NASA-CR-195879

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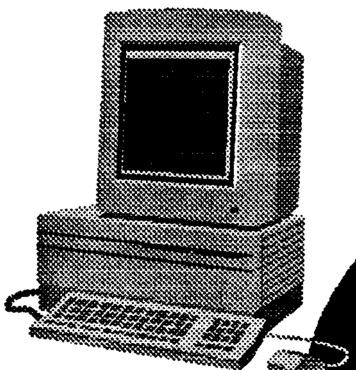
NASA HEADQUARTERS
CODE Q

SPACE FLIGHT RISK DATA COLLECTION/ANALYSIS PROJECT

FINAL REPORT

RISK AND RELIABILITY



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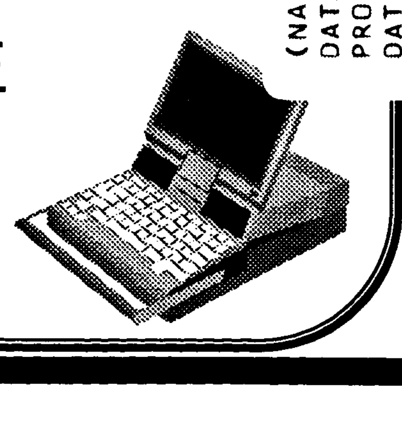

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(NASA-CR-195879) SPACE FLIGHT RISK DATA COLLECTION AND ANALYSIS PROJECT: RISK AND RELIABILITY DATABASE Final Report (Dimensions International) 137 p

NASA Space Flight Risk Data Collection/Analysis Project

FINAL REPORT

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1.0 PURPOSE

The focus of the NASA "*Space Flight Risk Data Collection and Analysis*" project was to acquire and evaluate space flight data with the express purpose of establishing a database containing measurements of specific risk assessment-reliability-availability-maintainability-supportability (RRAMS) parameters. The developed comprehensive RRAMS database will support the performance of future NASA and aerospace industry risk and reliability studies. Launch performance record archives and other launch reports maintained by the Range Safety Office (RSO) of the 45th Space Wing (formerly Eastern Space and Missile Command - ESMC) at Patrick Air Force Base served as the initial source for acquiring data to implement the development of the database. Other sources, such as, the Western Space and Missile Command (WSMC) or Wallops Space Flight Center might provide additional avenues for supplementing the database in the future.

One of the primary goals has been to acquire unprocessed information relating to the reliability and availability of launch vehicles and the subsystems and components thereof from the 45th Space Wing. After evaluating and analyzing this information, it was encoded in terms of parameters pertinent to ascertaining reliability and availability statistics, and then assembled into an appropriate database structure.

The development of the risk and reliability database is recognized to be important not only to NASA but the aerospace community in general. It is essential to have an established source for obtaining risk and reliability estimates as a prelude for conducting formalized reliability and risk assessment studies. In addition, a proven database source offers a mean for improving the risk and reliability analyses currently being performed on aerospace systems. The database system developed as part of the "*NASA Space Flight Risk Data Collection and Analysis*" project forms the building block and initial stepping stone for increasing the accuracy of NASA's risk and reliability measurements.

2.0 BACKGROUND

Dimensions International (DI) and its subcontractor, Science Applications International

Corporation (SAIC) began work on the "*NASA Space Flight Risk Data Collection and Analysis*" project in mid-May 1993. Initial work involved project planning and coordination between team member participants. Next, the project team visited the 45th Space Wing at Patrick Air Force Base, Florida in early June 1993 to acquire data and meet with range safety personnel. The 45th Space Wing trip resulted in the compilation of a large set of unprocessed launch performance reports covering several different launches by various launch vehicles. The launch vehicles for which data was obtained included the following: Atlas/Centaur, Apollo/Saturn, Brilliant Pebbles, Delta, Gemini, Jupiter/Juno, Redstone, Polaris, Pershing, Prospector (Joust), Red Tigress, Space Shuttle, Starbird, TMD Countermeasure Mitigation, and Vanguard. After reproducing the unprocessed data packages, DI/SAIC divided the data sets and returned them to their separate facilities for analysis and processing. After formally organizing the raw data, the project team undertook an extensive review process. Following this, several meetings and telephone conversations were held between DI, SAIC and NASA personnel to determine the appropriate and feasible failure parameters to be extracted from the data sets. This information resulted in the creation of a data encoding worksheet form (ref. Figure 2-1) used by the data analysts in extracting specific facts from the data sets. A second review of the raw launch vehicle data sets resulted in the initial development of an organized set of launch vehicle data notebooks. Next, DI/SAIC developed and submitted a formalized "Data Analysis Plan."[1] This plan described the approach and procedure the project team was to use in analyzing and evaluating the encoded information contained on the data encoding worksheets. In particular, it addressed the types of risk and reliability parameter measurements to be studied in reviewing the data sets. Also, it distinguished the specific statistic and probability computations to be made by the project analysts. DI and SAIC then used the guidelines furnished in the "Data Analysis Plan" to conduct comprehensive assessments of the data encoding worksheets. Launch vehicle notebooks were compiled containing the analysis results, the completed data encoding worksheets and the unprocessed launch vehicle performance records obtained from the 45th Space Wing. Similarly, computer database files were created for storing and maintaining the information contained on the data encoding worksheets. A separate database file was generated to incorporate the risk and reliability measurements computed for each launch vehicle, its systems, subsystems and components.

[1] 45th Space Wing Data Analysis Plan, DI-DAP-001

2.1 Project Summary

The *NASA Space Flight Risk Data Collection and Analysis* project brought together a collective team of experienced professionals knowledgeable in the field of risk and reliability engineering. Project team members included the Project Managers, Engineers and Data Analysts from Dimensions International, Incorporated (DI), the prime contractor and its subcontractor, Science Applications International Corporation (SAIC), as well as the NASA Headquarters Risk Program Manager. Figure 2-2, depicts the overall structure of the project team and identifies the primary contributing representatives from each organization.

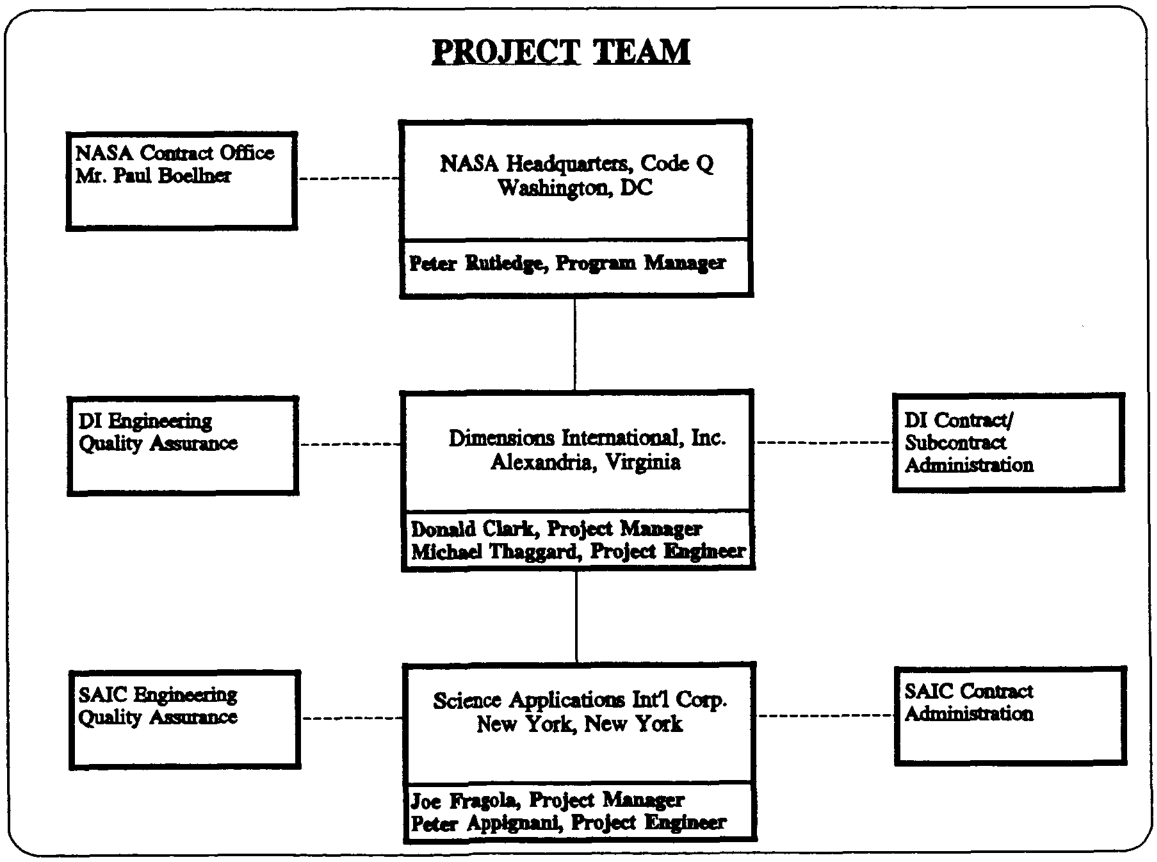

Figure 2-2. Space Flight Risk Data Collection and Analysis Project Team

LAUNCH VEHICLE DATA ENCODING SHEET **PAGE: ______**

VEHICLE PROGRAM: ____________ GENERATION OF VEHICLE: ____________ DATA PAGE: ______
LAUNCHED FROM: ☐ PAD: ____________ ☐ OTHER: ____________
DATE OF LAUNCH: ____________ TIME: ____________ ☐ GMT ☐ EST ☐ EDT
DURATION OF FLIGHT/TEST: ____________ RANGE: ____________
(nominal)
CONFIGURATION OF VEHICLE: ____________

RSO EVALUATION: ☐ SUCCESS ☐ FAILURE ☐ PARTIAL ☐ UNKNOWN
DI/SAIC EVALUATION: ☐ SUCCESS ☐ FAILURE ☐ PARTIAL ☐ UNKNOWN

TIME OF ANOMALY/FAILURE: ____________ ☐ TALO* (sec) ☐ GMT ☐ EST ☐ EDT
ANOMALY/FAILURE OCCURRENCE LOCATION:
STAGE: ☐ 1ST STG ☐ 2ND STG ☐ 3RD STG ☐ RE-ENTRY ☐ OTHER ____________ ☐ UNKNOWN
SYSTEM: ☐ PROPULSION ☐ GUIDANCE ☐ STRUCTURAL ☐ SEPARATION ☐ FLIGHT CONTROL
☐ ELECTRICAL ☐ OTHER: ____________
SUBSYSTEM: ____________

COMPONENT: ____________

FAILURE MODE: ____________

FAILURE ANALYSIS: ____________

METEOROLOGICAL CONDITIONS: ____________

COMMENTS: ____________

*TALO: Time After Lift Off in seconds

Revision 2; Thu, Jul 22, 1993

Figure 2-1. **Data Encoding Worksheet**

2.2 Project Process

The project team developed and used a formalized data collection and analysis process in taking the raw launch data, evaluating it, and generating a database containing certain risk and reliability estimates. This structured process is shown in Figure 2-3. The process was initiated with the acquisition of unprocessed launch performance records and an assortment of data packages obtained from the 45th Space Wing at Patrick Air Force Base, Florida. This information was reproduced at the 45th Space Wing location and carried back to DI and SAIC facilities for analysis. An initial screening step was done at the two facilities to filter out materials deemed non-contributory to the database development process. The remaining information packages underwent a thorough review and evaluation process to identify failure data. Next, project team data analysts used a prescribed data encoding format (ref. Figure 2-1) to accurately and consistently extract specific information from the data packages. The encoded data was reduced further by compiling facts on vehicle failure types, conditions and totals. Probability and statistical calculations were made using the reduced data including component failure probabilities and uncertainty limits. Products resulting from the data collection and analysis process include computer database files, launch vehicle notebooks, reports, graphs and tables. The primary byproduct, computer database files, is discussed herein along with graphs and tables resulting from the databases.

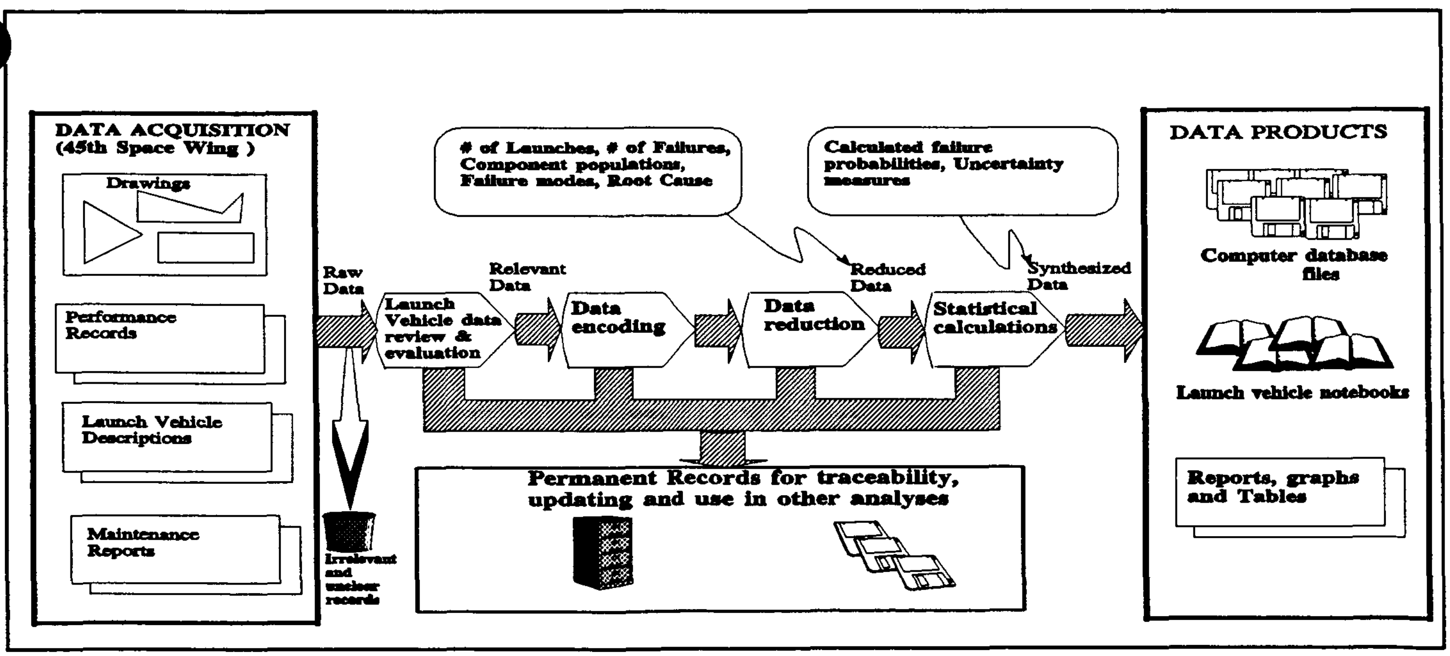

Figure 2-3. Data collection and analysis process

3.0 DATA PRODUCTS

As mentioned previously, two primary products, developed for delivery to NASA Headquarters, are resulting from conducting the formalized data collection and analysis process. They include launch vehicle notebooks and computer database files. The contents and makeup of each product is described in the succeeding sections.

