5				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	various from 8/20/81 to 4/3/84				
Description:	Channel 7 gain stepped from 2 to 3 (48 times)				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	None				
References:	RSS7, HCK25				

Name:	GOES-5				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	19-22 March 1990				
Description:	Power panel output degradation				
Diagnosis:	Radiation Damage-Solar Proton Event			**Sure:**	3
Impact:	Unknown			**Duration**	More than 1 wk
Category:	Solar Array Degradati				
Comments:	None				
References:	HCK33				

Name:	GOES-5				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	19 Oct 1989				
Description:	A major solar flare on 19 Oct degraded the solar array by about 0.5 amps				
Diagnosis:	Radiation Damage-Solar Proton Event			**Sure:**	3
Impact:	Unknown			**Duration**	More than 1 wk
Category:	Solar Array Degradati				
Comments:	None				
References:	RSS49				

Name:	GOES-5				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	1989				
Description:	The Central Telemetry Unit (CTU) experienced 4 SEUs				
Diagnosis:	SEU-Cosmic Ray			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	None				
References:	RSS49				

Name:	GOES-5				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	1989				
Description:	The Central Telemetry Unit (CTU) experienced six SEUs which were associated with solar flares				
Diagnosis:	SEU-Solar Proton Event			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	None				
References:	RSS49				

Name:	GOES-5 & 6				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	19-29 October 1989				
Description:	SEUs				
Diagnosis:	SEU-Solar Proton Event			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	Unknown				
References:	HCK33				

Name:	GOES-6				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	12-21 August 1989				
Description:	Power Panel output degradation				
Diagnosis:	Radiation Damage-Solar Proton Event			**Sure:**	3
Impact:	Unknown			**Duration**	More than 1 wk
Category:	Solar Array Degradati				
Comments:	None				
References:	HCK33				

Name:	GOES-6				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	22-30 Mar 91				
Description:	Power Panel Output Degradation				
Diagnosis:	Radiation Damage-Solar Proton Event			**Sure:**	3
Impact:	Equal to 3-year loss			**Duration**	More than 1 wk
Category:	Solar Array Degradati				
Comments:	None				
References:	JHA20				

Name:	GOES-6				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	19-22 March 1990				
Description:	Power panel output degradation				
Diagnosis:	Radiation Damage-Solar Proton Event			**Sure:**	3
Impact:	Equivalent to 3 years lost from end of life			**Duration**	More than 1 wk
Category:	Solar Array Degradati				
Comments:	None				
References:	HCK33				

Name:	GOES-6				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	9 Mar 1988				
Description:	The telemetry was permanently degraded				
Diagnosis:	SEU			**Sure:**	0
Impact:	Loss of several analog and digital channels			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	None				
References:	RSS50				

Name:	GOES-6				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	27 Sep 1986, 17 Mar 1986				
Description:	Uncommanded shift in visible Infrared Spin Scan Radiometer Atmospheric sounder (VAS) Earth window. X-ray scan shifted to calibration mode				
Diagnosis:	ESD			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	None				
References:	RSS7, RSS15				

Name:	GOES-6				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	7 Jul 1984				
Description:	Loss of pulse code modulated telemetry				
Diagnosis:	SEU			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	System Failure				
Comments:	None				
References:	RSS51				

Name:	GOES-6				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	12-21 August 1989				
Description:	Lost half of telecommunications system				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	None				
References:	HCK33, JHA20				

Name:	GOES-7				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	26 Feb 1989				
Description:	The VAS digital multiplexer bit mode command failed after the satellite came out of eclipse				
Diagnosis:	ESD Surface			**Sure:**	1
Impact:	Unknown			**Duration**	More than 1 wk
Category:	Random Part Failure				
Comments:	This satellite experienced several discharge events in 1987-9 that resulted in phantom commands				
References:	RSS7, RSS9				

Name:	GOES-7				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	12 Mar 89				
Description:	Communications Circuit Anomaly				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Lost imagery			**Duration**	Unknown
Category:	System Failure				
Comments:	None				
References:	JHA15				

Name:	GOES-7				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	19-30 Oct 89				
Description:	Solar Array power degradation				
Diagnosis:	Radiation Damage-Solar Proton Event			**Sure:**	3
Impact:	6 year's equivalent lifetime lost			**Duration**	More than 1 wk
Category:	Solar Array Degradati				
Comments:	None				
References:	JHA15				

Name:	GOES-7				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	19-22 March 1990				
Description:	Power panel output degradation				
Diagnosis:	Radiation Damage-Solar Proton Event			**Sure:**	3
Impact:	Equal to 3-years loss			**Duration**	More than 1 wk
Category:	Solar Array Degradati				
Comments:	None				
References:	HCK33, JHA20				

Name:	GOES-7				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	22-24 March 1991				
Description:	Solar array power degradation				
Diagnosis:	Radiation Damage-Solar Proton Event			**Sure:**	3
Impact:	Decrease of 2 to 3 years in expected satellite lifetime			**Duration**	More than 1 wk
Category:	Solar Array Degradati				
Comments:	None				
References:	HCK15 RSS61				

Name:	GOES-7				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Jun 1988				
Description:	The REPLY BUS switch uncommanded from A to B channel in the Central Telemetry Unit (CTU-1)				
Diagnosis:	SEU			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	None				
References:	JHA50				

Name:	GOES-8				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	19 Apr 1984 and 23 Apr 1994				
Description:	Sun-presence bit went high and latched ES				
Diagnosis:	SEU-Radiation Belts			**Sure:**	0
Impact:	No corrective action required			**Duration**	Unknown
Category:	Unknown				
Comments:	None				
References:	RSS68, JEM6				

Name:	GOES-8				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	8-10 Jan 97				
Description:	Main power supply for the automatic on-board pointing control failed				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	Satellite was out of operation much of the 8th and 9th and was switched back on using the back-up supply on the 10th of January			**Duration**	1 day to 1 wk
Category:	System Failure				
Comments:	None				
References:	JHA10				

Name:	GOES-8				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	28 Jun 96				
Description:	PCEM watchdog timer (WDT) timeout, resulting in a reset of the payload control electronics				
Diagnosis:	SEU-Cosmic Ray			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	System Failure				
Comments:	None				
References:	SWS1				

Name:	GOES-8				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	19&21 Apr, 2 Jun, 29 Jul, 9 Aug 1996				
Description:	Reset of Payload Control Electronics Module				
Diagnosis:	SEU-Cosmic Ray			**Sure:**	3
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	None				
References:	SWS1				

Name:	GOES-8 & 9				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	~ 6 Nov 97				
Description:	Star tracker problems				
Diagnosis:	Solar Proton Event			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	None				
References:	JHA8				

Name:	GPS				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	10-16 April 1990				
Description:	Unknown				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Other				
Comments:	'Experienced problems that may have resulted from enhanced > 2 MeV electron flux'				
References:	HCK33				

Name:	GPS (FSV-1)				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	13 June 1980				
Description:	Solar array wings were misdirected and were not tracking the sun. Tracking Mode changed to HOLD. Three separate logic changes had occurred since previous contact				
Diagnosis:	ESD Internal			**Sure:**	3
Impact:	Mistracking occurred for either 44 or 100 minutes before it was determined that the arrays were misdirected. Contingency command plans developed and added to OOH. When the anomaly was discovered all pre-planned activities were aborted and SV data monitored while a course of corrective action was planned			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Corrective action includes modification to follow-on vehicles. (Did this occur ?)				
References:	HCK27, HCK28, HCK29				

Name:	GPS 1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	2 Sep 78				
Description:	Frequency shifts in GPS clocks				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Loss of accuracy of the system until corrected			**Duration**	1 day to 1 wk
Category:	Degraded Performanc				
Comments:	While discussed, deep dielectric charging was not specifically identified as the cause. It was put forward by the contractor. Anomalies occurred during rapid rise in dose rate at mission altitude				
References:	HCK26, JFF4				

Name:	GPS 2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	3 Sep 78, 4 Sep 78, 5 Sep 78, 6 Sep 78, 6 Oc				
Description:	Frequency shifts in GPS clocks				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Loss of accuracy of the system until corrected			**Duration**	1 day to 1 wk
Category:	Degraded Performanc				
Comments:	While discussed, deep dielectric charging was not specifically identified as the cause. It was put forward by the contractor. Anomalies occurred during rapid rise in dose rate at mission altitude				
References:	HCK26, JFF4				

Name:	GPS 2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	8 Oct 78				
Description:	Clock Failure				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	None				
References:	HCK26, JFF4				

Name:	GPS 5118				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	17 JUL 1985				
Description:	Unexpected switch settings within the motor control electronics				
Diagnosis:	ESD			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	None				
References:	RSS6				

Name:	GPS SVN 26				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	09 OCT 95				
Description:	Software upset to the Attitude Control Subsystem processor (TI 9989)				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Geomagnetic storming and enhanced low energy electrons could have played a role in this anomaly				
References:	SWS1				

Name:	GPS SVN-28				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	09 Oct 95				
Description:	Bit hit to the TI 9789 processor				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	>2 MeV electrons were above internal charging event levels				
References:	SWS1				

Name:	GPS- SVN-11				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	11 Feb 94				
Description:	PCM-A and PLCM-B malfunctions resulting in bad telemetry data				
Diagnosis:	ESD Surface			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	Enhanced levels of 100 KeV electrons				
References:	SWS1				

Name:	HEO Spacecraft				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	various 1978				
Description:	Mission data exhibited dropouts				
Diagnosis:	Plasma Effects-Multipaction			**Sure:**	3
Impact:	Noise in mission data. Massive effort troubleshooting the problem. Workarounds were devised leaving anomaly only a modest nuisance			**Duration**	More than 1 wk
Category:	Degraded Performanc				
Comments:	Gamma ray radioactive source could reproduce the dropouts in laboratory tests				
References:	JBB1				

Name:	HEO spacecraft				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	Unknown				
Description:	At first turn-on the signal from four preamps were degraded by about 32 dB				
Diagnosis:	ESD Internal			**Sure:**	3
Impact:	Massive effort to test an engineering model of the subassembly to find a fix for subsequent missions. Redesign of the payload			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	None				
References:	HCK35				

Name:	HEO spacecraft (several)				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	Various				
Description:	False trips of limit switch				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	Significant effort spent troubleshooting. 'Band-aid' attempts were made to harden subsequent missions without much success. Anomaly ultimately became a minor annoyance			**Duration**	Unknown
Category:	Phantom commands				
Comments:	None				
References:	JBB1				

Name:	HEO Spacecraft F3				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	July and September 1982				
Description:	RS Uncommanded Mode Changes				
Diagnosis:	ESD Internal			**Sure:**	3
Impact:	No Significant Impact			**Duration**	Unknown
Category:	Phantom commands				
Comments:	None				
References:	JBB1				

Name:	HEO Spacecraft F4				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	July and September 1982				
Description:	RS Uncommanded Mode Changes				
Diagnosis:	ESD Internal			**Sure:**	3
Impact:	No significant impact			**Duration**	Unknown
Category:	Phantom commands				
Comments:	None				
References:	JBB1				

Name:	Hipparcos				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	15 Aug 1993				
Description:	Communication with the satellite was lost				
Diagnosis:	Total Radiation Dose			**Sure:**	0
Impact:	Mission Loss. Attempts to restart operations were unsuccessful and mission operations were terminated 4 years and 1 week after launch			**Duration**	Mission loss
Category:	Mission Loss				
Comments:	ESA astronomy satellite				
References:	RSS48				