3.1 Launch Vehicle Notebooks

Six notebooks were assimilated and delivered to the NASA Headquarters Program Risk Manager. Notebooks were organized by launch vehicle types. However, launch vehicles with a small number of launches were integrated together into a single notebook. Table 3-1 provides a summary of the notebook contents. Typically, the notebooks are arranged to include a vehicle description, graphs depicting the reliability measurements; tables containing probability and statistical measurements; completed data encoding worksheets and copies of the original launch performance records acquired from the 45th Space Wing.

Table 3-1. **Launch Vehicle Notebooks**

Notebook	Launch Vehicle(s)
I	Delta
II	Atlas
III	Polaris
IV	Pershing II
V	Jupiter/Juno; Saturn

Notebook	Launch Vehicle(s)
VI	Vanguard; Gemini; Space Shuttle; Red Tigress I; Red Tigress II; Starbird; TMD Countermeasure Mitigation; Brilliant Pebbles; Prospector (Joust)

3.1.1 Notebook I

Notebook I contains a compilation of information acquired and developed on the Delta launch vehicle. In particular, facts are included covering 179 Delta launches which occurred during the period of May 1960 to December 1992 from Cape Canaveral, Florida. Included in the notebook are graphs displaying the vehicle's success probabilities; tables summarizing the computed failure probabilities; completed data encoding worksheets; and copies of the acquired performance records. Also, a general description of the vehicle along with its history, as described by AIAA[2] is included.

3.1.2 Notebook II

The composition of Notebook II includes information and facts on the launches of the Atlas vehicle. Launch performance records covering Atlas launches from Cape Canaveral, Florida during the period of June 1957 to March 1993 are included. Several different Atlas configurations, ranging from the original A vehicle to the I model, are covered. Also included are graphs depicting the vehicle's success probabilities; tables summarizing the computed failure probabilities; and completed data encoding worksheets.

3.1.3 Notebook III

[2] Isakowitz, Steven J., "International Reference Guide to Space Launch Systems", AIAA, 1991 Edition

Notebook III includes an assimilation of the information on the Polaris missile. Information and facts covering 140 Polaris launches are addressed. The launch period is from April 1957 to April 1965. Also contained in the notebook is a brief vehicle description; graphs displaying the vehicle's success probabilities; completed data encoding worksheets; and copies of the acquired performance records. Several unique annotations and findings are noted throughout the notebook based on Polaris submarine launches.

3.1.4 Notebook IV

Pershing II launches during the period of July 1982 to March 1988 are covered in Notebook IV. In all, information on 43 launches is included. Also included are graphs depicting the vehicle's success rates; finished data encoding worksheets; and reproductions of the launch performance records acquired from the 45th Space Wing.

3.1.5 Notebook V

Notebook V incorporates data acquired on the Jupiter/Juno and Saturn launch vehicles. Information included covers 46 Jupiter/Juno launches and 20 Saturn launches. Jupiter/Juno launches occurred during the period of March 1957 to January 1963. Similarly, Saturn launches took place during the period of October 1961 to April 1970. Graphs showing the vehicles' success probabilities; tables reiterating the computed failure probabilities; completed data encoding worksheets; and copies of the acquired performance records are contained in the notebook.

3.1.6 Notebook VI

Notebook VI contains information and facts on several launch vehicles with a small number of launches or limited launch and/or failure information. This include facts and information on Vanguard, Gemini, Space Shuttle, Red Tigress I & II, Starbird, TMD Countermeasure Mitigation, Brilliant Pebbles and Prospector (Joust). Unlike the other notebooks, summary tables and graphs are not provided for all the vehicles. Vehicles with recent launches such as, Red Tigress, Starbird, TMD Countermeasure Mitigation, Brilliant Pebbles and Prospector have experienced one to four launches total and therefore in most cases do not provide enough failure data to make meaningful failure calculations.

3.1.7 Data Encoding Worksheets

Figure 2-1 shows a blank data encoding worksheet illustrating the format used in capturing specific information from the acquired launch performance records. The sheet is divided into two primary sections. The first section (or top portion of the form) provides an area for acquiring data on the launch itself. This includes space for identifying vehicle configuration, launch date, launch time, launch pad, range and so on. The second section (or lower portion) captures specific information on the launch failures, such as, time of anomaly/failure, failure mode, failure analysis and so on. The data encoding worksheets were completed by the DI and SAIC data analysts in reviewing and evaluating the launch performance records. Each worksheet corresponds to a specific launch performance record as noted by the *Data Page* box provided in the upper right-hand corner.

During the evaluation of the launch performance records the DI and SAIC data analysts went through several evaluation iterations. The first iteration involved an assessment of the launch vehicle's performance. Subsequent passes through the data was made with the aim of evaluaing the performance of the vehicle's lower level elements (i.e.,stages, systems, subsystems, and components). Equipment performance was assessed in terms success or failure. The *DI/SAIC Evaluation* block on the data encoding worksheets was annotated based on the analysts' assessment. Each iteration through the analysis process was conducted independent of the preceeding iterations. In this way, the analysts evaluated the performance of the lower level equipment elements (i.e., stages, systems, subsystems, and components) on their own merit. Thus, an incipient system failure resulting from a degraded subsystem and catastrophic component failure is analyzed as such.

Failure severities were classified into one of three categories in evaluating the launch performance records. These categories include **Catastrophic**, **Degraded**, and **Incipient**. The definition of the failure categories, tailored from definitions given in the IEEE

Standard[3] are summarized in Table 3-2.

Table 3-2. **Failure Severity Classifications**

FAILURE SEVERITY	EQUIPMENT LEVEL	DESCRIPTION
Catastrophic	Vehicle	Mission not accomplished. Examples include destroying the vehicle and not placing the satellite in an useable orbit.
	Stage	Stage fails to perform its intended function. Failure severity relates directly to the vehicle level.
	System	System fails to perform its intended function. Failure severity is only related to the system and not its impact on the stage or vehicle.
	Subsystem	Subsystem fails to perform its intended function. Failure severity is only related to the subsystem and not its impact on the system, stage or vehicle.
	Component	Component fails to perform its intended function. Failure severity is only related to the component and not its impact on the subsystem, system, stage or vehicle.
Degraded	Vehicle	The mission, as planned, was not accomplished but was ultimately successful. An example includes placing satellite in wrong orbit.
	Stage	Stage performance is lowered. An example would be when a stage fails to reach its proper altitude due to a guidance problem, however, it reaches an altitude high enough, so that the satellite could later be placed in a useable orbit.
	System	System performance is lowered. An example is the propulsion system not delivering its design thrust.
	Subsystem	Subsystem performance is lowered. Failure severity is only related to the subsystem and not its impact on the system, stage or vehicle.

[3] IEEE Std 500-1984 Appendix A

FAILURE SEVERITY	EQUIPMENT LEVEL	DESCRIPTION
	Component	Component performance is lowered. An example is an engine turbo pump failing to reach its design flow rate.
Incipient	Vehicle	Impact on the mission is insignificant.
	Stage	Impact on the stage is insignificant. An example includes a stage failing to reach its proper altitude due to the guidance system malfunctioning, however it does reach an altitude where the satellite can later be placed in its proper orbit.
	System	Impact on the system is insignificant. An example is when the propulsion system causes uneven thrust.
	Subsystem	Impact on the subsystem is insignificant. An example is an engine experiencing POGO.
	Component	Impact on the component is insignificant. An example is a turbo pump exhibiting minor vibrations.

3.1.8 Data Analysis Summary Reports

Failure probabilities are summarized in a tabular format and referenced in the notebooks as a "*Data Analysis Summary Report*" (ref. Figure 3-1). The information presented in the tables represent a compilation of the analysts' assessment of the failure information contained in the data encoding worksheets. Failure probabilities, based on the number of launch attempts described in the launch performance records, include data at the vehicle, stage, system, subsystem and component levels. Typically the tables include the number of failures, mean and median failure probabilities, upper and lower confidence boundaries, and estimating error factors.

3.1.8.1 Failure Probability Confidence Measure

Data contained in the launch performance records does not lend itself for computing time-related reliability estimates. Very few of the launch performance records contain information that identifies the specific time when a failure occurs. Some of the time-related failure facts that are provided do not indicate when some of the lower level elements (i.e., system, subsystem and components) failed. Much of this results from the early vehicles not having adequate instrumentation to pinpoint when failures occurred. Therefore, time-independent failure probabilities were calculated, and included in the *Data Analysis Summary Report* tables. The failure probabilities are estimated based on the number of launch attempts. Mean failure probabilities are calculated by dividing the number of failures by the total number of launch records. For example, the Polaris missile have 51 vehicle-level catastrophic failures identified in the data set of 140 launch records. Therefore, the launch vehicle's mean catastrophic failure probability is $\{^{51}/_{140}\}$ or 3.64E-01.

A classical data confidence measure based on the F and Chi-square distributions is used to determine the confidence boundary for the failure probabilities. The F (ref. equation 1) and Chi-square (ref. equation 2) expressions are furnished below. When the difference between the number of launches and failures is small (i.e., less than 100) then the F-distribution is applied. Similarly, when the difference is large (i.e., greater than 100) then the chi-square expression is used.

DATA ANALYSIS SUMMARY REPORT
ATLAS FAILURES PER LAUNCH ATTEMPT

Vehicle Code	Level/ Severity Code	Vehicle/Stage/System/Subsystem/Component	Failure Severity	Number of Failures	Mean	Median	95th	5th	Error Factor
		TOTAL FAILURES							
A	V	TOTAL ATLAS FAILURES	TOTAL FAILURES	78	3.63E-1	3.65E-1	4.20E-1	3.08E-1	1.35
A	VA	TOTAL ATLAS CATASTROPHIC FAILURES	CATASTROPHIC FAILURES	54	2.51E-1	2.54E-1	3.05E-1	2.03E-1	1.40
A	VB	TOTAL ATLAS DEGRADED FAILURES	DEGRADED FAILURES	11	5.12E-2	5.04E-2	8.47E-2	2.87E-2	1.78
A	VC	TOTAL ATLAS INCIPIENT FAILURES	INCIPIENT FAILURES	13	6.05E-2	6.36E-2	9.61E-2	3.58E-2	1.72
A	V1	ATLAS A FAILURES	TOTAL FAILURES	5	2.33E-2	2.64E-2	4.89E-2	9.20E-3	2.20
A	V1A	ATLAS A FAILURES	CATASTROPHIC FAILURES	4	1.86E-2	2.17E-2	4.26E-2	6.40E-3	2.38
A	V1B	ATLAS A FAILURES	DEGRADED FAILURES	1	4.70E-3	7.81E-3	2.21E-2	2.00E-4	4.73
A	V2	ATLAS B FAILURES	TOTAL FAILURES	6	2.79E-2	3.10E-2	5.51E-2	1.22E-2	2.08
A	V2A	ATLAS B FAILURES	CATASTROPHIC FAILURES	4	1.86E-2	2.17E-2	4.26E-2	6.40E-3	2.38
A	V2C	ATLAS B FAILURES	INCIPIENT FAILURES	2	9.30E-3	1.24E-2	2.93E-2	1.70E-3	3.21
A	V3	ATLAS C FAILURES	TOTAL FAILURES	5	2.33E-2	2.64E-2	4.89E-2	9.20E-3	2.20
A	V3A	ATLAS C FAILURES	CATASTROPHIC FAILURES	4	1.86E-2	2.17E-2	4.26E-2	6.40E-3	2.38
A	V3C	ATLAS C FAILURES	INCIPIENT FAILURES	1	4.70E-3	7.81E-3	2.21E-2	2.00E-4	4.73
A	V4	ATLAS D FAILURES	TOTAL FAILURES	32	1.49E-1	1.52E-1	2.00E-1	1.08E-1	1.50
A	V4A	ATLAS D FAILURES	CATASTROPHIC FAILURES	21	9.77E-2	1.01E-1	1.41E-1	6.55E-2	1.59
A	V4B	ATLAS D FAILURES	DEGRADED FAILURES	7	3.26E-2	3.57E-2	6.12E-2	1.53E-2	1.99
A	V4C	ATLAS D FAILURES	INCIPIENT FAILURES	4	1.86E-2	2.17E-2	4.26E-2	6.40E-3	2.38

Figure 3-1. **Atlas Data Analysis Summary Report (Page 1 of 9)**

$$\frac{[f][F_{0.05}(2f,2L-2f+2)]}{[L-f]+1+[f][F_{0.05}(2f,\ 2L-2f+2)]} \leq P_L \leq \frac{[f+1][F_{0.95}(2f+2,2L-2f)]}{[L-f]+[f+1][F_{0.95}(2f+2,2L-2f)]} \tag{1}$$

$$\frac{\chi^2_{0.05}(2f)}{(2L)} \leq P_L \leq \frac{\chi^2_{0.95}(2f+2)}{(2L)} \tag{2}$$

where, f is the number of failures
and, L is the number of launches

3.1.9 Typical Graphs

Two primary graphs are included in the notebooks for each launch vehicle. They include graphs of the *Ratio of Success to Launches* by launch sequence and by launch date. Depending on the performance of each individual vehicle, most graphs provided in the notebooks show an increasing or rising success rate as you move from left to right on both graphs. This partly results from the fact that the increasing number of launches, as you go from left to right, diminish the effect of the failures. Also, it results from a general reliability improvement that occurs over time (i.e., reliability growth). Two examples of the graphs contained in the data notebooks are shown in Figures 3-2 and 3-3. Figure 3-2 depicts the plot of success ratio to launch sequence for the Atlas launch vehicle. Two plots are provided. The top graph shows the success ratio when it is computed based on catastrophic failures only and the second (or lower) graph illustrates the case when the success ratio is calculated using all failures (i.e., catastrophic, degraded and incipient). Similarly, Figure 3-3 displays the two Atlas success ratio graphs when they are plotted against the date of launch.