Name:	HST				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	11 Apr 1994				
Description:	SAP test failed during SADE 1 slew, S/C into SAFE MODE				
Diagnosis:	SEU			**Sure:**	0
Impact:	Recovered from SAFE MODE			**Duration**	1 hr to 1 day
Category:	Upset				
Comments:	None				
References:	RSS68				

Name:	HST (STS-31)				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	9 Dec 1993				
Description:	The Data Interface Unit-2 (DIU -2), A Side, presented faulty telemetry readings for specific HST parameters				
Diagnosis:	Radiation Damage			**Sure:**	0
Impact:	Negligible effect. DIU-2 switched to redundant B-side permanently and problem cleared			**Duration**	Minimal
Category:	Spurious Signal				
Comments:	None				
References:	RSS33				

Name:	HST (STS-31)				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	4 Jul 1991				
Description:	Six of the telescopes status monitors failed. Guide star acquisition failures				
Diagnosis:	Radiation Damage-South Atlantic Anomaly			**Sure:**	0
Impact:	Unknown			**Duration**	More than 1 wk
Category:	Random Part Failure				
Comments:	None				
References:	RSS44				

Name:	HST (STS-31)				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	7 May 1990 , 20 Jun 1990				
Description:	Bit flips occurred in the RAM of Fine Guidance Electronics. High photomultiplier tube (PMT) counts in the fine guidance system				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	3
Impact:	Could not operate in South Atlantic Anomaly			**Duration**	Less than 10 min
Category:	Upset				
Comments:	None				
References:	RSS47, JHA Private Communication				

Name:	HST (STS-31)				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Apr 1990				
Description:	British Aerospace inspection of the old HST array found effects ranging from slight grazing to the puncture of cells and blankets				
Diagnosis:	Impact-Micrometeoroid			**Sure:**	3
Impact:	No degradation in the electrical performance from the tests made before launch			**Duration**	Minimal
Category:	Other				
Comments:	5000 to 6000 micromeoteroid impacts during four year life				
References:	RSS35				

Name:	INSAT -1				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	13 Sep 1987 to 26 Apr 1988				
Description:	6 bit flip errors				
Diagnosis:	SEU-Cosmic Ray			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	None				
References:	RSS55				

Name:	INSAT -1B				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	18 Mar-18 Apr 84				
Description:	Temperature Sensor Anomalies. Damaged FETs in telemetry thermal channels input circuits				
Diagnosis:	ESD			**Sure:**	1
Impact:	Unknown			**Duration**	More than 1 wk
Category:	Degraded Performanc				
Comments:	None				
References:	DCW3				

Name:	INSAT -2D				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	1 Oct 97				
Description:	Failed. Lost connection between power panels and batteries				
Diagnosis:	ESD Surface			**Sure:**	1
Impact:	Mission Loss. Shutdown the Indian stock exchange. Shut down communications between the central government and the provinces			**Duration**	Mission loss
Category:	Mission Loss				
Comments:	Major magnetic storm				
References:	JHA6, JHA7				

Name:	INSAT -2D				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Mar 96				
Description:	10 ESD Events				
Diagnosis:	ESD			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	None				
References:	JHA 16				

Name:	Intelsat 510 (International Telecommunicatio				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	15 Jan 1988				
Description:	Affected the attitude control system and caused uncommanded status changes				
Diagnosis:	ESD			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	None				
References:	RSS7				

Name:	Intelsat 511				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	25 Sep 86				
Description:	A status bit change caused the thruster to switch 'ON' and stay in that setting for 3 to 4 minutes. A normal 'blast' is only 200 ms				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	Less than 10 min
Category:	Phantom commands				
Comments:	The emergency thruster gas cut off worked after about 1 min. to stop the flow and limit the problem caused by this event				
References:	JHA11				

Name:	Intelsat 511				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	August 1993				
Description:	Disrupted attitude control system caused uncommanded status changes				
Diagnosis:	ESD			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	None				
References:	RSS7				

Name:	Intelsat 511				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	7 Oct 1995				
Description:	Thruster firing necessitated safe hold				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	Magnitude of thruster firing put satellite in safe sun acquisition mode. Anomaly at 6 pm satellite local time. Recovery from safe status at 6 pm local time requires the longest outage'			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	Earth acquisition regained @ 1624Z. 'some inconvenience', but no lasting damage				
References:	JEM15				

Name:	Intelsat 602				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	March 1991				
Description:	Experienced a step-like degradation [in power]				
Diagnosis:	Radiation Damage-Solar Proton Event			**Sure:**	2
Impact:	Unknown			**Duration**	More than 1 wk
Category:	Solar Array Degradati				
Comments:	None				
References:	JHA3				

Name:	Intelsat K				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	20 January 1994				
Description:	'Minor electrical disturbance' Momentum wheel Circuit Problem				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Pointing upset			**Duration**	10 min to 1 hr
Category:	System Failure				
Comments:	System control was re-established by switching to backup circuitry				
References:	HCK11, JHA20, JHA21				

Name:	Intelsat K				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	20 Jan 1994				
Description:	Disabled the momentum wheel control circuitry causing it to wobble and produce fluctuations in antenna coverage				
Diagnosis:	ESD			**Sure:**	0
Impact:	Use of backup system			**Duration**	1 hr to 1 day
Category:	System Failure				
Comments:	Full operational status was achieved on the same day after a backup system was activated				
References:	RSS2				

Name:	Intelsat Satellites (five vehicles)				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	August 1993				
Description:	Minor electrical disturbance				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Unknown			**Duration**	Minimal
Category:	Unknown				
Comments:	During a period of elevated energetic electron fluxes				
References:	HCK11, JEM8				

Name:	Iridium #11				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Unknown				
Description:	Problems with momentum wheel				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	Space News article (about 12/4/97) Third Iridium Satellite that has had problems				
References:	JHA5				

Name:	IRON 2102				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	03 Apr 97				
Description:	Reset of the Command and Data Handler (CDH)				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Spacecraft within the heart of the South Atlantic Anomaly				
References:	SWS1				

Name:	IRON 2102				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	23 Oct 96				
Description:	Command and Data Handler Processor reset				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Spacecraft located in South Atlantic Anomaly following severe geomagnetic storming				
References:	SWS1				

Name:	IRON 2102				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	15 Sep 95				
Description:	Bus Interface Module (BIM) reset				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Enhanced Inner Van Allen Belt				
References:	SWS1				

Name:	IRON 2102				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	25, 27, 29, 30, 31 May 96 3, 4, 6 Sep 96 13,				
Description:	Safehold state				
Diagnosis:	IR-Environmental Sources			**Sure:**	1
Impact:	Unknown			**Duration**	1 hr to 1 day
Category:	Other				
Comments:	None				
References:	SWS1				

Name:	IRON 2102				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	18 Mar 94				
Description:	GPS receiver lost track and failed to reacquire				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	Good geomagnetic storming and strongly enhanced energetic electrons. Should not happen in Iron 2102 orbit				
References:	SWS1				

Name:	IRON 2102				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	05 Dec 94				
Description:	Anomalous reset of the Command and Data handling Processor #2				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	None				
References:	SWS1				

Name:	IRON 2102				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	29 Jul 95				
Description:	Radar Illumination Verification System (RIVs) processor failure				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	1
Impact:	Unknown			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	Spacecraft within South Atlantic Anomaly				
References:	SWS1				

Name:	IRON 3122				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	18 Sep 97				
Description:	Command processor reset				
Diagnosis:	ESD			**Sure:**	1
Impact:	None			**Duration**	Unknown
Category:	Upset				
Comments:	Spacecraft within region where Field aligned currents are located				
References:	SWS1				

Name:	IRON 3122				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	15 Dec 97				
Description:	Command processor reset				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Spacecraft ascending within the heart of the South Atlantic Anomaly				
References:	SWS1				

Name:	IRON 4221				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	31 May 95				
Description:	Anomalous reset of the Command and Data Handling (CDH) processor				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Spacecraft within the heart of the South Atlantic Anomaly				
References:	SWS1				

Name:	IRON 4221				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	23 Nov 95				
Description:	Anomalous reset of the Command and Data Handling (CDH) processor				
Diagnosis:	SEU			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	None				
References:	SWS1				

Name:	IRON 4221				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	17 Jul 95				
Description:	Anomalous reset of the Attitude Control system (ACS) processor				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Disturbed geomagnetic and energetic particle environment				
References:	SWS1				

Name:	IRON 4221				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	26 Jun 95				
Description:	Anomalous reset of the Attitude control system (ACS) processor				
Diagnosis:	ESD			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Disturbed geomagnetic and particle environments				
References:	SWS1				

Name:	IRON 4221				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	06 Jul 95				
Description:	Anomalous soft reset of the Command and Data Handling (CDH) microprocessor				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Portions of the inner Van Allen Belt and the South Atlantic Anomaly in which this spacecraft was located are somewhat enhanced during solar minimum				
References:	SWS1				

Name:	IRON 4524				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	15 May 94				
Description:	Communications system hardware to switch oscillators				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	>2 MeV electrons enhanced				
References:	SWS1				

Name:	IRON 7092				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	15 Dec 94				
Description:	Communication interruption between the Battery Charge Regulator (BCR) and the Spacecraft Control Module (SCM)				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	Spacecraft descending through the heart of the Van Allen Belt				
References:	SWS1				

Name:	IRON 7092				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	08 Dec 95				
Description:	Anomalous loss of telemetry				
Diagnosis:	SEU			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Spacecraft transited the inner Van Allen Belt and the South Atlantic Anomaly				
References:	SWS1				

Name:	IRON 7092				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	01 Apr 95				
Description:	Battery Charge Regulator (BCR) reset causing the payloads to be turned off				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	1 hr to 1 day
Category:	Upset				
Comments:	Spacecraft within the horns of the outer Van Allen Belt				
References:	SWS1				

Name:	IRON 7092				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	06 Nov 94				
Description:	Attitude Control Subsystem declared contingency mode and cycled to initialization routines				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	Moderately disturbed geomagnetic and energetic particle environments at the time of the anomaly				
References:	SWS1				

Name:	IRON 7092				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	10 Dec 94				
Description:	Communication interruption between the Housekeeping Interface Unit (HIU) and the Payload Services Module (PSM)				
Diagnosis:	SEU			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Spacecraft ascending through the heart of the Van Allen Belt				
References:	SWS1				

Name:	IRON 7092				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	13 Dec 94				
Description:	Battery Charge Regulator (BCR) timer working double time				
Diagnosis:	SEU			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Spacecraft descending through the heart of the Van Allen Belt				
References:	SWS1				

Name:	IRON 7092				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	29 Sep 94				
Description:	Anomalous reset of the Payload Services Module (PSM) clock				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Spacecraft within the South Atlantic Anomaly				
References:	SWS1				

Name:	IRON 7092				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	04 Nov 94				
Description:	Communication interruption between the spacecraft Control Module (SCM) and Battery Charge Regulator (BCR)				
Diagnosis:	SEU			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Spacecraft within the heart of the Inner Van Allen Belt				
References:	SWS1				

Name:	IRON 7092				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	26 Mar 95				
Description:	Battery Charge Regulator (BCR) reset causing the payloads to be turned off				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	Unknown			**Duration**	1 hr to 1 day
Category:	Upset				
Comments:	Spacecraft located in the auroral zone that was observed to be intensified with enhanced precipitating energetic particle fluxes				
References:	SWS1				

Name:	IRON 7092				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	18 Dec 94				
Description:	Corruption of the Battery Charge Regulator (BCR) software				
Diagnosis:	SEU			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Spacecraft descending through the heart of the Van Allen Belt				
References:	SWS1				

Name:	IRON 7092				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	04-05 Nov 94				
Description:	18 anomalous periods of noise spikes that appeared within the multiple electrical power system telemetry points				
Diagnosis:	SEU			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	All of the anomalies were recorded while the spacecraft was within one of the following environments-the inner Van Allen Belt, South Atlantic Anomaly, and in or just below the 'horn region' of the outer Van Allen Belt				
References:	SWS1				

Name:	IRON 7092				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	17 Feb 95				
Description:	Communication interruption between the Spacecraft Computer and the Housekeeping interface unit (HIU) along with an associated Electrical Power System (EPS) battery charge code error				
Diagnosis:	SEU			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Spacecraft located within the Inner Van Allen belt				
References:	SWS1				

Name:	IRON 9364				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	16 Oct 92 19 Oct 92				
Description:	Glitch in earth sensor				
Diagnosis:	ESD Surface			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	None				
References:	SWS1				

Name:	IRON 9364				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	27 Oct 92 and 30 Oct 92				
Description:	Glitch in earth sensor reference				
Diagnosis:	ESD			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	None				
References:	SWS1				

Name:	IRON 9443				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	18 Oct 92				
Description:	Command check read malfunction				
Diagnosis:	ESD Surface			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	Spacecraft experienced a marked increase of energetic electron fluxes while traversing the local midnight sector				
References:	SWS1				

Name:	IRON 9445				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	06 Oct 95				
Description:	Electrical Integration Assembly (EIA) command processing				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	None				
References:	SWS1				

Name:	IRON 9445				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	08 Oct 95				
Description:	Electrical Integration Assembly (EIA) command processing anomaly				
Diagnosis:	ESD Internal			**Sure:**	3
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	None				
References:	SWS1				

Name:	IRON-9906				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	1992 to 1997				
Description:	The payload control electronics module (PCEM) suffered a watchdog timer(WDT) time-out which caused a payload reset. Occurred numerous times over spacecraft lifetime				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	3
Impact:	All stored data lost			**Duration**	1 hr to 1 day
Category:	Upset				
Comments:	None				
References:	SWS1				

Name:	IRON-9906				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	1997				
Description:	The payload control electronics module (PCEM) suffered a watchdog timer(WDT) time-out which caused a payload reset.. After last latch-up, spacecraft lost				
Diagnosis:	SEU			**Sure:**	3
Impact:	Mission Loss			**Duration**	Mission loss
Category:	Mission Loss				
Comments:	None				
References:	SWS1				

Name:	ISEE-1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	7 August 1978				
Description:	The ULEWAT instrument on ISEE-1 lost all isobutane gas over a 7 day period ~ 1 year after launch. Gas supply was intended to last for at least 5 years				
Diagnosis:	Impact-Micrometeoroid			**Sure:**	2
Impact:	Instrument returned useful low-energy particle data for ~ 1 years out of a potential of at least ~5 years (~20% science return from this instrument)			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	Micrometeroid impact likely but not conclusively proven. ISEE-1 was ~15 Re from Earth at the time the ULEWAT gas pressure began to decrease. The gas leak was small enough that the regulation system compensated for the loss for ~7 days, after which the supply ran out				
References:	RSS2				

Name:	ISEE-1 (International Sun-Earth Explorer)				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	After Oct 1977				
Description:	Detector window punctured				
Diagnosis:	Impact-Micrometeoroid			**Sure:**	0
Impact:	25% data loss			**Duration**	More than 1 wk
Category:	Degraded Performanc				
Comments:	None				
References:	RSS38				

Name:	Kosmos -1275				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	24 Jul 1981				
Description:	Broke up into over 200 trackable fragments while at an altitude of 977 km				
Diagnosis:	Impact-Hypervelocity collision with a piece			**Sure:**	0
Impact:	Unknown			**Duration**	Mission loss
Category:	Mission Loss				
Comments:	None				
References:	RSS37				

Name:	Landsat-3				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	After May 1978				
Description:	The multispectral scanner on board the Landsat-3 satellite experienced extra scan monitor pulses that caused early line starts or extra end of line codes				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Loss of data			**Duration**	More than 1 wk
Category:	Degraded Performanc				
Comments:	These events occurred over magnetic anomalies ??				
References:	RSS38				

Name:	LDEF (STS-41C)				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	After Mar 1984				
Description:	An aluminized-polyimide Kapton multilayer insulation sample located on the leading edge of the Long Duration Exposure Facility was eroded over the mission lifetime				
Diagnosis:	Atomic-oxygen Erosion			**Sure:**	3
Impact:	None			**Duration**	More than 1 wk
Category:	Other				
Comments:	This experimental study showed much wider and shallower undercut cavities than predicted, with implications for future low Earth orbit missions				
References:	RSS40				

Name:	LEO spacecraft				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	Unknown				
Description:	Problems in power system soon after launch. Bus load increased substantially. Concurrently problems were seen in RAM memory system				
Diagnosis:	SEU			**Sure:**	3
Impact:	Mission ops procedures were modified to include frequent power cycling of the RAMs to unlatch them. RAMs were turned off between ops. Required more complex ops planning. Some RAMs were permanently damaged			**Duration**	More than 1 wk
Category:	Degraded Performanc				
Comments:	Single Event Latchup occurring in RAMs. RAMs extremely susceptible to latchup were drawing greatly excessive current				
References:	JBB1				

Name:	LEO spacecraft				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	Unknown				
Description:	Uncommanded shutdowns of TWT HV supply				
Diagnosis:	Plasma Effects			**Sure:**	3
Impact:	Vehicle operations were modified to keep the pumpout holes out of the RAM direction. Required more complex OPS planning for life of vehicle. Threat of permanent failure			**Duration**	More than 1 wk
Category:	Phantom commands				
Comments:	Interaction between the ionospheric plasma coming through pumpout holes and the HV caused the TWT shutdowns. Shutdown occurred when pumpout holes were in the RAM direction				
References:	JBB1				

Name:	LEO spacecraft				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	19-29 October 1989				
Description:	Multiple switching off of microwave transmitter unit				
Diagnosis:	Solar Proton Event			**Sure:**	0
Impact:	Unknown			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	None				
References:	HCK33				

Name:	Magsat				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	After Oct 1979				
Description:	Loss of star camera data				
Diagnosis:	Sunlight			**Sure:**	2
Impact:	Loss of data for 30-40 minutes			**Duration**	More than 1 wk
Category:	Degraded Performanc				
Comments:	Direct sunlight on the sides of the sunshades that penetrated their black plastic skin				
References:	RSS38				

Name:	MARECS-A				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	31 August 85				
Description:	One section of a solar array panel failed while entering eclipse				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	Unknown			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	ESD Event which resulted in a short circuit through the cell to the back structure of the solar array panel'				
References:	DCW13				

Name:	MARECS-A				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	3, 17, 29 Mar 89				
Description:	50 switching events				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	Unknown			**Duration**	10 min to 1 hr
Category:	Phantom commands				
Comments:	Great magnetic storm				
References:	DCW11				

Name:	MARECS-A				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Feb 82 to Mar 91				
Description:	Spurious anomalies in the telemetry system requiring onboard processors to be manually reset. Pointing system suddenly went into an energy conserving 'safeing' mode shutting down all communications subsystems. Solar panel surfaces degraded to the point that power output dropped to unacceptable operating levels				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	Eventually taken out of service. The charging study improved the design of future satellites in the series			**Duration**	10 min to 1 hr
Category:	Phantom commands				
Comments:	Electrostatic discharges due to spacecraft charging. Localized arcing caused by surface charging while the satellite was in eclipse				
References:	RSS18, RSS19				

Name:	MARECS-A				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Feb 82 to Dec 84				
Description:	617 Phantom commands indicating that a main bus under-voltage had occurred				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	Required 3 telecommands to reset the telemetry latch			**Duration**	Less than 10 min
Category:	Spurious Signal				
Comments:	None				
References:	DCW13				

Name:	MARECS-A				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Feb 82to Dec 84				
Description:	Part of the AOCS autonomous protection logic disabled 157 times				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	Immediately re-enabled by telecommand			**Duration**	Less than 10 min
Category:	Phantom commands				
Comments:	None				
References:	DCW13				

Name:	MARECS-A				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Feb 82 to Dec 84				
Description:	ESD-Coupled stimuli into onboard logic. (205 events)				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	Some impact on mission when logic was enabled			**Duration**	Less than 10 min
Category:	Phantom commands				
Comments:	None				
References:	DCW13				

Name:	MARECS-A				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	25 March 1991				
Description:	Complete failure				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Mission Loss. Traffic switched to Intelsat commercial telecommunication satellite			**Duration**	Mission loss
Category:	Mission Loss				
Comments:	Period of high energetic electron fluxes following an solar proton event. It was being employed as a backup communications satellite at the time. Had a history of space-environment induced anomalies				
References:	HCK15, HCK33, JHA20, JHA4				

Name:	METEOSAT 2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	8/10/86- 10/22/86				
Description:	Single Parameter Switchings				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	Did not effect operations			**Duration**	Minimal
Category:	Phantom commands				
Comments:	None				
References:	DCW12				

Name:	METEOSAT 3				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	12-22 JAN 1994				
Description:	Arcing Problems				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	Images Lost			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	None				
References:	JHA 20				

Name:	Meteosat F-1				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Various from 12 Dec 77 to 3 Mar 78				
Description:	Large number of spurious switching events				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	None of the switching events caused a serious interruption to the METEOSAT mission but The inconvenience to the Space Operations Teams was considerable. Led to study by the Project Team and by Industry to determine the probable cause of these events and more importantly to determine if corrective action could be designed into future versions of METEOSAT. A series of current-injection tests and electron-radiation tests were carried out during 1978/79 on METEOSAT P1 spacecraft			**Duration**	10 min to 1 hr
Category:	Phantom commands				
Comments:	Extensive Modifications and Improvements incorporated into future spacecraft and resolved previous problems				
References:	DCW13				

Name:	Meteosat-F1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Various from Sept. 1981 to March 1982				
Description:	Only the occurrence of 'problems' were noted, no specific problem identified				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	Unknown in any detail			**Duration**	Unknown
Category:	Unknown				
Comments:	Based on hearsay. Anomaly list gives 13 dates and times but no specific effect				
References:	JFF ??				