Dimensions International, Incorporated 4501 Ford Avenue, Suite 1200 Alexandria, Virginia 22302

ATLAS RATIO OF SUCCESSES TO LAUNCHES
BY LAUNCH
(FOR 45TH SPACE WING DATA ONLY)

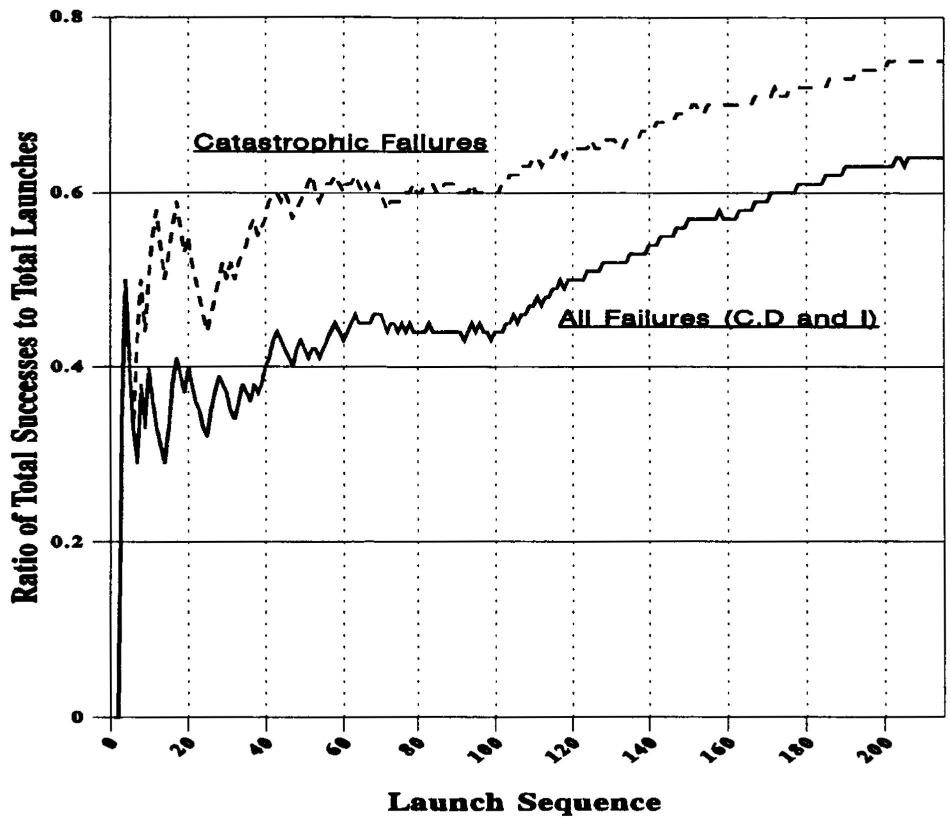

Figure 3-2. Atlas Ratio of Successes to Launches by Launch

ATLAS RATIO OF SUCCESSES TO LAUNCHES
BY DATE OF LAUNCH
(FOR 45TH SPACE WING DATA ONLY)

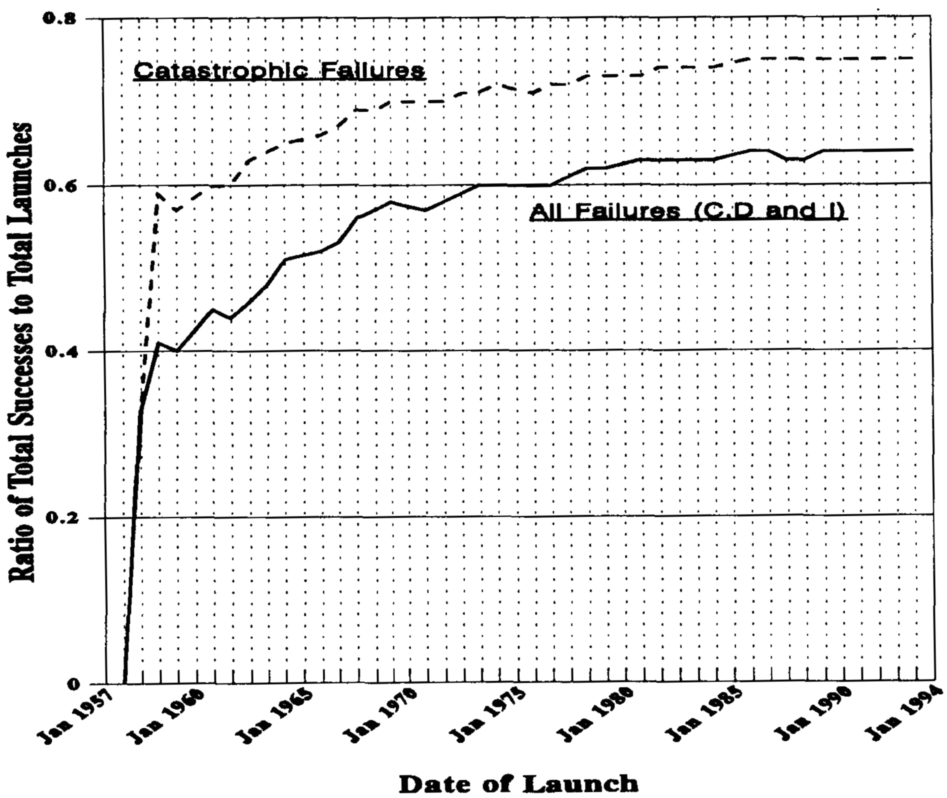

Figure 3-3. Atlas Ratio of Successes to Launches by Date

3.2 Database Files

Two types of database files have been developed as part of the launch vehicle database system. The first type incorporates information contained in the data encoding worksheets. The second type assimilates the reliability calculations and statistical uncertainties determined for the different launch vehicles and their subsystems and components. All computer files are structured using a dBase III Plus[4] compatible format based on guidance provided by the NASA Program Risk Manager.

The database files developed herein represent a unique consortium of space flight data. Much of the historical information collected and assimilated on the different launch vehicles is located in only one other source, that being the 45th Space Wing data files. The distinction of partial failures for the space flight components (i.e., degraded and incipient failure categories) cannot be found in any other sources. Thus, these database files are distinctive in several ways. In particular, this electronic storage medium permits easy searches for particular facts; allows information to be tracked; and makes the space flight data more accessible to more users. Also, the assimilation of this unique data set will ultimately foster improved risk and reliability studies.

3.2.1 **Data Encoding Database Files**

A total of eleven dBase III database files have been created to store the information contained on 11 of the launch vehicles' completed data encoding worksheets. These 11 files are organized into seven (7) individual $3^1/_2$ inch high-density diskettes. Figure 3-4 shows the distribution of data encoding database diskettes. Similar to the launch vehicle notebooks' organization, described in Table 3-1, the data encoding database diskettes are arranged such that six diskettes coincide with the six launch vehicle notebooks. The seventh diskette contains a comprehensive database file that is a accumulation of all the records contained in the individual database files. Because of its large memory requirements, the comprehensive database file has been compressed and archived using Pkzip[5] to accomodate storing it on a single diskette. To gain

[4] dBase III Plus is a licensed trademark of Ashton-Tate Company

[5]Pkzip, copyright of Pkware, Incorporated

access to this file will require it to be extracted from its archive form. Use the following steps to extract and store the file into a hard-disk directory:

(1) Insert the "Comprehensive" database diskette in drive A.
(2) Type A:
(3) At the A> prompt, type *pkunzip a:\dbaseiii\comp.zip c:\[dir]\[filename]*

Although the comprehensive database file contains the same information as that in the individual files, the individual launch vehicle databases are maintained to foster the development of these files. Since all vehicles have some unique characteristics, the separate database files apart from the comprehensive database, allows the user to restructure or tailor these databases based on the uniqueness of the vehicle.

Table 3-3 presents an overview of the comprehensive data encoding database file. It also identifies the disk locations for the individual database files for various launch vehicles. In addition, it shows that data encoding information on 14 launch vehicle/missile types is included in the comprehensive database file. Also shown is the launch period covered and the number of records in the database for each vehicle type. In all, the comprehensive database file contains 714 records corresponding to an equal number of completed data encoding worksheets housed in the notebooks. Provided in Appendix A is a partial listing of the total comprehensive database file.

The dBase III database files are being translated into the more current dBase IV format and will be organized using the structure shown below. Twenty-eight of the database fields listed correspond directly to data available on the data encoding worksheets (ref. Figure 2-1). Fields 27 (Root_Cause) and 28 (Cmmn_failr) were added to the database after the encoding worksheet format was established. These two fields contain useful information such as failure root causes and common or related failure events.

Fields 1, 2, and **3** are character fields housing information on the vehicle identification. Two different page numbers are annotated on the data encoding worksheets. The page numbers are stored in **Fields 4** and **5.** Encoding page numbers (*ENCD_PAGE*) correspond to the page numbers in the notebook. Data page numbers (*DATA_PAGE*) coincide with the launch performance record page numbers in the notebook. **Fields 6-15** contain information on the launch. This includes the launch pad (*LNCH_FRM*),

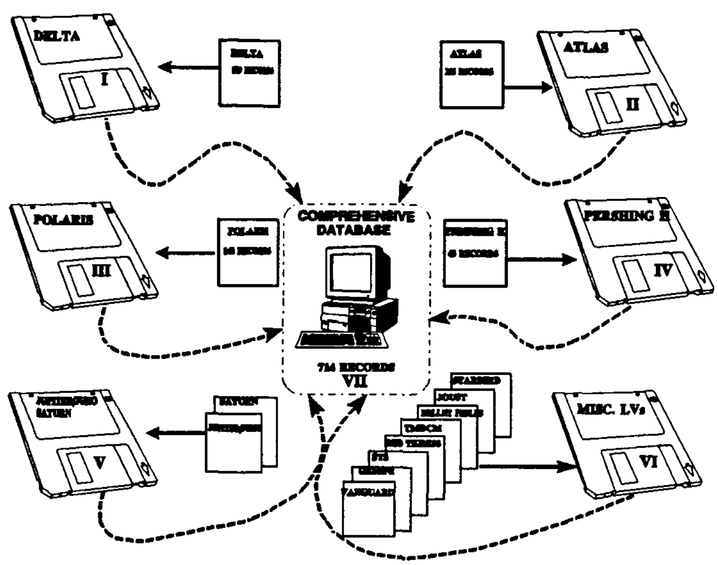

Figure 3-4. **Data encoding database diskettes**

launch date (*LNCH_DATE*), launch time (*LNCH_TIME*) and its time standard (*TIME_STD*), flight duration (*FLT_DUR*) and its units of measure (*DUR_UNITS*), nominal flight range (*RANGE*) and its units of measure (*RANGE-UNIT*), and the flight trajectory inclination (*INCLNTN*) and its units of measure (*INCL_UNIT*).

A narrative on the vehicle configuration is provided in **Field 16** (*VEH_CNFG*). **Fields 17** and **18** have a single character format for anotating the Range Safety Officer (RSO) and the project team analyst's assessment of the launch performance. One of four possible characters are typically supplied. They include "S" for success, "F" for failure, "P" for partial failure, and "U" for unknown. Based on the availability of information, data is primarily provided in **Fields 19-29** for those cases when the launch was determined by the data analysts to be non-successful. **Fields 19** and **20** furnish information on the time within the launch when the failure occurred (*ANOM_TIME*) and its units of measure (*TIME_MEAS*). Details, when appropriate, on the stage, system, subsystem and component that failed are given in **Fields 21-24**. **Field 25** (*FAIL_MODE*) contains failure mode data for the lowest-indentured identified failure item. Also, information regarding the results of the failure analysis is furnished in **Field 26** (*FAIL_ANAL*).

Several categories of failure root causes were used in assessing the launch vehicle failures contained in the database. These include abnormal equipment stresses, poor workmanship, defective materials, operator or human error and design deficiencies. In most cases the launch performance records do not provide sufficient information as to the failure root cause, however, in several instances the information is inferred. **Field 27** (*ROOT_CAUSE*) contains information on identified failure root causes.

To support potential future common cause and dependent failure analyses that may be performed, information on related failures are supplied in **Field 28** (*CMMN_FAILR*). Data page numbers (*DATA_PAGE*) of other launches exhibiting similar failure characteristics are included in this field.

Meteorological conditions at the time of the launch are described in **Field 29** (*MET_COND*). In addition, **Field 30** furnishes comments and remarks deemed appropriate by the data analysts. Typical comments might address unique features pertaining to the launch.

Number of data records: 714

Field	Field Name	Type	Width	Dec	Index
1	VEH_PROG	Character	50		N
2	VEH_GEN1	Character	30		N
3	VEH_GEN2	Character	25		N
4	ENCD_PAGE	Character	6		N
5	DATA_PAGE	Character	6		N
6	LNCH_FRM	Character	12		N
7	LNCH_DATE	Date	8		N
8	LNCH_TIME	Character	16		N
9	TIME_STD	Character	3		N
10	FLT_DUR	Numeric	10	2	N
11	DUR_UNITS	Character	8		N
12	RANGE	Numeric	11	2	N
13	RANGE_UNIT	Character	6		N
14	INCLNTN	Character	8		N
15	INCL_UNIT	Character	10		N
16	VEH_CNFG	Memo	10		N
17	RSO_EVAL	Character	1		N
18	ANL_EVAL	Character	1		N
19	ANOM_TIME	Numeric	18	2	N
20	TIME_MEAS	Character	6		N
21	STAGE	Character	20		N
22	SYSTEM	Character	32		N
23	SUBSYS	Character	90		N
24	COMPNT	Character	90		N
25	FAIL_MODE	Memo	10		N
26	FAIL_ANAL	Memo	10		N
27	ROOT_CAUSE	Character	65		N
28	CMMN_FAILR	Character	25		N
29	MET_COND	Character	60		N
30	COMMENTS	Memo	10		N

Table 3-3. **Comprehensive Data Encoding Database**

Launch Vehicle	Database Diskette	Individual Database File	Launch Period Covered in Database	Launches Covered in Database	Prominent Vehicle Configuration in Database
Apollo/Saturn	V	saturn.dbf	1961-1970	20	2 or 3 liquid stages w/ Lunar module.
Atlas	II	atlas.dbf	1957-1993	215	$1^1/_2$ liquid stages with Centaur or Agena upperstage.
Brilliant Pebbles	VI	otrlv.dbf	1992	1	CASTOR IV-A 1st stage, ORBUS 2nd stage.
Delta	I	delta.dbf	1960-1992	179	3 liquid stages w/ various quantities of strap-on CASTOR SRMs.
Gemini	VI	gemini.dbf	1964-1965	3	2 liquid stages.
Jupiter/Juno	V	jupjuno.dbf	1957-1963	46	Liquid 1st stage, down-scaled Sergeant 2nd and 3rd stages.
Pershing II	IV	prshng2.dbf	1982-1988	43	2 stage solid propellant rocket.
Polaris	III	polaris.dbf	1957-1965	140	Sub-launched 2 stage solid propellant missile.
Prospector	VI	otrlv.dbf	1991	1	Single stage CASTOR IV-A solid rocket motor.
Red Tigress I & II	VI	otrlv.dbf	1991-1993	4	TALO 1st stage, Sergeant 2nd stage, M57A1 3rd stage.
Space Shuttle	VI	sts.dbf	1981-1993	45	Integrated Shuttle Vehicle, External Tank, 2 SRBs.
Starbird	VI	otrlv.dbf	1990	1	TALO 1st stage, Sergeant 2nd stage, Orbus 3rd stage and Star 20B 4th stage.
TMD Countermeasure	VI	otrlv.dbf	1993	2	TALO 1st stage, Minuteman I 2nd stage.
Vanguard	VI	vngrd.dbf	1956-1959	14	Viking sounding rocket 1st stage, Aerobee sounding rocket 2nd stage, SRM third stage.
TOTAL				714	

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3.2.2 **Risk and Reliability Database**

Risk and reliability figures of merit computed as a part of analyzing the 45th Space Wing data are stored in its own separate database file distinct from the Data Encoding database files. This includes a compilation of computed data and facts on the various vehicles and their components listed in Table 3-3. The database includes the following: vehicle identification, vehicle code, vehicle element, equipment description, failure severity, listing of failure modes, notebook related data pages, the number of failures, the number of records, mean and median reliability estimates, 95th and 5th upper and lower confidence boundaries, and error factors. Appendix B contains a printout of the complete space flight Risk and Reliability database.

The Risk and Reliability database is related or associated with the Data Encoding database through the inputs provided in the "*Related Data Pages*" field. The unique page identifiers show the pages in the data encoding notebooks from which the information was derived. These same page numbers are included in the Data Encoding database in the "*Data_Page*" field. A single $3^1/_2$ inch high-density diskette houses the complete Risk and Reliability database file.

4.0 OVERVIEW OF LAUNCH VEHICLES

Table 3-3 depicts the fourteen launch vehicles or missiles contained in the database. Provided herein, where appropriate, is a brief overview and description of the launch vehicles addressed. In several cases very little information is available on the newer vehicles and thus only a sparse description can be provided. In other cases, a very good overview and summary is available for many of the common launch vehicles.

4.1 Atlas

The Atlas space launch vehicles, manufactured by General Dynamics, derived from the Atlas Intercontinental Ballistic Missile (ICBM) series developed in the early-1950s. The primary one and one-half stage vehicle has played a major role in early lunar exploration activities. In particular, the early unmanned Ranger, Lunar Orbiter and Surveyor programs used Atlas vehicles. Also, the Mariner and Pioneer planetary probes were launched by Atlas vehicles.

Figure 4-1 depicts the Atlas evolution starting with the LV-3A in 1958 up to the IIAS in 1993. A description of the vehicle configurations is summarized in Table 4-1. The Atlas A, B, and C were developmental ICBMs. Atlas D, E, and F configurations were deployed as operational ICBMs during the 1960s. During that time, some Atlas Ds were modified as space launch vehicles in the LV-series. LV-3A, 3B, and 3C launch vehicles evolved from a modifiction of the basic D's vehicle structure and subsystems.

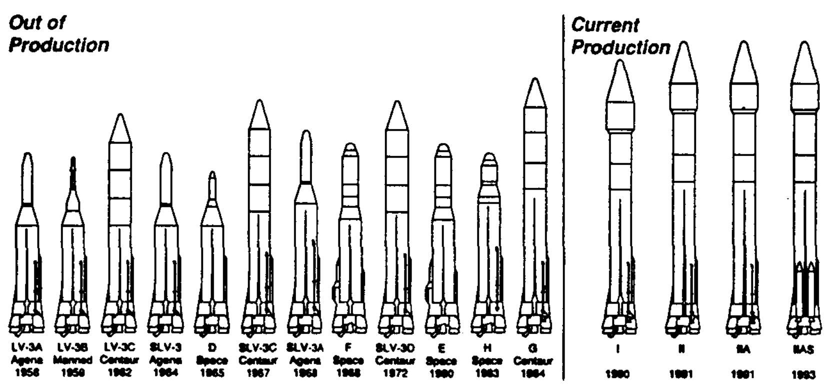


Figure 4-1. **Atlas Launch Vehicle Configurations**[6]

The Standardized Launch Vehicle (SLV) series derived from a need to reduce lead times in transforming Atlas missiles to space launch vehicles. The SLV-series began with the SLV-3 vehicle, which used an Agena upper stage. From the SLV-series evolved the E, F, G and H vehicles. Eventually the I, II, IIA and IIAS configurations were developed with the aim of also supporting commercial launches.

[6]Graphics source: International Reference Guide to Space Launch Systems, Steven J. Isakowitz, 1991

Atlas vehicles are fueled by a mixture of liquid oxygen (LOX) and kerosene (RP-1). Later configurations, such as, the IIASs also incorporate Castor IVAs solid rocket motors to provide added lift. The Atlas liquid fuel booster propulsion is provided by the Rocketdyne engine system, which includes a sustainer, vernier and two booster engines. In the Atlas II, IIA, IIAS vehicles, the vernier engine was replaced with a hydrazine roll control system. All engines are ignited prior to liftoff. During flight the booster section is jettisoned and lift is maintained by the sustainer engine until propellant depletion. Atlas vehicles are typically integrated with the Centaur upperstage vehicle. However, earlier flights used the Agena upperstage. Atlas is separated from the Centaur inflight by a pyrotechnic flexible linear shaped charged system attached to its interstage adapter.

Preliminary results from this study show that the Atlas is a moderately reliable launch vehicle. Its overall mean success rate is computed to be approximately 75%.

Table 4-1. **Atlas Configuration Descriptions**

Vehicle Configuration	Description
A	ICBM single stage test vehicle.
B, C	ICBM 1-$^1/_2$ stage test vehicle.
D	ICBM and later space launch vehicle.
E, F	Initially ICBM (1960), then a reentry test vehicle (1964), then a space launch vehicle (1968).
LV-3A	Same as D except Agena upper stage.
LV-3B	Same as D except man-rated for project Mercury.
SLV-3	Same as LV-3A except reliability improvements implemented.
SLV-3A	Same as SLV-3 except stretched 117 inches.

Vehicle Configuration	Description
LV-3C	Launched with Centaur D upper stage.
SLV-3C	Same as LV-3C except stretched 51 inches.
SLV-3D	Same as SLV-3C except Centaur upgraded to D-1A and Atlas electronics integrated with Centaur (no longer radio guidance).
G	Same as SLV-3D but Atlas lengthened 81 inches.
H	Same as SLV-3D except with E/F avionics and no Centaur upper stage.
I	Same as G except strengthened for 14 ft payload fairing, and ring laser gyro added.
II	Same as I except Atlas lengthened 108 inches, engines uprated, hydrazine roll control added, verniers deleted, and Centaur stretched 36 inches.
IIA	Same as II except Centaur RL-10s engines uprated to 20K lbs thrust and 6.5 seconds Isp increase from extendable RL-10 nozzles.
IIAS	Same as IIA except 4 Castor IVA strap-on SRMs added.

4.2 Brilliant Pebbles

The Brilliant Pebbles launch vehicle is comprised of a Castor IV-A solid rocket motor first stage, an ORBUS 1 second stage, a Guidance/Control/Avionics (GCA), and a forward payload. Using monocoque and semi-monocoque structure design, Brilliant Pebbles is a relatively recent deployed launch vehicle. Only one launch is noted in the enclosed database files. The one launch noted in the database resulted in a catastrophic launch vehicle failure.

4.3 Delta

The Delta launch vehicle, developed by McDonnell Douglas Corporation, evolved from the U.S. Air Force's Thor Intermediate Range Ballistic Missile (IRBM) program (ref. Figure 4-2). The original Delta had a capacity for launching 100 pounds to Geostationary Transfer Orbit (GTO). Over the years it has continually matured and improved to support larger payloads. The current Delta II vehicles have a capacity of placing payloads in excess of 4,000 lbs in GTO. Delta evolution is summarized in Table 4-2, where its various configurations are shown.

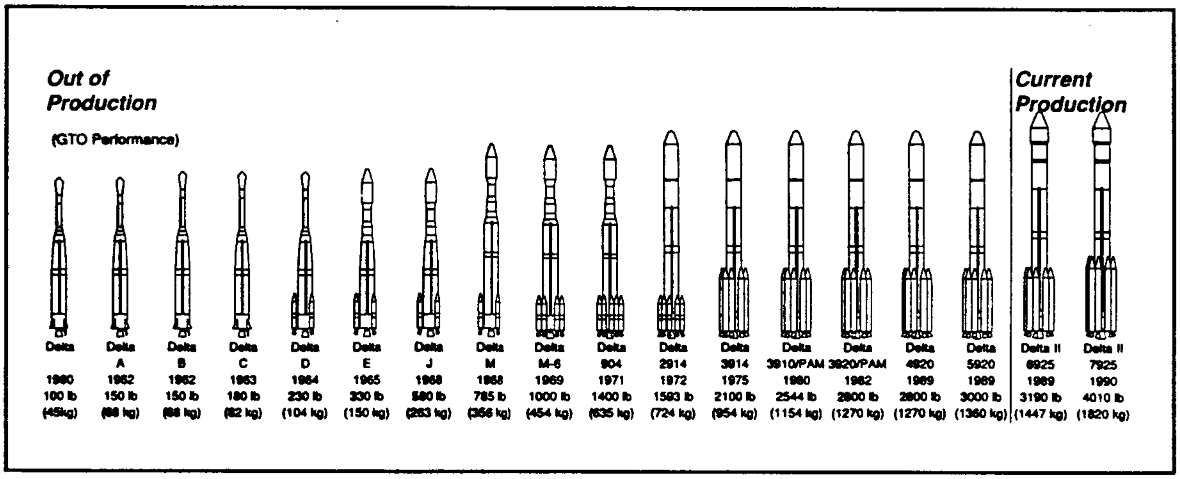


Figure 4-2. **Delta Launch Vehicle Configurations**[7]

As evidence by the information in Table 4-2, Delta has undergone several changes since its maiden launch in 1960. The 1960 Delta used a reconfigured Thor booster with a Rocketdyne MB-3 engine as its first stage, an Aerojet AJ10-118 second stage, and the Vanguard X-248 solid rocket motor as the third stage. Considerable changes occurred thereafter. Many modifications involved the use of additional strap-on solid rocket motors to accomodate increased payload capacities. Other changes have

[7]Graphics source: International Reference Guide to Space Launch Systems, Steven J. Isakowitz, 1991

included stretched fuel tanks; and improved first, second, and third stage engines.

Contemporary Delta designs incorporate a first stage with an engine system housing the Rocketdyne RS-27 main engine, and two Rocketdyne LR101-NA-11 vernier engines. The first stage contains the aft attachments for the strap-on solid rocket motors. The RS-27 main engine provides a thrust capacity of 207,000 lbs. The two vernier engines furnish roll control during the main engine burn, and attitude control after main engine cutoff (MECO) and before second stage separation. Added thrust is provided by the strap-on solid rocket motors.

Delta's second stage uses the Aerojet AJ10-118K engine fueled with nitrogen tetroxide and Aerozine 50 (A50) storable propellants. Gaseous helium is used for pressurization, and a nitrogen cold gas jet system furnishes attitude control during glide intervals and roll control during powered flight. Gimbals are hydraulically activated to provide pitch and yaw control.

The third stage uses a Star-48B solid rocket mounted on a spin table. Prior to third-stage deployment, the stage and spacecraft are spun-up using spin rockets that rotates the assembly on a spin bearing. An ordnance sequencing system is used to release the third-stage and spacecraft after spin-up, when the Star-48B is ignited and to separate the spacecraft following the motor burn.

Delta has proven to be a highly reliable launch vehicle. Its estimated mean success rate, calculated from data herein, is about 94%.