Name:	Meteosat-F1 (European Space Agency Mete				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	After Nov 1977				
Description:	150 anomalies in first 3 years				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	Meteosat F-2 was modified prior to launch in June 1994 to eliminate some of the problems that F-1 experienced, and equipped with instrumentation to measure electrons in the energy range that could cause spacecraft charging			**Duration**	10 min to 1 hr
Category:	Phantom commands				
Comments:	None				
References:	RSS23, RSS24, RSS25				

Name:	MILSTAR DFS-1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	3/94-9/97				
Description:	Processor Upsets (142) with automatic reboot				
Diagnosis:	SEU-Cosmic Ray			**Sure:**	3
Impact:	Minimal operational impact. Some ground terminals that have just logged in have to reboot. Cost to study upsets in the range from $200K to $500K			**Duration**	Minimal
Category:	Upset				
Comments:	Reboot takes 1-2 sec. Restores state from 30-60 sec ago				
References:	HCK34				

Name:	MILSTAR DFS-2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	11/95-9/97				
Description:	75 Processor Upsets with automatic reboot				
Diagnosis:	SEU-Cosmic Ray			**Sure:**	2
Impact:	Minimal operational impact. Some ground terminals that have just logged in have to reboot. Cost to study upsets in the range from $200K to $500K			**Duration**	Minimal
Category:	Upset				
Comments:	Reboot takes 1-2 sec. Restores state from 30-60 sec ago				
References:	HCK34				

Name:	MILSTAR-DFS 1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	19 April 94, 26 April 94, 15 June 94				
Description:	Processor Upsets that have required manual resets				
Diagnosis:	SEU-Cosmic Ray			**Sure:**	3
Impact:	2-3 hr required to regain operational status			**Duration**	1 hr to 1 day
Category:	Upset				
Comments:	Problem related to software errors that precluded automatic reboot. Software errors that produced these reboots have been fixed				
References:	HCK34				

Name:	Mir SS				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	After Feb 1986				
Description:	Chronic power shortages				
Diagnosis:	Impact-Debris			**Sure:**	0
Impact:	Unknown			**Duration**	More than 1 wk
Category:	Solar Array Degradati				
Comments:	Solar panels have been battered by tiny meteorites, space debris, and atomic oxygen				
References:	RSS36				

Name:	MSTI				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	04 Jan 93				
Description:	TCM relay or PCM decoder malfunction, or encryption device malfunction (Bit Hit) lost all telemetry contact				
Diagnosis:	SEU			**Sure:**	0
Impact:	Mission Loss			**Duration**	Mission loss
Category:	Mission Loss				
Comments:	None				
References:	SWS1				

Name:	MSTI 2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	5 Sep 1994				
Description:	Contact with satellite was lost				
Diagnosis:	Impact-Micrometeoroid			**Sure:**	0
Impact:	Mission Loss			**Duration**	Mission loss
Category:	Mission Loss				
Comments:	Orbital debris impact to a wire bundle causing an electrical short and/or spacecraft charging				
References:	RSS67				

Name:	MSTI-2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	14 Aug 94				
Description:	CPU reset resulting in loss of attitude control				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	1
Impact:	Loss of data			**Duration**	1 hr to 1 day
Category:	Upset				
Comments:	Spacecraft was descending into the outer edge of the South Atlantic Anomaly				
References:	SWS1				

Name:	MSTI-2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	18 JUN 94				
Description:	CPU reset				
Diagnosis:	SEU			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	None				
References:	SWS1				

Name:	NATO 3A				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Multiple in 1978				
Description:	Attitude determination errors				
Diagnosis:	ESD Surface			**Sure:**	2
Impact:	Improper narrow beam antenna pointing			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	Times of errors were not all well known, but all overlapped local midnight. The most accurately timed events occurred in the pre to just post midnight regions. Surface charging/discharging suspected to have caused erroneous attitude data from earth sensors				
References:	JFF8				

Name:	NATO 3A				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	11 Jan 1987				
Description:	Attitude control problems				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Other				
Comments:	None				
References:	RSS7				

Name:	NATO 3B				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	11 Jan 1987, Aug and Sep 1987				
Description:	Three attitude control anomalies, three phantom command anomalies				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	None				
References:	RSS7				

Name:	NATO 3B				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Multiple in 1978				
Description:	Attitude determination errors				
Diagnosis:	ESD Surface			**Sure:**	2
Impact:	Improper narrow beam antenna pointing			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	Times of errors were not all well known, but all overlapped local midnight. The most accurately timed events occurred in the pre to just post midnight regions. Surface charging/discharging suspected to have caused erroneous attitude data from earth sensors				
References:	JFF8				

Name:	NATO 3C				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Dec 1986 to Sep 1987				
Description:	Five attitude control anomalies				
Diagnosis:	ESD Internal			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	None				
References:	RSS7				

Name:	NIMBUS 7				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	After Oct 1978				
Description:					
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	High energy particles caused electrical component damage ??				
References:	RSS54				

Name:	NOAA 10				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	13 Mar 89				
Description:	Excessive x-axis gyro speed after magnetic moment unloading causing the roll/yaw coil to switch to backup mode				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	High Solar activity				
References:	RSS49				

Name:	NOAA 10				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	1 Oct 89				
Description:	The SCU 28 volt switch power indicated an 'on' reading				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	Command line glitch or solar influence				
References:	RSS49				

Name:	NOAA 11				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	11-20 March 1989				
Description:	??				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	Anomalies occur within trapped radiation regions				
References:	HCK33				

Name:	NOAA 11				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	10 April 1990				
Description:	Experienced pitch reaction wheel glitches. Usual process of transferring spin to the momentum wheel was reversed and the wheel 'spun-up' the satellite				
Diagnosis:	Magnetic Field Variability			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	Major magnetic storm on 10-11 April 1990				
References:	HCK33				

Name:	NOAA 11				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	22-24 March 1991				
Description:	Loss of automatic attitude control				
Diagnosis:	Solar Proton Event			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	Command line glitch or solar influence ??				
References:	HCK15, JHA 20				

Name:	NOAA 7				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	After Jun 1981				
Description:	Magnetic coil unloadings were not completely effective				
Diagnosis:	Higher than expected torque from solar press			**Sure:**	0
Impact:	Unknown			**Duration**	1 hr to 1 day
Category:	Degraded Performanc				
Comments:	None				
References:	RSS38				

Name:	NOAA 8				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	July 1984 ?				
Description:	sudden failure				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Loss of S/C			**Duration**	Unknown
Category:	Mission Loss				
Comments:	Computer problems that became acute early on 12 June 1984-JHA				
References:	JEM9				

Name:	NOAA 9				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Mar 89				
Description:	Unusual momentum wheel activity that resulted in roll/yaw coil switching to its backup mode. Proper attitude control was maintained through the event				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	High Solar Activity				
References:	RSS49				

Name:	NOAA-? Three satellites				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Mar 89				
Description:	Had trouble unloading torque due to the large ambient magnetic field charges in orbit				
Diagnosis:	Magnetic Field Variability			**Sure:**	2
Impact:	Unknown			**Duration**	1 hr to 1 day
Category:	Degraded Performanc				
Comments:	Great Magnetic Storm				
References:	JHA15				

Name:	NOAA-10				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	29-30 Sept 1989				
Description:	Phantom Command				
Diagnosis:	Solar Proton Event			**Sure:**	3
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	Rare 'Phantom Command'				
References:	HCK33, JHA20				

Name:	Olympus				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	11-12 August 1993				
Description:	Service interrupted, began to spin slowly				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Satellite retired from service because it was low on fuel for attitude control and station keeping			**Duration**	Mission loss
Category:	Mission Loss				
Comments:	At the time of the Perseid meteor shower				
References:	JEM10				

Name:	ROSAT				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	26 January 1991				
Description:	CPU for attitude control had an upset				
Diagnosis:	SEU			**Sure:**	1
Impact:	Lost control for 14 hours			**Duration**	1 hr to 1 day
Category:	Upset				
Comments:	(Roentgen Satellite)				
References:	JHA 13				

Name:	SAMPEX				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	20 JULY 1992-present				
Description:	Dual high voltage supplies in LICA instrument move to maximum ~4KV output level while control voltages remain nominal; most likely to occur in auroral zone & while S/C is at 0-8 local time				
Diagnosis:	ESD Surface			**Sure:**	2
Impact:	Premature aging of micro-channel plates due to hv spikes. Instrument off-line for ~3 months in 1992 during anomaly investigation. Instrument powered off 15 min/day from on-board HV monitor. Lost ~5% of science data from this instrument			**Duration**	More than 1 wk
Category:	Degraded Performanc				
Comments:	Correlation with s/c shadowing and auroral zone precipitation suggest surface charging plays a role in the anomaly				
References:	JEM11				

Name:	SBS 1				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	After 1981				
Description:	Hundreds of events over an eight year period affecting the attitude control system				
Diagnosis:	ESD			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Phantom commands				
Comments:	(Satellite Business Systems telecommunications satellite)				
References:	RSS7				

Name:	SCATHA				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	After 1981				
Description:	Hundreds of events over an eight year period affecting the attitude control system				
Diagnosis:	ESD Surface			**Sure:**	1
Impact:	Minimal			**Duration**	Minimal
Category:	Phantom commands				
Comments:	(Spacecraft Charging at High Altitude satellite, P78-2)				
References:	RSS7				

Name:	SCATHA (Spacecraft Charging at High Altit				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	22 Sep 1982				
Description:	A filter change of state in one of the magnetic field monitors, timing errors in the Plasma Wave Analyzer				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	A 2-minute loss of data			**Duration**	Less than 10 min
Category:	Phantom commands				
Comments:	A particularly large number of arcing events				
References:	RSS22				

Name:	SEDS-2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	14 Mar 1994				
Description:	20 km tether was severed				
Diagnosis:	Impact-Micrometeoroid			**Sure:**	2
Impact:	Experiment ended prematurely			**Duration**	Mission loss
Category:	Mission Loss				
Comments:	(Small Expendable Deploy Satellite)				
References:	RSS62				

Name:	Skylab				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	11 Jul 1979				
Description:	Prematurely re-entered the Earth's atmosphere				
Diagnosis:	Atmospheric drag			**Sure:**	2
Impact:	None			**Duration**	More than 1 wk
Category:	Other				
Comments:	None				
References:	RSS41				

Name:	Skynet 2B				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	1975 to 1976				
Description:	Anomalies in timing circuits of the telemetry and command subsystem. 300 were investigated				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	(UK defense communications satellite)				
References:	RSS30				

Name:	SMM				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	After Feb 1980				
Description:	The C Gyro failed				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Control was regained and the B Gyro was used			**Duration**	1 day to 1 wk
Category:	Random Part Failure				
Comments:	Transient radiation susceptibility of complementary MOS semi-conductors in the electronics. (Solar Maximum Mission)				
References:	RSS38				

Name:	SMM				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	1985				
Description:	Anomaly in the onboard computer placed the spacecraft in 'safe hold' condition				
Diagnosis:	SEU			**Sure:**	0
Impact:	Science data interrupted for 8 days			**Duration**	More than 1 wk
Category:	Upset				
Comments:	(Solar Maximum Mission)				
References:	RSS57				

Name:	SMM				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Jan 1986				
Description:	Some 'safe holds' during spacecraft operation due to problems in the on board computer				
Diagnosis:	SEU-Cosmic Ray			**Sure:**	0
Impact:	8K of memory (out of 48K total) was lost. Loss of data during safe hold recovery			**Duration**	More than 1 wk
Category:	Random Part Failure				
Comments:	(Solar Maximum Mission)				
References:	RSS58				

Name:	Solar-A				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	After Aug 1991				
Description:	0.05 mm hole in the thin film membrane covering the optical system				
Diagnosis:	Impact-Micrometeoroid			**Sure:**	0
Impact:	Loss of the visual portion of the telescope			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	(Yohkoh)				
References:	RSS63				

Name:	SPOT-3				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	10 Jan 95				
Description:	Transmitter / Downlink problems				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	Spacecraft within the heart of the South Atlantic Anomaly				
References:	SWS1				

Name:	STRV 1A				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	June 1994				
Description:	Background increases in MCP detectors				
Diagnosis:	Energetic electrons			**Sure:**	0
Impact:	Unknown			**Duration**	More than 1 wk
Category:	Degraded Performanc				
Comments:	None				
References:	JEM5				

Name:	STS-45				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	Mar 1992				
Description:	The space shuttle Atlantis suffered two gouges (1.9x1.6 in. and 0.4x1 in.) on the upper portion of the right wing leading edge				
Diagnosis:	Impact-Micrometeoroid			**Sure:**	3
Impact:	None			**Duration**	Minimal
Category:	Other				
Comments:	Low relative velocity debris impact on-orbit or during re-entry, or prelaunch or ascent debris. Raised concern about the consequences of a higher energy impact to the integrity of the space craft				
References:	RSS64				