Table 4-2. **Delta Modifications**

Vehicle	Modified Stage	Modification
Delta	1	Modified Thor, MB-3 Block I engine.
	2	Vanguard AJ10-1 118 propulsion system.
	3	Vanguard X-248 motor.

Vehicle	Modified Stage	Modification
Delta A	1	Engine replaced with MB-3 Block II.
Delta B	2	Tanks lengthened, higher energy oxidizer used.
Delta C	3 PLF	Replaced with Scout X-258 motor. Bulbous replaced low drag.
Delta D	0	Added 3 Thor-developed solid rocket motors (Castor I)
Delta E	0 1 2 3 PLF	Castor II replaced Castor I. MB-3 Block III replaced Block II. Propellant tanks widened. Replaced with USAF-developed FW-4 motor. Fairing enlarged to 65 in. diameter (from Agena).
Delta J	3	TE-364-3 used.
Delta L, M, N	1 3	Tanks lengthened, RP-1 tank widened. Varied - FW-4 (L). TE-364-3 (M). None(N)
Delta M-6, N-6	0	Six Castor II used.
Delta 900	0 2	Nine Castor II used. Replaced with Transtage AJ10-118F engine.
Delta 1604	0 3	Six Castor II employed. TE-364-4 used.
Delta 1910, 1913, 1914	0 3 PLF	Nine Castor II. Varied - None (1910), TE-364-3 (1913), TE-364-4 (1914). 96 in. diameter replaced 65 in.

Vehicle	Modified Stage	Modification
Delta 2310, 2313	0	Three Castor II.
	1	RS-27 replaced MB-3.
	2	TR-201 engine replaced AJ10-118F.
	3	Varied - None (2310), TE-364-3 (2313), TE-364-4 (2314).
Delta 2910, 2913, 2914	0	Nine Castor II.
	3	Varied - None (2910), TE-364-3 (2913), TE-364-4 (2914).
Delta 3910, 3913, 3914	0	Nine Castor IV replaced Castor II.
	3	Varied - None or PAM (3910), TE-364-3 (3913), TE-364-4 (3914).
Delta 3920, 3924	2	AJ10-118K engine replaced TR-201.
	3	Varied - None or PAM (3920), TE-364-4 (3924).
Delta 4920	0	Castor IVA replaced Castor IV.
	1	MB-3 replaced RS-27.
Delta 5920	1	RS-27 replaced MB-3 engine.
Delta 6925	1	Tanks lengthened 12ft.
	3	STAR 48B motor used.
	PLF	Bulbous. 114 in. diameter used.
Delta 7925	0	GEMs replaced Castor IVA.
	1	RS-27A replaced RS-27 (12:1 expansion ratio).

4.4 Gemini

Development of the Gemini launch vehicle focused primarily on putting man in orbit. The launch vehicle consisted of two liquid stages, fueled with hydrazine and UDMH propellant. It included the Aerojet's propulsion system which was comprised of XLR 87-7 and XLR 91-7 engines, producing thrusts of 430,000 lbs and 100,000 lbs respectively.

Only three launches are noted in the database. All three were completely successful.

4.5 Jupiter/Juno

Evolving out of the Redstone and Jupiter IRBM programs, Jupiter/Juno was developed in the early 1950s. Jupiter's initial configuration (Jupiter C) included a slightly longer stage one tank than the Redstone, 37.5 ft instead of 32.08 ft. The Jet Propulsion Laboratory (JPL) developed the second stage, which consisted of a cluster of 11 scaled-down Sergeant missiles, each 4 feet long and 6 inches in diameter. Each missile provided 1,600 lbs of thrust. Similarly, the third stage was comprised of three more scaled-down Sergeant missiles.

By the late 1950s Jupiter was modified into Juno II as a means of providing a greater orbital capacity. As a first stage, the Juno used a Jupiter IRBM measuring 58 ft long and 105 inches in diameter. This stage used a Rocketdyne engine that burned LOX and RP-1 in providing 150,000 lbs of thrust. As with its predecessor, Juno II used the JPL-developed second stage consisting of a cluster of 11 scaled-down Sergeant missiles.

The Jupiter/Juno series achieved two significant milestones in U.S. space flight. First, the Jupiter C was the first successful launcher of a U.S. satellite, Explorer 1 on February 1, 1958. Second, Juno II with Pioneer 3 as a payload, provided the first successful U.S. flyby of the Moon on December 6, 1958.

All Jupiter/Juno launches occurred at the Cape Canaveral Air Force Station, Florida launch site. Thus, the database contained herein represent one of the few sources where launch information on these vehicles have been captured and organized.

Based on the data acquired herein, Jupiter/Juno is said to have achieved moderate reliability results. Its estimated mean success rate is computed as 67%.

4.6 Pershing II

The Pershing II is the second generation of the Pershing missile developed by Martin Marietta Orlando Aerospace Company. With a height of 35 feet, the two-stage solid propellant rocket, typical payload included a terminally guided nuclear warhead. With an improved guidance system, the Pershing II was far more accurate than its Pershing I predecessor. It housed a radar system in its nose cone that compared target imagery with prestored computer images for inflight course adjustments. The medium-range missile, had a maximum range of 1200 miles and was primarily launched from mobile launchers at the Cape Canaveral Air Force Station, Florida.

Unlike most missile programs, Pershing II was developed and produced concurrently. Several missiles were designated for "hot-shot" launches which implied the missiles were exposed to several hours of prelaunch environmental stresses. Typically this required the missile undergo two weeks of land-based manuevers, where it was driven over 1500 miles of dirt and paved roads and put through 50 countdown sequences. It was then broken down into its major parts, returned to the Missile Command at Redstone Arsenal and placed into a chamber where temperatures ranged from 110 to 160 degrees during a four-day period. The process was repeated, and then the missiles were kept at a constant 135 degrees for five days, followed by a "cold-soak" of the rocket motors at 5 degrees below zero for five days. Finally, the entire missiles were maintained in a heated plywood shelter at Cape Canaveral at a constant 91 degrees for two weeks before launch.

With a computed mean success rate of 95%, the Pershing II proved to be highly reliable. Only two of the 43 launches documented in the database ended in a catastrophic failure.

4.7 Polaris

The submarine launched Polaris ICBM weighs approximately 66,000 pounds and has a range of roughly 1,100 nautical miles. The two stage solid rocket missile contains an inertial guidance system. The payload is a reentry body, normally a warhead.

Typically the missile is launched from a tube in the submarine, while the submarine is submerged. The missile is ejected from the launch tube with pressurized air and is forced to the surface where the first stage is ignited. It is guided to its target by the inertial guidance system. Once ejected, the missile does not require any commands (from either land-based stations or the submarine) to complete its mission. Missile attitude is controlled by the use of several jetevators for the first stage and by a fluid injection thrust vector control system for the second stage.

4.8 Prospector (Joust)

Prospector is a sophisticated guided single stage CASTOR IV-A solid propellant rocket designed to deliver small payload into sub-orbital flight. The rocket contains five primary elements including the nosecone, payload module, service module, Castor IVA motor and Aft skirt assembly. Housed inside the nosecone is a recovery system, floatation aid and recovery beacon and antennas. Similarly, the service module contains the Guidance and Control Computer (GCC), PCM Encoder, Rate Control System, Flight Termination, Inertial Guidance System, Telemetry system, and Electronics. The aft skirt assembly included a stabilization flare, air and jet vanes, and actuators.

4.9 Red TigressI & II

Red Tigress I is a guided single stage solid propellant rocket designed to deliver small payloads into sub-orbital flight. The 29 ft. missile includes a nosecone section, payload module, M56A1 solid propellant motor and fin/aft skirt structure. A Nozzle Control Unit (NCU) is used to guide the single stage missile.

Red Tigress II consists of an unguided first stage Talos with a guided second stage Sergeant and guided third stage M57A1. The unguided first stage requires wind weighting techniques up to second stage ignition. The second stage Sergeant is guided using a combination of air and jet vanes mounted in the aft skirt structure. The third stage M57A1 is fully guided using a NCU and four vectorable nozzles.

Red Tigress II has a separation system that includes V-bands with pyrotechnic release mechanisms for staging of the Talos, Sergeant and M57A1 motors, separation of the nose, and release of the payload module. It also includes a standardized guidance and control avionics package used by both the launch vehicle and the payload module attitude control.

4.10 Saturn

Saturn V was the last in the Saturn series which included Saturn I, Saturn IB and Saturn V. It included a S-IC first stage, a S-II second stage, a S-IVB third stage and an Instrumentation Unit (IU). Before its phase out in 1975, the Saturn vehicle accomplished several significant events including the Apollo missions to the moon and several rendezvous trips to the Skylab station.

Saturn's S-IC stage was developed by Boeing Company and it contained five F-1 rocket engines. These engines were the most powerful liquid propellant engines ever flown. Rockwell designed and built the S-II second stage which was powered by five J-2 engines. Propellants for the J-2 engines were carried in a single fuel tank with a common bulkhead design and included an associated propellant utilization system to monitor propellant consumption. The McDonnell Douglas S-IVB third-stage was powered by a single J-2 engine. This stage also incorporated a single propellant tank with a common bulkhead design and a propellant utilization system. Major vehicle electronic units were housed in the Instrumentation Unit which was developed by IBM. These included telemetry, communications, tracking and crew safety systems.

4.11 Space Shuttle

The Space Shuttle consists of a reusable delta-winged orbiter vehicle; two reusable solid propellant rocket boosters; and an expendable external tank containing liquid fuel for the orbiter's three main engines. Four orbital configurations are contained in NASA's inventory including Columbia, Discovery, Atlantis, and Endeavor (replacement vehicle for the Challenger). The shuttle's maiden launch took place on April 12, 1981 with a successful Columbia flight. Twenty-three subsequent flights were also successful up to the Challenger accident which took place on January 28, 1986.

The delta-winged orbiter vehicle is designed as a reusable space transport vehicle. It contains a crew compartment which can accomodate up to seven crewmembers. It also has a 60 by 15 ft cargo bay which can accomodate payloads to be orbited in space or the spacelab module for conducting microgravity experiments. Propulsion is provided by the three Space Shuttle Main Engines (SSMEs) located in the aft fuselage. Fuel for the SSMEs are contained in the External Tank. Added in-flight thrust is provided by the two solid rocket boosters which contribute 80 percent of the Space Shuttle's total lift-off thrust.

4.12 Starbird

The Starbird consists of a Talos solid rocket first stage; a Sergeant solid second stage; an Orbus I third stage and a Star 20B fourth stage. The rocket includes a release hinged compression band fairing which houses the payload. It was designed to support the Strategic Defense Initiative (SDI) program by testing sensor suite ability and its capability for performing acquisition, track and discrimination. Only one launch is noted in the database.

The Talos solid rocket first stage is manufactured by Hercules. The solid rocket was originally developed as the boost phase propulsion system for the AIM-8 Talos surface to air missile (SAM). It has since been incorporated into several launch vehicle designs.

4.13 TMD Countermeasure

Early configurations of the TMD Countermeasure launch vehicles included a Talos first stage; a Minuteman I (Aries) second stage; a vented interstage unit connecting the two stages and a payload module assembly. The payload module include the guidance control and avionics (GCA) and flight test experiments (i.e., targets). In addition, the rocket includes a reentry vehicle. Four fins are attached to the aft end of the Talos and Aries motors for aerodynamic stability.

4.14 Vanguard

The Vanguard rocket was derived from the Viking, a scientific sounding rocket whose technology grew out of the V-2 program. Viking was modified into the Vanguard through modifications which increased its capacity and added upper stages. Other changes included using a General Electric thrust motor in the first stage and switching from LOX and alcohol to LOX and RP-1 for fuel. The second stage, developed by

Aerojet, modified the Navy's Aerobee sounding rocket to produce 7,500 lbs of thrust using UDMH and white fuming nitric acid as propellants. A new solid-fuelded rocket, developed by Allegany Ballistics Laboratory (ABL) of the Hercules Powder Company, was used as the third stage.

5.0 SUMMARY

The database files provided herein furnish sufficient information for conducting preliminary reliability and risk analyses on aerospace equipment. The databases can be sorted and query functions enacted to summarize specific pieces of information on component, subsystem, system and vehicle failures. Examples of the types of failure information that can be derived from the databases are given in the succeeding sections.

An useful risk and reliability database will always remain in an incomplete state. Incomplete databases allow for growth and continuous improvements through the addition of better information over time. The database files furnished herein are incomplete, however, as noted previously, sufficient information is contained in them to support the performance of some preliminary reliability analyses. For example, failure totals and probabilities can be obtained which identify prominent equipment failures and offer some insight into failure trends. Through the use of the database query commands failure totals and probabilities for specific LV, system, subsystem and component types can be quickly acquired.

5.1 Failure Summary

Table 5-1 provides a summary of the failure totals comprised in the Risk and Reliability database. This information is also presented in Figure 5-1 in the form of a pie chart. Table 5-1 outlines the number of launch failures by severity. Thus, based on the 716 launches documented in the Data Encoding database, 219 (or 30.6%) were deemed as failures or partial failures by the DI/SAIC data analysts. Out of the 219 failures, 146 were catastrophic, 44 degraded, 25 incipient and four were classified as unknown. The lightly shaded areas in the pie-chart highlight the proportion of failures typically overlooked in performing reliability analyses. Reliability engineers primarily consider catastrophic failures, however, the inclusion of the failures in the gray areas (i.e., degraded, incipient and unknown) provide a more accurate reflection of the vehicle's performance.

Table 5-1. **Total Launch Failures**

Failure Severity	Number of Failures
Catastrophic	146
Degraded	44
Incipient	25
Unknown	4
Total	219

5.1.1 **Launch Vehicle Failure Probabilities**

Figure 5-2 shows the computed failure probabilities and uncertainty bounds for the individual launch vehicles. Moreover, the graph depicts the level of information available in the Risk and Reliability database file. The diagram shows in a comparative format the estimated unreliability or failure probabilities for the vehicles. In addition, each estimate's confidence bounds reflect the amount of data available in the database for the vehicle. Large confidence bounds, such as TMDC's is reflective of its small number of records contained in the database. Presently, the database contains information on only two TMDC launches which is reflected in the large uncertainty shown.

In general, a graph such as TMDC's is interpreted as meaning the estimated mean

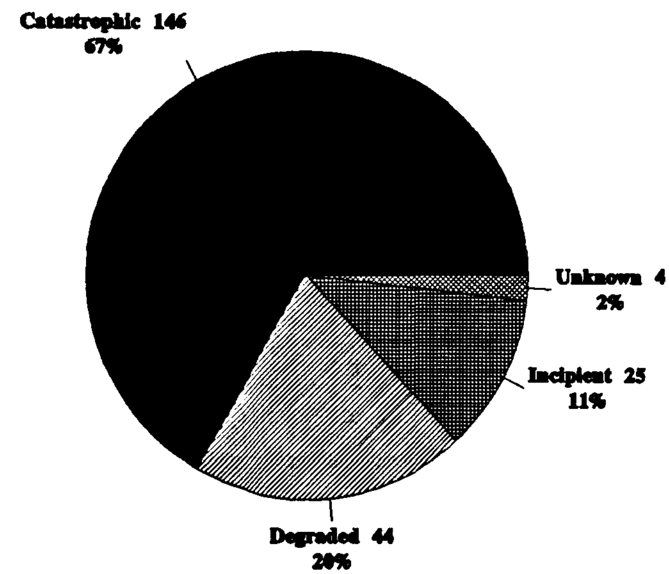
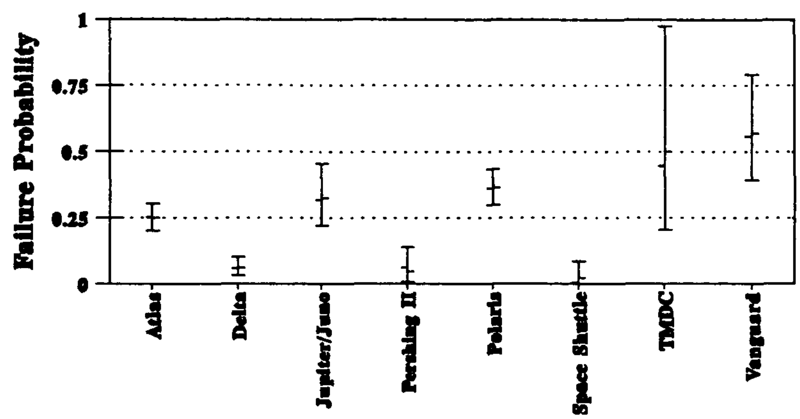


Figure 5-1. **Launch failures in the database**

failure probability for TMDC is 0.50. However, there is a 95% probability that the true failure probability is not greater than 0.975 and a 5% chance it is not less than 0.205. Conversely, Atlas' graph indicates that the estimated mean failure probability for Atlas is 0.251 with a 95% chance it is not greater than 0.305 and a 5% probability it is less than 0.203. This shows clearly that there is much less uncertainty with the Atlas' estimate. This is expected since the Atlas estimate is based on many more records contained in the database.

5.1.2 Generic Failure Totals

Failure summaries for generic aerospace equipment can be obtained from the Risk and Reliability database. The phrase "*generic*" signify that equipment types, such as rocket engines, vary from vehicle to vehicle, but are grouped here under a common classification. Figures 5-3, 5-4 and 5-5 show the comparative failure totals for several generic launch vehicle systems, subsystems and components, respectively. Generic systems such as, Electrical, Flight Control, Guidance, Propulsion, Separation and Structural are displayed in Figure 5-3. There, the number of catastrophic, degraded

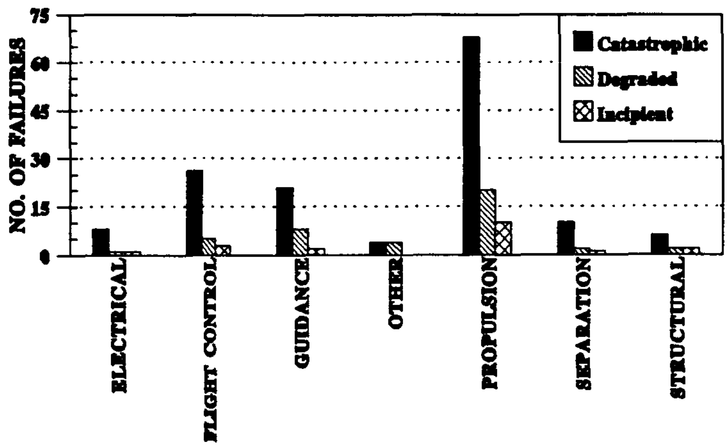


	Atlas	Delta	Jupiter/Juno	Pershing II	Polaris	Space Shuttle	TMDC	Vanguard
95th	0.305	0.102	0.457	0.139	0.436	0.086	0.975	0.794
5th	0.203	0.033	0.222	0.008	0.3	0.0004	0.205	0.393
Mean –	0.251	0.061	0.326	0.046	0.364	0.022	0.5	0.571
Median –	0.254	0.058	0.318	0.062	0.362	0.006	0.447	0.559

Launch Vehicles

Figure 5-2. Launch Vehicle Failure Probability Estimates

and incipient failures contained in the database for each system is shown. Moreover, the bar-graphs show the relative magnitude of failures for the systems. In addition, the graph shows that propulsion failures are predominate when compared to other systems.



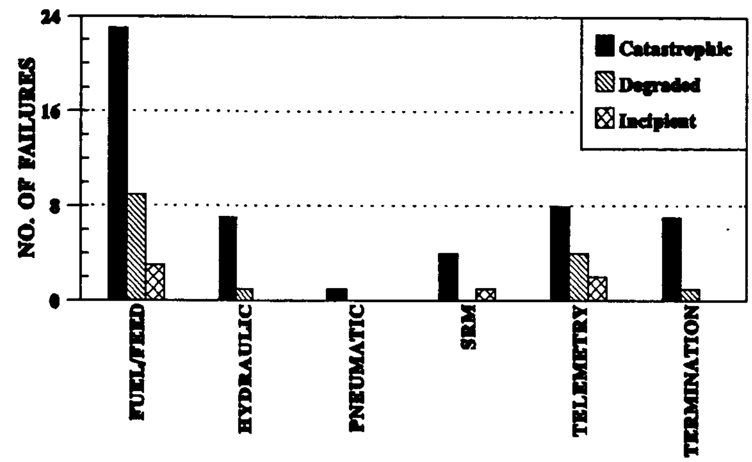
	ELECTRICAL	FLIGHT CONTROL	GUIDANCE	OTHER	PROPULSION	SEPARATION	STRUCTURAL
Catastrophic	8	26	21	4	68	10	6
Degraded	1	5	8	4	20	2	2
Incipient	1	3	2	0	10	1	2

SYSTEM

Figure 5-3. Generic System Failures

Figure 5-4 depicts the failure totals for several generic subsystems including Fuel/feed, Hydraulic, Pneumatic, Solid Rocket Motor (SRM), Telemetery, and Termination. Information on other subsystems is also available in the database, but not shown here. Here, subsystems responsible for performing fuel distribution are the dominant failure contributors.

A comparative look at the failure summaries for several different generic components is provided in Figure 5-5. Components depicted include engine, motor, pump, switch and valve. Here again, other component types are also contained in the database, but are not shown.



Catastrophic	23	7	1	4	8	7
Degraded	9	1	0	0	4	1
Incipient	3	0	0	1	2	0

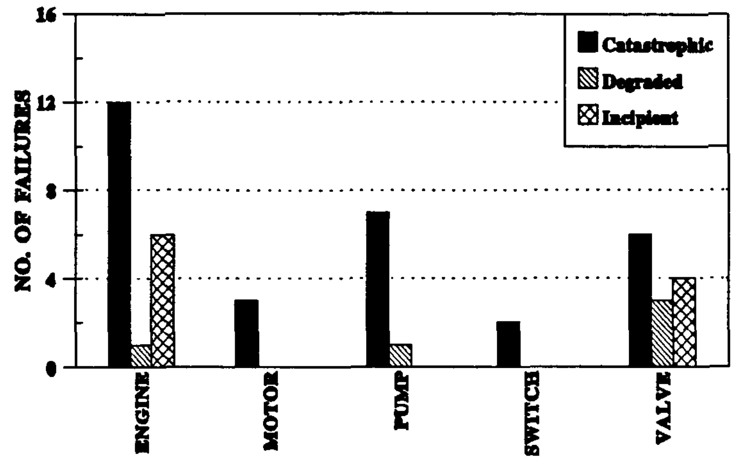
SUBSYSTEM

Figure 5-4. Generic Subsystem Failures

5.1.3 Failure Sequence

Although only a limited amount of time-related failure information is available in the database, some measure of the relative time in the mission when failures occurred can be estimated. The Risk and Reliability database contains failure totals for the different vehicle stages. In particular, it has the number of failures (by severity) in the first, second, third, re-entry and other stage types. Figure 5-6 illustrates the summary of launch vehicle stage failures in a pie chart format.

This is not an accurate manner for estimating the specific time in the mission when a failure can be expected to occur. However, it does provide a relative measure in the sequence of events as to when the predominant number of failures might have taken place. Thus, most failures appear to have occurred within the first 2-3 minutes of the launch based on the large representation of first stage failures shown in Figure 5-6.



	ENGINE	MOTOR	PUMP	SWITCH	VALVE
Catastrophic	12	3	7	2	6
Degraded	1	0	1	0	3
Incipient	6	0	0	0	4

COMPONENT

Figure 5-5. Generic Component Failures

Here, many of the vehicles contained in the database are recognized as having first stages that burn approximately 2-3 minutes in duration.

5.2 Preliminary Analysis

The NASA "*Space Flight Risk Data Collection and Analysis*" project has resulted in the accumulation of an unique data set acquired from the 45th Space Wing at Patrick Air Force Base (PAFB). This particular data collection enables preliminary analyses to be performed focusing on studying the current reliability trend of United States launch vehicles' performance. Recent national and global events related to a shake-up in the aerospace industry during the post-Cold War and U.S. deficit-reduction era, might be resulting in a negative or downward trend in U.S. launch vehicles' reliability. The constant turnover in aerospace personnel, with an associated erosion in the experience or knowledge-base, is expected to lead to organizational confusion, training inadequacies and a loss of institutional culture and morale. Ultimately, a decrease or

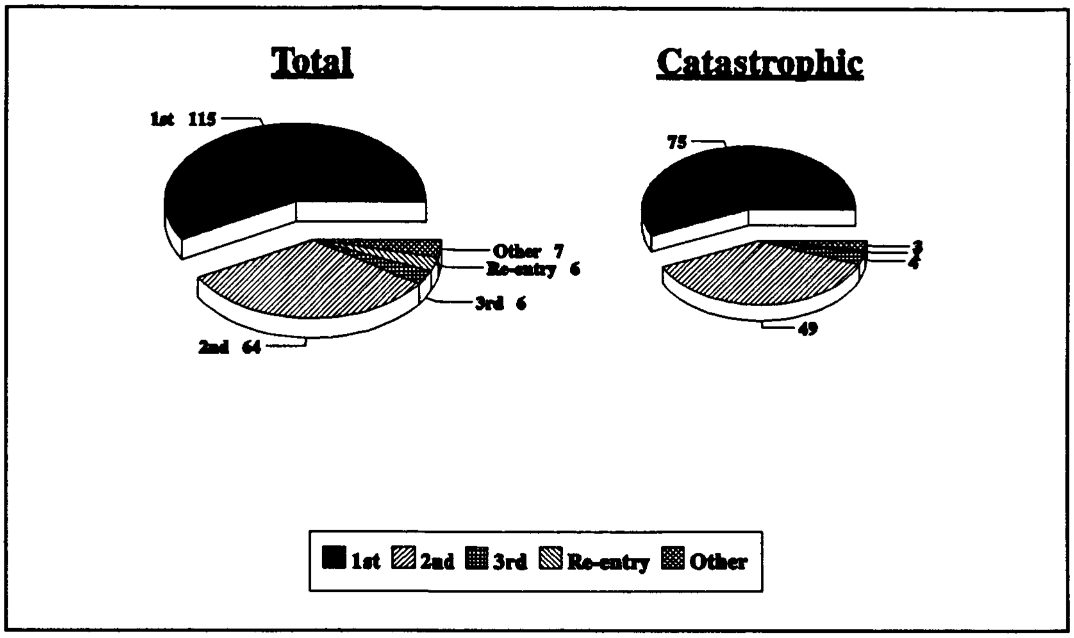


Figure 5-6. Summary of stage failures

decline in launch vehicle performance and reliability can be expected.

The results, based on this single data source, seem to support a downward or declining launch reliability trend. Although a single data source is recognized not to be reflective of the entire national environment, preliminary results here might indicate that additional study is warranted.

5.2.1 **Preliminary Reliability Trend Analysis**

A preliminary launch reliability trend analysis is conducted herein based on the use of the space flight data acquired from the 45th Space Wing at Patrick Air Force Base. The analysis includes performance data obtained on 14 launch vehicles covering approximately 700 launches. Table 3-3 provides an encapsulation of the launch vehicles considered in performing the launch reliability trend.

The overall reliability trend for the 45th Space Wing launches is determined by first computing the ratio of successes (i.e., probability of success) for each vehicle covered

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in Table 3-3. Figure 5-7 provides two graphs that depict the ratio of successes for the 45th Space Wing launches. The first graph is based on all vehicle failures. Conversly, the second plot is based solely on catastrophic failures. A moving weighted average of the vehicle launch reliability is determined to minimize the variation of reliability for each of the years shown in the total launch profile (i.e., 1956 - 1992). A five-year moving average based on yearly reliability estimates is used to minimize the fluctuations that could occur in a given year due to a small number of launches. Furthermore, a weighted moving average was applied to properly distribute the importance of reliability values for years having a large set of launches.