Name:	STS-49				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	May 1992				
Description:	Chip in upper right hand corner of the thermal window pane				
Diagnosis:	Impact-Debris or Micrometeoroid			**Sure:**	0
Impact:	Unknown			**Duration**	Minimal
Category:	Other				
Comments:	Impact occurring on or around flight day 8				
References:	RSS34				

Name:	STS-61				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	6 Dec 1993				
Description:	Star tracker failed				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	0
Impact:	Following a power cycle the star tracker passed a self test and functioned nominally for the rest of the mission The Y star tracker failed to acquire navigation stars for approximately 5 hours			**Duration**	1 day to 1 wk
Category:	System Failure				
Comments:	Single event upset in the South Atlantic Anomaly. The high altitude flown on STS-61 resulted in increased radiation exposure				
References:	RSS43				

Name:	Symphonie A				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	After Nov 1974				
Description:	History of non-critical anomalies (i.e. modulation losses and logic upsets)				
Diagnosis:	ESD Surface			**Sure:**	2
Impact:	A reset command is sent from the control center if necessary			**Duration**	10 min to 1 hr
Category:	Upset				
Comments:	(French-German experimental communications satellite)				
References:	RSS29				

Name:	Symphonie B				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	After Aug 1975				
Description:	History of non-critical anomalies (i.e. modulation losses and logic upsets)				
Diagnosis:	ESD Surface			**Sure:**	2
Impact:	A reset command is sent from the control center if necessary			**Duration**	10 min to 1 hr
Category:	Upset				
Comments:	(French-German experimental communications satellite)				
References:	RSS29				

Name:	TDRS 1				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	1984-1990				
Description:	Anomalous responses in the Attitude Control System (ARCS) traced to state changes in the Random Access Memory (RAM) in the ACS				
Diagnosis:	SEU-Cosmic Ray			**Sure:**	0
Impact:	Ground control was required to maintain the satellite's proper attitude. Had to change TDRS 2 parts before launch			**Duration**	More than 1 wk
Category:	Degraded Performanc				
Comments:	Same chip used in HST				
References:	RSS53, JHA23				

Name:	TDRS 1				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	1984 to 1990				
Description:	Anomalous responses in the Attitude Control System (ACS) traced to state changes in the Random Access Memory (RAM) in the ACS				
Diagnosis:	SEU-Cosmic Ray			**Sure:**	3
Impact:	Ground control was required to maintain the satellite's proper attitude. Prompted changes in the ACS design of future TDRS missions			**Duration**	More than 1 wk
Category:	Degraded Performanc				
Comments:	None				
References:	RSS53				

Name:	TDRS 1				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	1984-1990				
Description:	Anomalous responses in the Attitude Control System (ARCS) traced to state changes in the Random Access Memory (RAM) in the ACS				
Diagnosis:	SEU-Cosmic Ray			**Sure:**	0
Impact:	Temporary loss of attitude control			**Duration**	More than 1 wk
Category:	Degraded Performanc				
Comments:	None				
References:	RSS49				

Name:	TDRS 2				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	19-29 October 1989				
Description:	SEUs				
Diagnosis:	SEU-Solar Proton Event			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	'Even the hardened TDRS-2 and -3 experienced SEUs'				
References:	HCK33				

Name:	TDRS 3				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	19-29 October 1989				
Description:	SEUs				
Diagnosis:	SEU-Solar Proton Event			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	'Even the hardened TDRS-2 and -3 experienced SEUs'				
References:	HCK33				

Name:	TDRS 4				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	8 May 1989				
Description:	Earth Sensor Assembly (ESA) roll output alarm				
Diagnosis:	SEU-Solar Proton Event			**Sure:**	0
Impact:	Temporary loss of attitude control			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	None				
References:	RSS49				

Name:	TDRS 4				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	1 Aug 1993				
Description:	Erratic ACS data and the spacecraft slowly started to diverge from Earth pointing				
Diagnosis:	SEU			**Sure:**	2
Impact:	User services out for 8 hours before CTE and CPE units re-enabled			**Duration**	1 hr to 1 day
Category:	Upset				
Comments:	None				
References:	RSS33				

Name:	TDRS 4				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	26 Aug 1993				
Description:	An Earth sensor assembly roll and pitch 'glitch' lasted 2 seconds causing ESA ' 'fail-safe' to occur				
Diagnosis:	SEU			**Sure:**	0
Impact:	Reaction wheels run down to zero, re-enabled by ground command, S/C recovery in 5 minutes			**Duration**	Less than 10 min
Category:	Upset				
Comments:	None				
References:	RSS33				

Name:	TDRS 5				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	10 Aug 1991				
Description:	A control sensor parameter momentarily exceeded its caution limit				
Diagnosis:	SEU			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	None				
References:	RSS44				

Name:	TDRS 5				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	12 Dec 93				
Description:	Normal mode outputs from the Control Processing Electronics (CPE) went into a disabled state, with numerous attitude control system (ACS) parameters out of limits. S/C started to lose its attitude reference				
Diagnosis:	SEU			**Sure:**	0
Impact:	CPE re-initialized and reloaded. no loss of user data			**Duration**	Minimal
Category:	Upset				
Comments:	None				
References:	RSS33				

Name:	TDRS 6				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	10 Jul 93				
Description:	Earth Sensor Assembly A Pitch Channel output cautioned at 0/.3199 deg for one update period				
Diagnosis:	SEU			**Sure:**	1
Impact:	None			**Duration**	Minimal
Category:	Upset				
Comments:	Single Event Upset in the Command and Telemetry electronics (CTE) buffer. Self-healing				
References:	RSS33				

Name:	TDRS 6				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	4 Jun 1994				
Description:	Control processor initialized itself, causing attitude divergence				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	Loss of data until reinitialized			**Duration**	Unknown
Category:	Upset				
Comments:	Control processing electronics reinitialized from ground station				
References:	RSS68				

Name:	TDRS-1				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	1 Apr 1992				
Description:	The Control Processing Electronics stopped running due to CPE/CTE sync failure				
Diagnosis:	SEU-Cosmic Ray			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	System Failure				
Comments:	None				
References:	RSS54				

Name:	TDRS-1				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	2 Nov 1989				
Description:	Upset in command processor electronics				
Diagnosis:	SEU-Cosmic Ray			**Sure:**	0
Impact:	Temporary loss of attitude control			**Duration**	Unknown
Category:	Upset				
Comments:	None				
References:	RSS49				

Name:	TDRS-1				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	19-20 October 1989				
Description:	50 SEUs in radiation susceptible memory chips				
Diagnosis:	SEU-Solar Proton Event			**Sure:**	3
Impact:	Unknown			**Duration**	1 day to 1 wk
Category:	Degraded Performanc				
Comments:	Unhardened RAM				
References:	HCK33				

Name:	TDRS-7				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	6 Dec 1995				
Description:	Loss of attitude control				
Diagnosis:	SEU-Cosmic Ray			**Sure:**	0
Impact:	Unknown			**Duration**	1 hr to 1 day
Category:	Upset				
Comments:	SEU in the control processing or command and telemetry electronics. An emergency RAM reload did not help and the S/C started to pitch and tumble very quickly as the reaction wheel speeds started dropping				
References:	RS69				

Name:	TDRSS				
Commercial:	☐	**NASA/NOAA:**	☑	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	After April 1983				
Description:	Arcing anomalies in several different subsystems over their operating lifetimes, most seriously in the attitude control system processor electronics				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	Rapid manual intervention was required to prevent loss of control of the satellites			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	None				
References:	RSS16, RSS17				

Name:	Telecom 1A				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	After 4 Aug 1984				
Description:	Interrupted data transmissions				
Diagnosis:	ESD			**Sure:**	0
Impact:	Mission Loss			**Duration**	Mission loss
Category:	Mission Loss				
Comments:	Was removed from service and used as a backup				
References:	RSS10, RSS14				

Name:	Telecom 1A				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	Various				
Description:	Switch-off problems in its Syracuse [military communications] payload				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	Intermittent loss of communications			**Duration**	1 hr to 1 day
Category:	Degraded Performanc				
Comments:	Electrostatic charge buildup on the satellite's thermal shielding related to an underground metalized dielectric covering that was added at the last minute to cover a fiberglass area of the satellite				
References:	HCK31				

Name:	Telecom 1B				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	15 January 1988				
Description:	Suffered a failure of both its normal and backup attitude control systems				
Diagnosis:	ESD Surface			**Sure:**	2
Impact:	Mission Loss. Relay traffic switched to Telecom 1A. Two of three French TV channels were switched to Telecom 1A			**Duration**	Mission loss
Category:	Mission Loss				
Comments:	Electrostatic discharges coupling with exposed electrical wiring. At the time of the loss it was the prime platform for the Syracuse military communications relay which was switched to Telecom 1A. Severe magnetic storm on 15 January 1988 with peak Kp of 7.3				
References:	HCK31, RSS10				

Name:	Telstar 401				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	9 Oct 1994				
Description:	Satellite stabilization briefly lost				
Diagnosis:	ESD Surface			**Sure:**	0
Impact:	1-hour disruption in service			**Duration**	1 hr to 1 day
Category:	Phantom commands				
Comments:	None				
References:	RSS1				

Name:	TEMPO				
Commercial:	☑	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	3/25/97				
Description:	Loss of 2.7 A of Solar Array Current multiple times				
Diagnosis:	ESD Surface			**Sure:**	3
Impact:	The problems will result in reduced power toward the end of the satellites projected lifetime			**Duration**	More than 1 wk
Category:	Solar Array Degradati				
Comments:	The anomalies on 4/11/97 occurred during a large magnetic storm				
References:	HCK7, HCK8				

Name:	TOPEX				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	7 NOV 1993				
Description:	Failure of the ASTRA 1B star tracker				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	None				
References:	JEM12				

Name:	TOPEX				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	7 Nov 1993				
Description:	ASTRA 1A TEC off				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	None				
References:	JEM12				

Name:	TOPEX				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	13 May 1994				
Description:	EU anomaly				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	None				
References:	JEM12				

Name:	TOPEX				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	25 May 1994				
Description:	ASTRA 1B star tracker flatline				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	None				
References:	JEM12				

Name:	TOPEX				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	4 June 1994				
Description:	RIU 6A anomaly				
Diagnosis:	ESD Internal			**Sure:**	1
Impact:	Unknown			**Duration**	Unknown
Category:	Unknown				
Comments:	None				
References:	JEM12				

Name:	Unknown				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	6 October 1981				
Description:	Premature ignition of a random number of ordnance devices caused subsequent damage to payload during BECO, SECO, MECO1 and MECO2. There was shorting of numerous circuits				
Diagnosis:	Triboelectric charging of PLF			**Sure:**	2
Impact:	Damage to solar arrays and payload			**Duration**	More than 1 wk
Category:	Other				
Comments:	Charging of fairing surfaces during accent with discharges onto payload causing circuit shorts and premature ordnance ignition on faring and payload. No direct evidence but scenario could explain the fact that damage did occur to antenna, array and payload with several circuits shorted				
References:	JFF1				