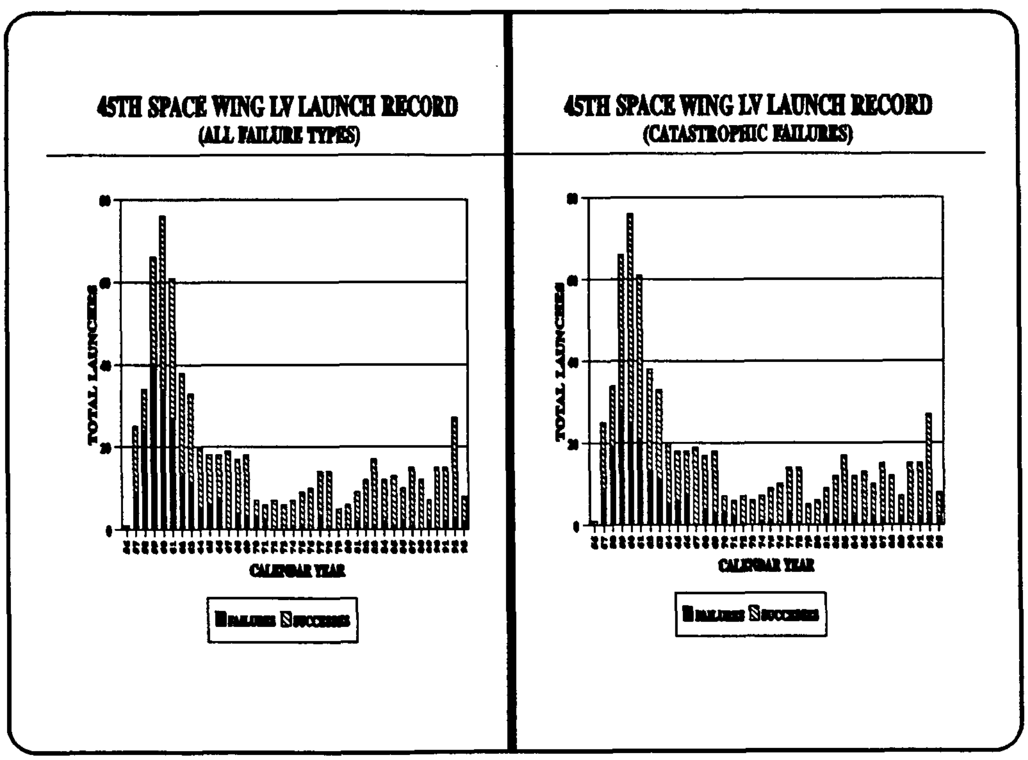

Figure 5-7. **45th Space Wing Launch Record**

5.2.1.1 Weighted Moving Average Reliability

Considering previous time-period measurements (i.e., prior years), the weighted moving average's approach is used to forecast the value for the next or succeeding time-period. The forecasted value is the weighted average of a fixed number of past values.

If we let x_1, x_2, ..., x_n represent past time periods with observed values y_1, y_2, ...,y_n then the predicted value y_{n+1} for the next time period, x_{n+1}, is given by the expression below. Assuming that y_n is the current time period.

$$y_{n+1} = \frac{1}{k} \sum_{j=0}^{k-1} y_{(n-j)} \tag{3}$$

where y_n = current time period,
and k = number of time periods or measurements.

The weighted moving average technique modifies the simple average approach shown above by smoothing data fluctuations and thus developing a trend. Each data value is replaced by the weighted average of itself and surrounding values. In this way, extreme fluctuations are minimized and the overall trend revealed.

In computing the weighted moving average, we let k represent the number of samples on either side of a given data value used in the averaging. The averaged reliability estimates for the first and last periods are computed by repeating the first and last values, respectively, to obtain two points on each side of the end points for averaging. For a five year moving average, k equals two (2) (i.e., two prior periods, the current period and two future periods), resulting in five values being averaged. Here, the weighted average value is computed as shown below.

$$\bar{y}_k = \frac{\sum_{j=i-k}^{j=i+k} w_j y_j}{\sum w_i} \tag{4}$$

For the 45th Space Wing launch reliability, the weighting technique is based on the number of launches attempted for each given year. This results in reliability values determined from a large number of launches having a greater influence or carrying more weight than those derived from small launch years. Figure 5-8 displays the weighted moving average launch reliability values for the 45th Space Wing. The illustration shows a curve with an increasing or positive slope for the first 30 years and slight declining or downward slope for the reliability estimates plotted in recent years (i.e., 1990s).

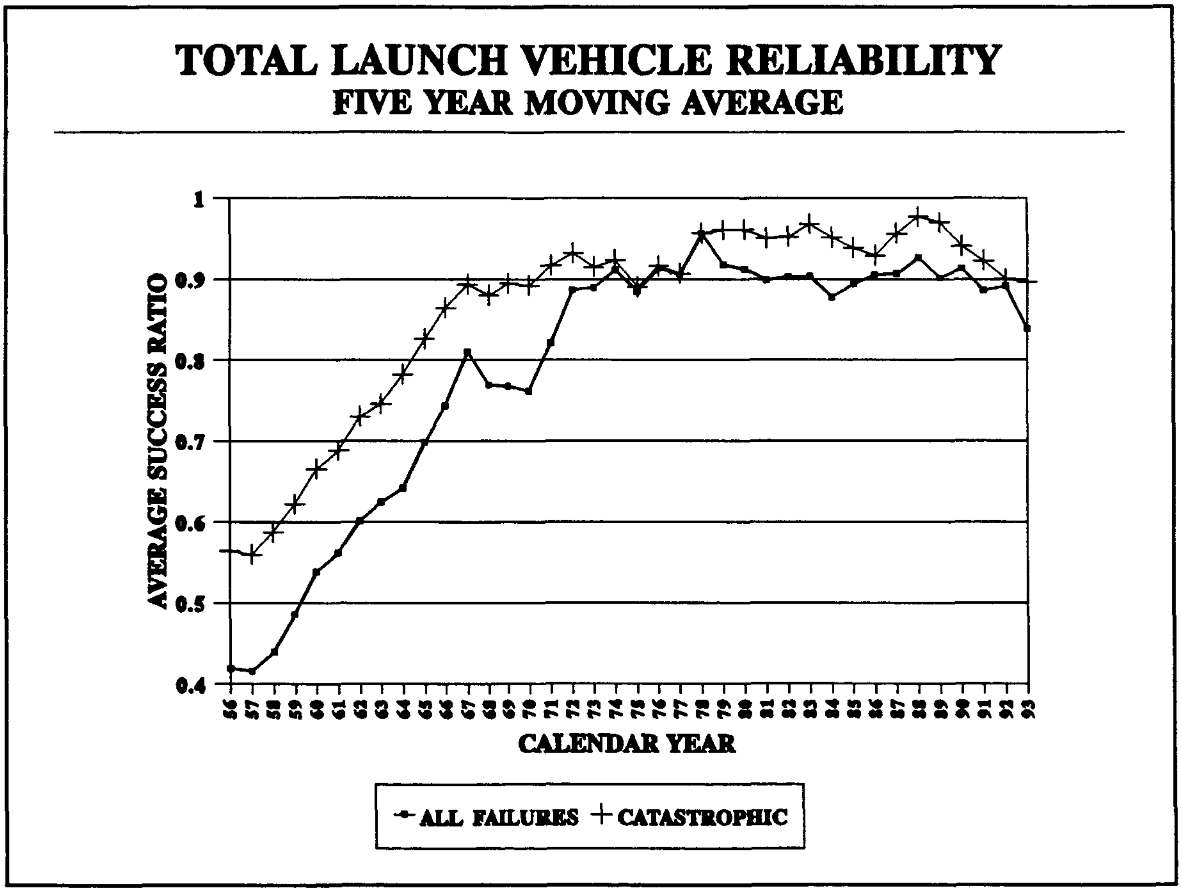

Figure 5-8. 45th Space Wing Launch Reliability

5.2.2 Relative Risk Analysis

The computed relative risk is important and useful in comparing risks and in quantifying how a factor affects the system's overall reliability. In general, when the risks R_1 and R_2 are estimated for two factors, respectively, the relative risk (RR) is the ratio R_1/R_2. In the case where only two factors are considered, a 2x2 contingency matrix approach can be used to figure the relative risk. The general approach for estimating the relative risk is presented below.

When two factors are considered a 2x2 contigency matrix such as the following is constructed:

	Failure	Non-Failure
Factor Present	X_{11}	X_{12}
Factor Absent	X_{21}	X_{22}

X_{ij} is the integer value counts for the observed data

Corresponding to the observed data table is the table of true, but *unknown*, underlying probabilities:

	Failure	Non-Failure
Factor Present	P_1	$1\text{-}P_1$
Factor Absent	P_2	$1\text{-}P_2$

Thus, the estimated relative risk is given by the following:

Here, the relative risk is defined to be a measure of the probability of a failure given that a factor is present to the probability of a failure, given that it is absent. Therefore,

$$RR = \frac{\dfrac{X_{11}}{X_{11}+X_{12}}}{\dfrac{X_{21}}{X_{21}+X_{22}}} \tag{5}$$

the relative risk is a ratio of these probabilities and is given as:

$$RR = P_1/P_2$$

When RR equals one, the risk of failure is independent of whether the factor is present or absent. Similarly, when RR equal r_i then it is interpreted to mean that the probability of failure is r_i times greater with the factor present than without it.

5.2.2.1 **Relative Risk of Unmanned Missions**

The above RR approach can be applied to estimate the relative risk of manned missions. From the Risk and Reliability database, information can be obtained on the number of manned mission failures compared to unmanned mission malfunctions. This information can be translated into an appropriate 2x2 contigency matrix. Fifty-six records in the Data Encoding database address manned missions. These include four Atlas, 45 Space Shuttle, and seven Saturn (Apollo) launches. Therefore, 660 records in the Data Encoding database address unmanned missions. Of the 56 manned missions, only one catastrophic failure is noted. However, two degraded and incipient failures each are also identified. Thus, a total of five failures of all types are noted for the 56 manned missions. The 660 unmanned missions include 145 catastrophic, 42 degraded, 23 incipient and four unknown failures; for a total of 214. Translating the catastrophic failure information into a contigency matrix format results in the following:

	Failure	Non-Failure
Man Present	1	55
Man Absent	145	515

This corresponds to the following underlying probabilities:

	Failure	Non-Failure
Man Present	0.0179	0.9821
Man Absent	0.2197	0.7803

The relative risk is calculated as:

$$RR_{manned} = \frac{\frac{(1)}{(1 + 55)}}{\frac{(145)}{(145) + (515)}} = \frac{(0.0179)}{(0.2197)} = 0.0813 \qquad (6)$$

$$RR_{unmanned} = \frac{\frac{(145)}{(145) + (515)}}{\frac{(1)}{(1 + 55)}} = \frac{(0.2197)}{(0.0179)} = 12.27 \qquad (7)$$

This is interpreted to mean that the probability of failure is 12.3 times greater for unmanned missions as compared to manned missions. This reflects the improved reliability achieved in providing man-rated quality assurance programs for manned missions.

5.2.2.2 **Relative Risk of SRMs**

The above relative risk approach can be used to assess the risk of launch vehicles employing solid rocket motors. The Data Encoding database contain failure information on three vehicle types comprised of 1) liquid fuel only, 2) solid propellant only, and 3) combination of liquid and solids. Table 5-2 provides a breakdown of the vehicle types contained in the Data Encoding database. It shows the number of successes and failures identified for each vehicle.

Table 5-2. **Summary of Vehicle Types**

Vehicle Type	Vehicle	Successes	Failures				Total
			Catastrophic	Degraded	Incipient	Unknown	
Liquid Only							
	Atlas	137	51	11	13	0	212
	Gemini	3	0	0	0	0	3
	Saturn	10	0	7	3	0	20
	Total	150	51	18	16	0	235
Solids Only							
	Brilliant Pebbles	0	1	0	0	0	1
	Pershing II	40	2	0	1	0	43
	Polaris	82	51	7	0	0	140
	Prospector	0	1	0	0	0	1
	Red Tigress	3	1	0	0	0	4
	Starbird	0	0	0	0	1	1
	TMDC	1	1	0	0	2	
	Total	126	57	7	1	1	192
Liquids & Solids							
	Atlas	0	3	0	0	0	3
	Delta	153	11	10	1	4	179
	Jupiter/Juno	20	15	7	4	0	46
	Space Shuttle	42	1	1	1	0	45
	Vanguard	3	8	1	2	0	14

Vehicle Type	Vehicle	Successes	Failures				Total
			Catastrophic	Degraded	Incipient	Unknown	
	Total	218	38	19	8	4	287

The corresponding 2x2 contigency matrix containing catastrophic failures is constructed as follows:

	Failure	Non-Failure
SRM Present	95	384
SRM Absent	51	184

The relative risk is computed in the following way:

$$RR_{SRM} = \frac{\dfrac{(95)}{(95) + (384)}}{\dfrac{(51)}{(51) + (184)}} = \frac{(0.1983)}{(0.2170)} = 0.914 \qquad (8)$$

Since the relative risk is very close to one, the risk of failure is independent of whether the launch vehicles employ SRMs or not.

6.0 APPLICATION

As mentioned previously, the primary purpose for developing the Risk and Reliability database is to provide a convenient source for locating risk and reliability data for use in conducting probabilistic risk assessments (PRAs) and reliability analyses. Thus, the principal application of the enclosed databases is viewed as supporting future PRA and reliability studies.

6.1 Probabilistic Risk Assessments (PRAs)

In assessing risk the analyst attempts to envision how the future will turn out for a certain system if a certain course of action is undertaken. Thus, the risk analysis attempts to answer the following set of questions:

(i) What can happen? Or, what can go wrong?
(ii) How likely is it that the *what can go wrong* will happen?
(iii) If it does happen, what are the consequences?

In answering these questions a list of outcomes or "scenarios", as suggested in Table 6-1 is formulated. The *i*th line in Table 6-1 represents a triplet: $<s_i, p_i, x_i>$.

where s_i is a scenario identification or description;
p_i is the probability of that scenario; and
x_i is the consequence or evaluation measure of that scenario.