Name:	Unknown or Classified				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	Multiple-Dates unknown				
Description:	Loss of link and noisy data				
Diagnosis:	Plasma Effects-Multipaction			**Sure:**	3
Impact:	Cause loss of data and useless noisy data. Duration of losses were unpredictable but could last minutes. There were many occurrences. Result was degraded system performance. Design was changed to eliminate problem for follow-on satellites			**Duration**	10 min to 1 hr
Category:	Degraded Performanc				
Comments:	Multipaction in classic parallel plate high voltage capacitor in T/M subsystem. Multipaction onset cause by environmental radiation generating free electrons inside the capacitor. Multipaction was duplicated on the ground using a radioactive source to initiate the process.				
References:	JFF9				

Name:	Unknown or Classified				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	Multiple in 1980				
Description:	'Broadband dropout'				
Diagnosis:	Plasma Effects-Breakdown			**Sure:**	2
Impact:	Loss of data during dropouts. Operational workaround required. Vents were redesigned to fix problem on later S/C			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	Ion ingestion caused sputtering of High Voltage terminals and subsequent breakdown with loss of output from TWTs. Subsequent operations were designed to minimize ram ion ingestion with good success. References discuss problem and not actual anomaly				
References:	JFF5, JFF6, JFF7				

Name:	Unknown spacecraft				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	6, 8, 9, 14th Mar 89				
Description:	Episodes of uncontrolled tumbling				
Diagnosis:	Unknown			**Sure:**	0
Impact:	Interfered with operational functions			**Duration**	Unknown
Category:	Unknown				
Comments:	Great Storm Period				
References:	JHA15				

Name:	Unknown. Identified as F3				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	8-10 September 1982				
Description:	Telemetry anomalies near perigee on 4 occasions				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	Report covers multiple satellites in the same HEO orbit with 'telemetry' anomalies. Same as Unknowns F2 and F4. Multiple satellites had anomalies on same days				
References:	JFF3				

Name:	Unknown. Identified as F4				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	8-10 September 1982				
Description:	Telemetry anomalies on 3 occasions				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	Report covers multiple satellites in the same HEO orbit with 'telemetry' anomalies. Same as Unknowns F2 and F3. Multiple satellites had anomalies on same days				
References:	JFF3				

Name:	Unknown. or Classified Identified as F2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☑	**Foreign:**	☐
Dates:	10 September 1982				
Description:	Telemetry anomalies near perigee				
Diagnosis:	ESD Internal			**Sure:**	2
Impact:	Unknown			**Duration**	Unknown
Category:	Spurious Signal				
Comments:	Report covers multiple satellites in the same HEO orbit with 'telemetry' anomalies. Same as Unknowns F3 and F4. Multiple satellites had anomalies on same days				
References:	JFF3				

Name:	UOSAT 2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	After Feb 1984				
Description:	Upsets in large dynamic NMOS and static CMOS memories				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	3
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	Upsets in large dynamic NMOS and static CMOS memories, strongly localized to the South Atlantic region				
References:	RSS52				

Name:	UOSAT 2				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☑
Dates:	19-29 October 1989				
Description:	Many SEUs particularly in the South Atlantic Anomaly Region				
Diagnosis:	SEU-South Atlantic Anomaly			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Upset				
Comments:	None				
References:	HCK33				

Name:	Vehicle 4487				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☐
DoD:	☑	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	08 Aug 95				
Description:	Redundant attitude control system (ACS) failed to acquire the sun				
Diagnosis:	ESD			**Sure:**	2
Impact:	Unknown			**Duration**	More than 1 wk
Category:	System Failure				
Comments:	None				
References:	SWS1				

Name:	Viking Lander 1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	After Aug 1975				
Description:	Variations in Gas Chromatograph Mass Spectrometer Ion Pump current				
Diagnosis:	ESD			**Sure:**	0
Impact:	Operations with a degrading high voltage source			**Duration**	More than 1 wk
Category:	Degraded Performanc				
Comments:	Arcing/corona				
References:	RSS28				

Name:	Voyager 1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	1979				
Description:	An on-board clock lost 8 seconds due to 40 spurious power-on reset signals				
Diagnosis:	ESD			**Sure:**	0
Impact:	Unknown			**Duration**	Unknown
Category:	Degraded Performanc				
Comments:	Jovian Radiation				
References:	RSS38				

Name:	Voyager 1				
Commercial:	☐	**NASA/NOAA:**	☐	**Scientific:**	☑
DoD:	☐	**Classified/Other:**	☐	**Foreign:**	☐
Dates:	After Sep 1977				
Description:	Star tracker number 2 could not be commanded into cone angle settings 2, 4, or 5				
Diagnosis:	Radiation Damage			**Sure:**	0
Impact:	Unknown			**Duration**	More than 1 wk
Category:	Random Part Failure				
Comments:	Transistor leakage caused by 2 or more Delrin insulating sleeves decomposing due to high intensity radiation				
References:	RSS38				

Appendix B

Space Environment Impact Database References

DCW2 Table of spacecraft anomalies by contractor, private communication, D. C. Wilkinson, NOAA, NGDC, Boulder, CO, 22 January 1998.

DCW3 Ltr from R. Ashiya, INSAT-1 Space Segment Project Branch Office, Palo Alto, CA to D. Wilkinson, NOAA, NGDC, Boulder, CO, 27 September 1984.

DCW4 List of Anomaly in GMS-3, Letter from I. Kubota, Meteorological Satellite Center, Tokyo, Japan, to J. H. Allen, NOAA, NGDC, Boulder, CO, 15 August 1985.

DCW5 Spacecraft Anomaly Database, FAX from David E. B. Wilkins, ESOC to J. H. Allen and D. C. Wilkinson, NOAA, NGDC, Boulder, CO, 2 August 1985.

DCW6 Response to Workshop Letter, memo from J. Allen to D. Wilkinson, NOAA, NGDC, Boulder, CO, 28 June 1985.

DCW7 Ltr from P. N. Wadham, Manager, Satellite Engineering Group, Telesat, Canada to J. H. Allen, NOAA, NGDC, Boulder CO, 20 April 1989.

DCW8 P. N. Wadham, The Effects of Electrostatic Discharge Phenomena on Telesat's Domestic Communications Satellites, paper presented at the NATO/AGARD meeting in The Hague, Holland, June 1986.

DCW9 Ltr from P. N. Wadham, Manager, Satellite Engineering Group, Telesat, Canada to J. H. Allen and D. C. Wilkinson, NOAA, Boulder, CO, 26 June 1986.

DCW10 Satellite Failure Listing - Faillist7, private communication, D. C. Wilkinson, NOAA, NGDC, Boulder, CO, 22 January 1998 (Telesat Restricted).

DCW11 Satellite Anomalies, E-mail msg from D. Wilkins, ESOC, ESA to J. H. Allen, NOAA, NGDC, Boulder CO, 3 April 1989.

DCW12 Satellite Switching Events (ESD), Ltr from D. E. B. Wilkins, ESOC, to J. H. Allen, NOAA, NGDC, Boulder CO, 11 November, 1986.

DCW13 D. J. Rodgers, Correlation of Meteosat-3 Anomalies with Data from the Spacecraft Environment Monitor, Internal ESTEC Working Paper No. 1620, June 1991.

DCW14 David. E. B. Wilkins, Electro-Static Discharge (ESD) Effects at Geostationary Altitudes, Case studies of ESD on two geostationary satellites, preprint, 10 April 1986.

DCW15 Message from D. Wilkinson to J. Allen, 10 December 1985.

DCW16 Letter from Enbrael (sp ??) to D. Wilkinson, 20 December 1990.

HCK1 DSCS HESSA Anomalies and the Space Environment, Interoffice Correspondence from M. Chen to B. Ferro, The Aerospace Corporation, 1 July 1997.

HCK2 DSCS HESSA Anomalies, Executive Summary, presentation by F. J. Agardy, The Aerospace Corporation, 2 December 1996.

HCK3 FAX from S. Kaminski to H. Koons and M. Chen, The Aerospace Corporation, 5 May 1996.

HCK4 Evaluation of Space Radiation Sources/Effects Causing the Separate, Single Anomalies Observed in the DSCS III B4 and B9 Spacecraft, Martin Marietta Astro Space, Program Information Request/Release, U-1GJ2-DSCS-OSF-138, 11 July 1994.

HCK5 Comments on MMA Analysis of DSCS III Anomalies, Interoffice Correspondence from H. Koons to Craig Smith, The Aerospace Corporation, 10 October 1994.

HCK6 DSCS III On-Orbit Events, FAX from Craig Smith to H. Koons, The Aerospace Corporation, 15 November 1994.

HCK7 Preliminary Assessment of TEMPO Anomalies, Interoffice Correspondence from H. Koons to G. Paulikas, The Aerospace Corporation, 13 May 1997.

HCK8 Toshiba Wins Loral Deal, Space News, 8(45), 24-30 November 1997, p.3.

HCK9 Recent Satellite Anomaly and Space Weather Conditions, J. H. Allen, in Interim International STEP Newsletter, 1(3), June 1996, p.2..

HCK10 Current Satellite Anomalies, Memorandum from Joe. H. Allen to Dr. Michael A. Chinnery, NOAA, NGDC, 21 January 1994.

HCK11 Chronology of Recent Geostationary Satellite Anomalies, Memorandum from J. H. Allen to file, NOAA, NGDC, 24 January 1994.

HCK12 Spacecraft Charging and ESD: A possible cause for Anik failures, Interoffice Correspondence from R. Briet to distribution, 26 January 1994.

HCK13 Canadian Satellite failure pinned on storm; Intelsat probes link, Article: 17292, 25 January 1994.

HCK14 Control System Failure on Anik E2, Telesat Canada News Bulletin, 20 January 1994.

HCK15 Spacecraft Problems in Association with Episodes of Intense Solar Activity and Related Terrestrial Phenomena During March 1991, M. A. Shea et al., *IEEE Trans. On Nuclear Sci.,* 39(6), 1754, 1992.

HCK16 Two Satellites Are Crippled By Disturbance, Wall Street Journal, 24 January 1994.

HCK17 SAMPEX Measurements of the Magnetospheric Charged-Particle Environment During the ANIK E and Intelsat K Operational Anomalies, D. N. Baker et al, preprint FAXed by M. Lauriente to H. Koons, 23 March 1994.

HCK18 Implications of the Jan 94 Failures of the Telesat Canada Anik E1 and E2 Reaction Wheels to Assessment of ECEMP Hardness of Honeywell Reaction Wheel Assemblies, Report G049536, [author and organization not mentioned], 15 February 1994.

HCK19 Vehicle Anomalies, J. B. Blake, Aerospace Technical Memorandum ATM-83(3940-05)-1, The Aerospace Corporation, 22 November 1982.

HCK20 Report on the MARECS A In Flight Anomalies, Investigations and Recommended Modifications for MARECS B and ECS, Report TP 7962, British Aerospace Public Limited Company, June 1982 (Proprietary – For Official Use Only)

HCK21 CRRES Telemetry Anomalies, letter from Capt. John B. Dowden to Distribution, Dept. of the Air Force, Space Test and Transportation Office, Los Angeles AFB, 1 June 1991.

HCK22 Recent Anomalies, Consolidated Satellite Test Center FAX from Dale Petersen to H. Koons, 11 April 1991.

HCK23 All Systems Go Aboard Anik E1, Telesat Canada News Bulletin, 20 January 1994.

HCK24 Twin Failures Bewilder Anik Duo's Technicians, Space News, 24-30 January 1994, p.2.

HCK25 Distribution of GOES Anomalies, FAX from M. Lauriente, NASA GSFC, to H. Koons, 6 December 1993.

HCK26 Clock Frequency-Shift-Anomalies and the Natural Radiation Environment, J. B. Blake, Aerospace Technical Memorandum ATM-79(4472-01)-6, The Aerospace Corporation, 10 January 1979.

HCK27 Assessment of the 13 June 1980 Anomaly Using SCATHA Orbital Data, A. L. Vampola, Aerospace Technical Memorandum ATM-81(6472-05)-2, The Aerospace Corporation, 24 October 1980

HCK28 GPS Anomaly Meeting, Interoffice Correspondence from A. L. Vampola to R. Broussard, The Aerospace Corporation, 30 September 1980.

HCK29 DR 511-065 ± Solar Array Wing Hold Report, Rockwell internal report, 1980 (received as attachment to HCK28)

HCK30 Expert System Diagnosis of NOAA 13 Anomaly, letter from H. C. Koons, The Aerospace Corporation, to Michael Lauriente, NASA GSFC, 23 March 1994.

HCK31 Attitude Control Lost On France's Telecom 1B, Aviation Week & Space Technology, 25 January 1988, p. 30.

HCK32 Spacecraft Charging Quick Reaction Study Final Report, TRW Inc. Electronics & Defense Sector, July 1987.

HCK33 Solar-Terrestrial Activity Affecting Systems in Space and on Earth, J. H. Allen and D. C. Wilkinson, in Solar-Terrestrial Predictions - IV, Proceedings of a Workshop at Ottawa, Canada, May 18-22, 1992, NOAA, Environmental Research Laboratories, Boulder, CO, September 1993.

HCK34 Paul Vaughan, private communication, 16 January 1998.

HCK35 Harry Koons, personal knowledge, 6 February 1998.

JEM1 ADEOS shutdown on 24 September 1996, E-mail msg from F. Eden to J. H. Allen, NOAA, NGDC, Boulder, CO, 2 October 1996.

JEM2 Description of modified ALEXIS satellite attitude control, FAX from Lt. Col. Glenn Kweder, Defense Nuclear Agency, to J. H. Allen, NOAA, NGDC, Boulder, CO, 7 February 1994.

JEM3 Description of bit flip on AUSSAT-K1, E-mail msg from D. C. Wilkinson, NOAA, NGDC, Boulder, CO, to J. H. Allen, NOAA, NGDC, Boulder, CO, 10 December 1985.

JEM4 Brasilsat A1 & A2 anomaly list, ltr from J. A. Rocha, EMBRATEL, to D. C. Wilkinson, NOAA, NGDC, Boulder, CO, 20 December 1990.

JEM5 G. L. Wrenn & A. J. Sims, Internal charging in the outer zone and operational anomalies, Radiation Belts: Models and Standards, Geophys. Monograph 97, 275-278, 1996.

JEM6 GOES-8 anomaly assessment, FAX from K. D. Scro, Air Force Space Forecast Center, Falcon AFB, CO, to J. H. Allen, NOAA, NGDC, Boulder, CO, 17 May 1994.

JEM7 M. Shimodaira & H. Yamada, Anomalies of Japanese satellites observed in space environment, preprint.

JEM8 Intelsat anomaly log for August 1993, FAX from A. Dunnet, INTELSAT, to J. H. Allen, NOAA, NGDC, Boulder, CO, 7 February 1994.

JEM9 B. Littin, America's weather birds...their care and feeding, NOAA magazine, 15, 9-12, December 1995.

JEM10 Olympus satellite service interruption, FAX from L. Lanzerotti, AT&T Bell Labs, to J. H. Allen, NOAA, NGDC, Boulder, CO, 7 February 1994.

JEM11 P. H. Walpole, G. M. Mason, J. E. Mazur, D. J. Mabry, J. E. Stephens, R. Whitley, & D. C. Welch, High voltage power supply anomalies on the SAMPEX/LICA instrument associated with geomagnetic activity, Trans. Am. Geophys. U. 76 (Suppl.), F433, 1995.

JEM12 TOPEX satellite events, presentation at 13th SAMPEX team meeting by D. N. Baker, U. Colorado, 5 February 1996.

JEM13 ISEE-1 ULEWAT gas pressure failure, E-mail msg from B. Klecker, Max Planck Institute for Extraterrestrial Physics, to J. E. Mazur, Aerospace Corp., 12 January 1998.

JEM14 Investigation panel releases report on NOAA-13 failure, NASA press release 94-157, 20 September 1994.

JEM15 INTELSAT 511 thruster firing anomaly, Interim International STEP Newsletter, 1, November 1995.

JFF1 Gageby, J, Premature Ordnance Ignition, Failure investigation notes, October 6, 1981

JFF2 Mizera, P F, Meteosat Electrostatic Discharges, Aerospace, IOC to A L Vampola, September 20, 1982.

JFF3 Blake, J B, Vehicle Anomalies, ATM 83(3940-05)-1, November 22, 1982.

JFF4 Blake, J B, On the correlation between GPS clock frequency-shift-anomalies and the natural radiation environment, Aerospace ATM 79(4472-01)-6, January 10, 1979.

JFF5 Fennell, J F, Ion Currents Into Apertures, Aerospace ATM 81(6960-05)-6, March 31, 1981.

JFF6 Fennell, J F, and J B Blake, Vehicle Potentials and Ion Collection, Aerospace ATM 81(6960-05)-3.

JFF7 Kayser, D C, Calculations of Vehicle Wake Ion Densities and Currents, Aerospace ATM 81(6960-04)-3, April 3, 1981.

JFF8 Fennell, J F, Spacecraft Charging - NATO III Briefing, summer 1978

JFF9 Fennell, J F, personal experience, no report available.

JHA1 Satellite anomalies, etc., E-mail from D. Gorney, The Aerospace Corporation, El Segundo, CA to J. H. Allen, NOAA, NGDC, Boulder, CO, 8 April 1991.

JHA2 Satellite anomaly report from Japan, E-mail from Toyohisa Kamei, Kyoto Univ., Japan to J. H. Allen, NOAA, NGDC, Boulder, CO, 11 April 1991

JHA3 Satellite anomalies, etc., E-mail from D. Gorney, The Aerospace Corporation, El Segundo, CA to J. H. Allen, NOAA, NGDC, Boulder, CO, 13 April 1991

JHA4 Satellite anomaly report from Japan, E-mail from Toyohisa Kamei, Kyoto Univ., Japan to J. H. Allen, NOAA, NGDC, Boulder, CO, 13 April 1991

JHA5 Re: Iridium #11 problem, E-mail from J. H. Allen, NOAA, NGDC, Boulder, CO, to Glenn Kweder, 5 December 1997.

JHA6 RE: New List for SCOSTEP/JHA, E-mail from Y. Kamide, Nogoya Univ., Japan to to J. H. Allen, NOAA, NGDC, Boulder, CO, 15 November 1997.

JHA8 New List for SCOSTEP/JHA, E-mail from J. H. Allen, NOAA, NGDC, Boulder, CO to Distribution, 14 November 1997.

JHA9 D. N. Baker et, al., An Assessment of Space Environmental Conditions During the Recent Anik E1 Spacecraft Operational Failure, in NASA ISTP Newsletter, Vol. 6 No. 2, June 1996.

JHA10 Ltr from J. H. Allen, NOAA, NGDC, Boulder, CO to Gordon Wrenn, Space Department, DRA Farnborough, England, 4 March 1997.

JHA11 H.-L. Lam and J. Hruska, Magnetic Signatures of Satellite Anomalies, J. Spacecraft and Rockets, 28, 93-99, January-February 1991.

JHA15 J. Allen, Herb Sauer, Lou Frank, and P. Reiff, Effects of the March 1989 Solar Activity, preprint of EOS article from J. Allen, 21 January 1998.

JHA16 Location of INTELSAT satellites during March 1996, FAX from A. Dunnet to J. Allen, 12 April 1996.

JHA20 Solar-Terrestrial Event Impacts in Space and at Earth, presentation to the Committee on Solar-Terrestrial Research (CSTR) Committee on Solar & Space Physics (CSSP) by J. H. Allen, NOAA, NGDC, Boulder, CO to Distribution, 16 February 1994.

JHA21 M. Lauriente and A. L. Vampola, Spacecraft Anomalies due to Radiation Environment in Space, presented at the NASDA/JAERI 2nd International

Workshop on Radiation Effects of Semiconductor Devices for Space Applications, Tokyo, Japan, 21 March 1996.

JHA22 Comments on Space News article on ADEOS safe hold, e-mail from Frank Eden to Joe Allen 2 December 1996.

JHA23 J. H. Allen, private communication, 21 Jan 1998.

JLR1 System Operability Update, Review and Characteristics Evaluation (SOURCE) Program Printouts, M. J. Engle, Aerospace Corporation Report No. TOR-0089 (44-9-30)-1, Anomaly 1017, TRW Letter 35.83-404.

JLR 2 SOURCE Document Anomaly 1012, Summary Sheet.

JLR3 SOURCE Document Anomaly 2020, Letter 3121:9153 from F. L. Davis to Brig. Gen. H. Estes on 6 March 1975.

JLR4 SOURCE Document Anomaly 2022, IOC E. F. Martina to Distribution on 28 Feb 1978.

JLR5 SOURCE Document Anomaly 3014, TRW Letter 35.83-385 from E. Noneman to Brig. Gen. H. Estes.

JLR6 SOURCE Document Anomaly 2002, IOC F. Martina to Distribution on 25 April 1974.

JLR7 SOURCE Document Anomaly 2029, Letter 2221:8263 W. G. King to Brig. Gen. H. Estes on July 15, 1974.

JLR8 SOURCE Document Anomaly 2026, Summary Sheet.

JLR9 SOURCE Document Anomaly 2033, Undated notes by B. K. Ching.

JLR10 SOURCE Document Anomaly 1083, IOC 35.81-2699 R. B. Trombley to J. E. Murrin.

JLR11 SOURCE Document Anomaly 1097, Letter ESS-8:85-163 from D. N. Baker to C. Pratt.

JLR12 SOURCE Document Anomaly 1098, TRW Letter D. C. Stager to HQ Space Division/YG on 18 July 1986.

JLR13 SOURCE Document Anomaly 1088, IOC From B. K. Ching to E V Bersinger on 15 Nov 1983.

JLR14 SOURCE Document Anomaly 1089, Letter ESS-8:84-112 from D. N. Baker to Charles Pratt.

JLR15 SOURCE Document Anomaly 1080, Minutes of Flight 9 Tiger Team Meeting #5 on 18 Feb 1983.

JLR16 SOURCE Document Anomaly 1077, IOC 83.5215.47-7 from R. G. Pruett to B. K. Ching

JLR17 SOURCE Document Anomaly 1085, Summary Sheet.

JLR18 SOURCE Document Anomaly 2034, AESC Letter 3221:440 from A. F. Bishop to Lt. Don Pardee on 19 Feb 1979.

PCA1 R. Debor and K. Hoke, Defense Meteorological Satellite Program System Anomaly Monitoring Status, The Aerospace Corporation, 25 April 1997.

PCA2 P. C. Anderson and H. C. Koons, Spacecraft Charging Anomaly on a Low-Altitude Satellite in an Aurora, *J. Spacecraft and Rockets, 33(5),* 734-738, 1996.

RSS1 *The Space Review,* Airclaims, October 25, 1994, P. ATLAS 5/D

RSS2 "Electromagnetic Storm Hits Intelsat Satellite," Space News, Vol. 5, No 5, January 31 -February 6. 1994, p. 3.

RSS3 Knapp, Bill, "Telsat Ponders Using Thrusters To Salvage Anik," Space News. Vol. 5, No. 5, January 3 1 - February 6, 1994, p. 1.

RSS4 Hughes, David, "Telsat Succeeds in Anik E2 Rescue," Aviation Week & Space Technology, July 4, 1994, p. 32.

RSS5 "Mobile Satellite Reports," Vol. 15, No. 12. June 21, 1991

RSS6 *The Space Review*, Airclaims. September 21, 1994, p. N&H 4/B.

RSS7 Spacecraft Anomaly Database, Version. ANOM5I, National Geophysical Data Center, Solar-Terrestrial Physics Division, Boulder CO, March 1994.

RSS8 Garret. Henry, Berry, "The Charging Of Spacecraft Surfaces." *Reviews of Geophysics and Space Physics,* Vol. 19, No. 4, November, 1981, p. 577-616.

RSS9 Elsen, William, G., *Orbital Anomalies in Goddard Spacecraft for CY 1989*, Assurance Requirements Office, Office of Flight Assurance, NASA Goddard Space Flight Center, July 1990.

RSS10 *DBS News*, Phillips Publishing Co.. February 1, 1988.

RSS11 Lenorovitz, Jeffrey, M., "Arabsat Communications Satellite Experiences Cryo-Control Problems," Aviation Week & Space Technology, March 25, 1985, p. 22.

RSS12 Wadham, P., N., " The Effects of Electrostatic Discharge Phenomena on Telsat's Domestic Communications Satellites," AGARD, The Aerospace Environment at Attitude and Its Implications for Spacecraft Charging," 1987.

RSS13 Shockley, Edward, F.. *Orbital Anomalies in Goddard Spacecraft 1984*, Assurance Requirements Office, Office of Flight Assurance, NASA Goddard Space Flight Center, September 1985.

RSS14 *The Space Review*, Airclaims, October 25, 1994, p. ARIANE 3/A.

RSS15 Elsen, William, *G., Orbital Anomalies in Goddard Spacecraft for CY 1986,* Assurance Requirements Office, Office of Flight Assurance. NASA Goddard Space Flight Center, April 1987.

RSS16 Garret, H., and Whittlesey, "Environment Induced Anomalies on the TDRSS and the Role of Spacecraft Charging," 28th Aerospace Sciences Meeting, January 8-11, Reno, Nevada.

RSS17 Orbital Anomalies in Goddard Spacecraft annual reports prepared for the System Reliability and Safety Office, NASA Goddard Space Flight Center, 1983-1993.

RSS18 Capart, J., J., and Dumesnil, J., J., "The Electrostatic Discharge Phenomena on Marecs-A, *ESA Bulletin*, No. 34, May 1983, p. 22-27.

RSS19 Frezet, M., et. al., "Assessment of Electrostatic Charging of Satellites in the Geostationary Environment." *ESA Journal*, Vol. 13, No. 2, 1989, p.89-116.

RSS20 Farthing. Winifred. H.. Brown, James. P.. and Bryant. William. C.. Differential Spacecraft Charging on the Geostationary Operational Environmental Satellites, NASA Technical Memorandum 83908. Goddard Space Flight Center. Greenbelt Maryland, March 1982.

RSS21 Shockley, Edward, R, Orbital Anomalies in Goddard Spacecraft 1982-1983. Assurance Requirements Office, Office of Flight Assurance, NASA Goddard Space Flight Center, July 1984.

RSS22 Koons, Harry, C., and Gorney, David, J. "Relationship Between Electrostatic Discharges on Spacecraft P78-2 and the Electron Environment." Journal of Spacecraft and Rockets, Vol. 28, No. 6. November-December 1991. p. 683-688.

RSS23 Hodge, D., and Leverington. D.. "Investigation of Electrostatic Discharge Phenomena on the Meteosat Spacecraft," *ESA Journal*, Vol. 13. 1979. p. 101 -113.

RSS24 Frezet, M., et. al., "Assessment of Electrostatic Charging of Meteosat Satellite in the Geostationary Environment," IEEE Transactions on Nuclear Science, Vol. 35, No. 6, 1988, p. 1400-1406.

RSS25 Sims, Andrew, J., Electrostatic Charging of Spacecraft in Geosynchronous Orbit, Defense Research Agency Tech. Memo SPACE 389, Farnborough, Hampshire, U.K., December 1992.

RSS26 Stevens, N., John, "Preliminary Report on the CTS Transient Event Counter Performance through the 1976 Spring Eclipse Season," *Proceedings of the Spacecraft Charging Technology Conference,* NASA Lewis Research Center, February, 1977, p.81-105.

RSS27 Gore, J., Victor, "Design Construction and Testing of the Communications Technology Satellite Protection Against Spacecraft Charging:' *Proceedings of the Spacecraft Charging Technology Conference,* NASA Lewis Research Center, February, 1977, p.773-787.

RSS28 Bloomquist, Charles, and Graham, Winifred, *Analysis of Spacecraft On-Orbit Anomalies and Lifetimes,* NASA Contract NAS-27229, NASA Goddard Space Flight Center, February 10, 1983.

RSS29 Dechezelles, J.J., " Some Knowledge of Dynamics and Space Materials Derived from Inflight Performance of Symphonie Satellites," *International*

Astronautics Federation International Astronautics Congress, 27th, Anaheim, CA, October 10-16, 1976.

RSS30 Robbins, A., and Short, C., D., "Space Environmental Effects in the SKYNET 2B Spacecraft," *Proceedings of the Spacecraft Charging Technology Conference,* NASA Lewis Research Center, February, 1977, p.853-863.

RSS31 Inouye, George, T., "Spacecraft Charging Anomalies on the DSCS 11 Launch 2 Satellites," *Proceedings of the Spacecraft Charging Technology Conference,* NASA Lewis Research Center, February, 1977, p. 829-852.

RSS32 Stevens, N., John, Rosen, Alan, and Inouye, George, T., "Communication Satellite Experience in the Seventies," *AIAA 25th Aerospace Sciences Conference,* Reno, Nevada, January, 1987.

RSS33 "Orbital Anomalies in Goddard Spacecraft for CY 1993," Office of Flight Assurance, Goddard Space Flight Center, June 1994.

RSS34 "STS-49 In-Flight Anomaly Report," STS-49-V36.

RSS35 Hempsell, M., "Hubble Array Impacts," *Spaceflight,* Vol. 36, November 1994.

RSS36 Iannotta, B., "Power Shortage Forces Crew at Mir to Rely on Backup," *Space News,* October 24-30 1992.

RSS37 McKnight, D., "Determining the Cause of a Satellite Fragmentation: A Case Study of the Kosmos 1275 Breakup," 38th Congress of the International Astronautical Federation, Brighton, United Kingdom October 10-17, 1987.

RSS38 "Analysis of Spacecraft On-Orbit Anomalies and Lifetimes," Goddard Space Flight Center, February 10, 1983.

RSS39 Wadham, P.N., "The Effects of Electrostatic Discharge Phenomena on Telesat's Domestic Communications Satellites," Satellite Engineering Group, Telesat Canada, pp. 25-1/25-5.

RSS40 De Groh, Kim K., Banks, Bruce A., "Atomic Oxygen Undercutting of Long Duration Exposure Facility Aluminized-Kapton Multilayer Insulation," *Journal of Spacecraft and Rockets*, Vol. 31, No. 4, July-August 1994, pp. 656-664.

RSS41 Tribble, A. C., "Spacecraft Interactions with the Space Environment," AIAA 33rd Aerospace Sciences Meeting and Exhibit, January 9-12, 1995, Reno, NV.

RSS42 "Solar Radiation Strikes Another Blow to ETS-6," *Aviation Week & Space Technology,* October 3, 1994, p. 66.

RSS43 "STS-61 (OV- 105, FLT #5) Official Inflight Anomaly Report.

RSS44 Elsen, William G., "*Orbital Anomalies in Goddard Spacecraft for CY 1991*," Office of Flight -Assurance, Goddard Space Flight Center, October 1992.

RSS45 Adams, L., "A Verified Proton Induced Latch-Up in Space, "*IEEE* Transactions *on Nuclear Science,* NS-39, pp, 1804–1808.

RSS46 Campbell, A. B., "SEU Flight Data From CRRES MEP, "IEEE Transactions on Nuclear Science, Vol. 38, No, 6, December 1991, pp. 1647-1654.

RSS47 Elsen, William G., "Orbital Anomalies in Goddard Spacecraft for CY 1990," Office of Flight Assurance, Goddard Space Flight Center, September 1991.

RSS48 "ESA Bulletin," August 1993, #75, p. 14.

RSS49 Elsen, William G., "Orbital Anomalies in Goddard Spacecraft for CY 1989," Office of Flight Assurance, Goddard Space Flight Center, July 1990,

RSS50 Elsen, William G., "Orbital Anomalies in Goddard Spacecraft for CY 1988," Office of Flight Assurance, Goddard Space Flight Center, November 1989,

RSS51 Shockley, Edward F, "Orbital Anomalies in Goddard Spacecraft 1984," Office of Flight Assurance, Goddard Space Flight Center, September 1985.

RSS52 Adams, L., "Proton Induced Upsets in the Low Altitude Polar Orbit, "*IEEE Transactions on Nuclear Science,* Vol. 36, No. 6, December 1989, pp. 2339-2343.

RSS53 Wilkinson, D., "TDRS-1 Single Event Upsets and the Effect of the Space Environment." *IEEE Transactions on Nuclear Science,* Vol. 38, No. 6, December 1991

RSS54 "Orbital Anomalies in Goddard Spacecraft for CY 1992," Office of Flight Assurance, Goddard Space Flight Center, October 1993.

RSS55 "Spacecraft Anomaly Database," National Oceanic & Atmospheric Administration, National Geophysical Data Center, Solar-Terrestrial Physics Division.

RSS56 Shockley, Edward F., "Orbital Anomalies in Goddard Spacecraft 1982-1983b" Office of Flight Assurance, Goddard Space Flight Center, July 1984.

RSS57 Elsen, William G., "Orbital Anomalies in Goddard Spacecraft 1985," Office of Flight Assurance, Goddard Space Flight Center, September 1996.

RSS58 Elsen, William G., "Orbital Anomalies in Goddard Spacecraft for CY 1996," Office of Flight Assurance, Goddard Space Flight Center, April 1987.

RSS59 Carts, Yvonne A., "Astronomers Report Benefit of Hubble Fix," *Laser Focus World,* September 22, 1994, pp.15-17.

RSS60 "Orbital Anomalies in Goddard Spacecraft for CY 1992," Office of Flight Assurance, Goddard Space Flight Center, October 1993

RSS61 Shea, M. A., Smart, D.F., Allen, J.H. and Wilkinson, D.L., "Spacecraft Problems in Association with Episodes of Intense Solar Activity and Related Terrestrial Phenomena During March 1991," *IEEE Transactions in Nuclear Science,* Vol. 39, December 1992.

RSS62, *Space Flight Environment International Engineering Newsletter,* Vol. VI, No. 2, May -June, 1995, p. 9.

RSS63 Internal Memorandum, Jeff Anderson to Richard Leach, NASA Marshall Space Flight Center, February 24, 1995.

RSS64 STS-45 Inflight Anomaly Report

RSS65 *Space News,* December 12-18, 1994, p. 23.

RSS66 Freeman, Michael, T., "Spacecraft On-Orbit Deployment Anomalies: What Can be Done?" *IEEE AES Systems Magazine, April,* 1993, p. 3-15.

RSS67 Herr, Joel, L., *Review and Comments On MSTI-2 Failure Report,* NASA Marshall Space Flight Center, Report No. 212-010-94-017, Sverdrup Corporation, December 1994.