Table 6-1. **Scenario List**

Scenario	Likelihood	Consequence
S_1	p_1	x_1
S_2	p_2	x_2
:		
S_N	p_N	x_N

If this table contains all possible scenarios, then it addresses the three questions mentioned above and is recognized as the risk. In general, risk is defined as the set of triplets:

$$R = \{<s_i, p_i, x_i>\}, \qquad i = 1, 2, ..., N.$$

The information contained in the risk and reliability database, including failure probabilities, failure descriptions, failure modes and root causes will assist PRA analysts in defining measures for the first two parameters (i.e., s_i and p_i) in the set of triplets.

6.2 Failure Mode Effects Analysis (FMEA)

The principal risk and safety methods used in the space industry are the failure mode effects analysis (FMEA), criticality analysis and hazard analysis. In general, the Risk and Reliability database provides an useful source in conducting the FMEA and criticality analysis. The FMEA is primarily hardware oriented and consists of evaluating the failure modes for individual components and assessing their effects. It is an inductive analysis that systematically details all possible component failure modes and their effects on the system. Typical component failure modes are provided in several reference sources. The compilation of these failure modes for specific space flight hardware is one of the principal aim of the risk and reliability database.

6.3 Criticality Analysis

Performance of a criticality analysis provides an useful technique for identifying component failures that pose significant safety problems. As part of the analysis method, component failure modes are rated in one of four criticality categories. The four categories[8] include:

Category 1: Failure resulting in potential life.
Category 2: Failure resulting in potential mission failure.
Category 3: Failure resulting in potential delay or loss of operational availability.
Category 4: Failure resulting in excessive unscheduled maintenance.

Component failure mode criticalities are ranked by computing a criticality number C_r with the use of the following expression:

[8]defined by the Society of Automotive Engineers (SAE) in *Aerospace Recommended Practice (ARP) 926*

$$C_r = \sum_{n=1}^{N} \beta \alpha K_E K_A \lambda_G \times 10^6, \quad n = 1,2,\ldots,N \tag{9}$$

where C_r = criticality number for the system component in losses per million trials,
n = critical failure modes in the system component that fall under a particular loss statement,
N = last critical failure mode in the system component under loss statement,
λ_G = generic failure frequency of the component (e.g., failure probabilities contained in the Risk & Reliability database).
K_A = operational factor that adjusts λ_G for the difference between operating stresses when λ_G was measured and the operating stresses under which the component is going to be used,
K_E = environmental factor that adjusts λ_G for differences between environmental stresses when λ_G was measured and the environmental stresses under which the component is going to be used,
α = fraction of λ_G attributable to the critical failure mode,
β = conditional probability that the failure effects of the critical failure mode will occur, given that the critical failure mode has occurred.

6.4 Application of Bayes' Theorem

Typically in conducting a risk assessment there is a need to acquire an estimate for the likely occurrence of a certain event, such as a solid rocket booster (SRB) rupture, for a specific vehicle type (i.e., vehicle m). In other words it is essential to know the frequency, ϕ_m of the event.

Information on an event's frequency of occurrence is generally regarded as falling into three categories:

(1) General background knowledge of the design and manufacture of the system, its operating conditions and environment, and so on.

(2) Experience obtained thus far on the specific system.

(3) Experience acquired on similar systems with similar vehicles (e.g., risk and reliability database).

For a specific system, there might be f_m occurrences (failures) in L_m launches. Therefore, the type (3) information would consist of a set of doublets:

$$\begin{gathered} <f_1, L_1> \\ <f_2, L_2> \\ \vdots \\ <f_j, L_j> \end{gathered}$$

giving the experience of all vehicles which are deemed to be "similar" to the specific vehicle being studied.

Ideally, these three types of information are combined into a single probability curve, $p(\phi_m/E)$ expressing the current state of knowledge about ϕ_m. The fundamental conceptual tool suited to this purpose is Bayes' theorem, which is written as follows:

$$p(\phi_m / E) = p(\phi_m)[\frac{p(E / \phi_m)}{p(E)}] \tag{10}$$

where $p(\phi_m/E)$, the "posterior," is the probability assigned to ϕ_m after having evidence E; $p(\phi_m)$, the "prior," is the probability given to ϕ_m before learning the evidence E; $p(E/\phi_m)$, the "likelihood," is the conditional probability that evidence E would be observed if the true frequency were actually ϕ_m; and p(E), is the prior probability of the evidence E.

Based on Bayes' theorem, information types (1) and (3) represents the "generic" prior, $p(\phi_m)$. The vehicle specific information, type (2) constitutes the evidence, E and enters the calculation through the likelihood function:

$$p(E\ /\ \phi_m) = \left(\frac{(\phi_m L_m)^{f_m}}{k_m!}\right)e^{-\phi_m L_m} \tag{11}$$

The denominator in equation (4), p(E) is then the sum, or integral, of the numerator

$$p(E) = \int_0^\infty p(\phi_m)p(E\ /\ \phi_m)d\phi_m \tag{12}$$

and ensures that the normalization of $p(\phi_m/E)$ is correct.

In summary, Bayes' theorem can be used in concert with the information contained in the Risk and Reliability database and other evidence that might be present about a given system to improve and refine the frequency of occurrence estimates. The Bayesean application provides a method to reduce or minimize the uncertainty boundary centered around the computed figures-of-merits.

7.0 RECOMMENDATIONS

The DI and SAIC project team has made significant progress in extracting and synthesizing relevant RRAMS data from a limited data source, such as the 45th Space Wing. This is evident by the compilation of information in the launch vehicle notebooks and database files. However, additional research will be required to make the database a more useful source in conducting probabilistic risk assessments and reliability studies. The present incomplete database files permit general analyses to be performed, primarily at the system and vehicle levels. However, more detail information on different component failure rates, failure modes and root causes would greatly enhance the database in supporting future risk assessments. In addition, the acquisition of data on other launch vehicles not presently contained in the present database files (e.g., Titan) would improve the coverage of different component types. Also, the acquisition of data from other sources beside the 45th Space Wing is necessary not only for the purpose of bolstering the database, but to provide a more diverse compendium of space flight risk data. Since, launch vehicle processing contribute somewhat to space flight outcomes (i.e., success or failure), it would be advantageous to acquire data from more than one source besides the 45th Space Wing, since its single process style might bias the results contained in the Risk and Reliability database.

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APPENDIX A

DATA ENCODING DATABASE PARTIAL PRINTOUT

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
ATLAS	4A	Dummy non-separable rocket vehicle; one-stage; XLR-89-NA-1 Engines; S-band, DOVAP & Azusa beacons	A1	6/11/57	F	F	A drop in the fuel supply to the B2 engine resulted in a drop in performance. This caused both engines to move hard-over as compensation. The missile was destroyed by RSO at 50.1 seconds.
ATLAS	6A	GE Mark 2 Mod I R/V; MA-1 Propulsion system; GE Mod II Guidance System; Azusa and Dovap transponders	A2	9/25/57	S	S	Test number 1382.
ATLAS	12A	GE Mark 2 Mod I R/V; MA-1 Propulsion system; GE Mod II Guidance System; Azusa and Dovap transponders	A3	12/17/57	S	P	Test number 1383. Impact indicated at less than 0.2 nm from target.
ATLAS	10A	GE Mark 2 Mod I R/V; MA-1 Propulsion System; GE Mod II Guidance System; Azusa and Dovap transponders; GE IP System	A4	1/10/58	S	P	Test number 1511. Impact indicated within one or two nm off the target.
ATLAS	13A	CV Low Drag Nose R/V; MA-1 Propulsion System; GE Mod II R-IG System; Azusa B transponder and GE IP System	A5	2/7/58	F	F	Test number 1512. All systems operated satisfactorily until affected by the propulsion system failure and explosion.
ATLAS	11A	GE Mark 2 Mod I R/V; MA-1 Propulsion System; GE Mod II Guidance System; Azusa and Dovap transponders; GE impact-prediction (IP) system	A6	2/20/58	F	F	Test number 1513. Impact occurred at 2300nm downrange.
ATLAS	15A	CV Low Drag Nose (B-series) R/V; MA-1 Propulsion System; Model II radio-inertial (R-I) guidance system; Azusa B transponder; IP beacons	A7	4/5/58	S	S	Test number 1730.
ATLAS	16A	CV Low Drag Nose (B Series) R/V; MA-1 Propulsion System; GE Mod II Radio-Inertial (R-I)	A8	6/3/58	S	S	Test number 1729. The only apparent discrepancy was excessive roll during the self-guided booster phase. The probable cause is an incorrect operation of programmer switches which provide roll program input.
ATLAS	3B	GE Mark 2 Mod I R/V; MA-1 Propulsion System; Mod III guidance system; Azusa B transponder; S-band beacon	A9	7/19/58	S	S	Test number 2501.
ATLAS	4B	GE Mark 2 Mod 1 R/V; MA-1 Propulsion System; GE Mod II Radio-Inertial Guidance System; Azusa transponder	A10	8/2/58	F	F	Test number 30. Since the complete airframe telemetery system was removed to reduce weight, little information was received as to the nature of the failure.
ATLAS	5B	Dummy R/V; One-stage; XLR-89-NA-1 Engines; Azusa and DOVAP transponders; gyro cannister flight control system.	A11	8/28/58	F	F	A loss of liquid oxygen regulator reference pressure caused both engines performance level to drop to 40% of normal, 43.3 seconds into the flight. Subsequently, both engines shut down due to LOX starvation. The missile was destroyed at 74 seconds.
ATLAS	8B	Dummy nose cone; XLR-89-NA-1 Propulsion System; Gyro cannister Flight Control System; GE Mod IB Guidance System; Azusa and Dovap transponders.	A12	9/14/58	S	S	A loss of one or more phases of primary 400 cycle AC power resulted in the abrupt cut off of all signals to and from the ground at 85 seconds.
ATLAS	6B	Dummy nosecone R/V; XLR-89-NA-1 Propulsion system; Gyro cannister flight control system; GE mod IB Guidance System; Azusa and Dovap transponders; range safety beacon and command system.	A13	9/18/58	S	S	Except for an electrical transient prior to burnout, all systems operated satisfactorily.
ATLAS	9B	Dummy nosecone R/V; XLR-89-NA-1 Propulsion System; Gyro cannsister flight control system; open-loop GE mod IB Guidance System; Azusa and Dovap Mark II transponders; range safety beacon and command systems.	A14	11/17/58	P	F	Unexplained propellant sloshing started building up shortly before 100 seconds, and eventually led to missile instability and breakup.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
ATLAS	12B	Dummy nosecone; XLR-89-NA-1 Propulsion System; Gyro Cannister Flight Control System; GE Mod IB Radio Guidance System; Azusa and Dovap Mark II transponders; range safety beacon and command system.	A15	11/28/58	P	F	Divergent oscillation began in the engine positions and in the rate gyro outputs. The engines continued to oscillate between stops until loss of power at 124.78 seconds.
ATLAS	10B	Dummy nosecone R/V; Rocketdyne Propulsion System; Gyro Cannister Flight Control System; Open-loop GE Mod IB Guidance System; Azusa and Dovap transponders; S-band beacon; Range safety command system.	A16	12/18/58	P	P	At 96.5 seconds turbopump speed dropped for about one second. It then increased again and remained normal until about 105.4 seconds when it abruptly stopped operating. This led to the B2 turbopump stopping and the engines shutting down. Normal s
ATLAS	3C	Dummy nosecone R/V; Rocketdyne Propulsion System; Gyro cannister flight control system; open-loop GE mod IB Guidance System; Azusa and Dovap Mark II transponders; s-band beacon; range safety command system	A17	12/23/58	S	S	Erratic operation of S-band beacon. Failure of GE pulse beacon.
ATLAS	13B	GE Mark 2 Mod I R/V; MA-1 Propulsion System; GE Mod II Guidance System; Azusa and Dovap Transponders	A18	1/15/59	F	F	Test number 1564
ATLAS	4C	GE Mark 2 Mod 2A R/V with Sandia Warhead test package; MA-1 Propulsion system; GE Mod III System; Azusa B Transponder	A19	1/27/59	F	F	Test number 10. R/V did not separate.
ATLAS	11B	GE Mark 2 Mod 1 R/V; MA-1 Production engine assembly; GE Mod II Guidance System; Azusa B and Dovap transponders; GE Impact Prediction	A20	2/4/59	S	S	Test number 29.
ATLAS	5C	GE Mark 2 Mod 1F R/V; MA-1 Propulsion System; Mod III Radio-Inertial guidance system; Azusa B transponder	A21	2/20/59	F	F	Test number 251.
ATLAS	7C	RVX-2 R/V; MA-1 Propulsion System; Mod III Radio-Inertial Guidance System; Azusa B transponder	A22	3/18/59	F	F	Test number 761.
ATLAS	3D	GE Mark 2 Mod 2A with Sandia test package; Rocketdyne MA-2; Mod III radio guidance	A23	4/14/59	F	F	Test number 1002. Reason for valve opening undetermined, but either equipment failure and/or operator error suspected.
ATLAS	7D	GE RVX-2 R/V; Rocketdyne MA-2; Mod III Radio Guidance	A24	5/18/59	F	F	Test number 1754. Missile exploded 65 seconds after liftoff.
ATLAS	5D	GE Mark II Mod II A R/V with Sandia test package; 2 stages; MA-2 Propulsion System; Mod III radio-inertial guidance system	A25	6/6/59	F	F	Test number 1753. Explosion occurred at 160 seconds after liftoff.
ATLAS	8C	RVX-2 R/V; MA-1 Propulsion System; Mod III R-IG System; Azusa B transponder	A26	7/21/59	S	S	Test number 2103.
ATLAS	11D	Mark II Mod I AE R/V; 2 stages; Rocketdyne MA-2; Mod III Radio-Inertial Guidance System; Azusa and S-band transponders	A27	7/28/59	S	S	Test number 2002. Major discrepancies noted in performance of several major systems.
ATLAS	14D	GE Mark II Mod 2A R/V with Sandia test package; 2 stages; Rocketdyne MA-2; Mod III radio-inertial guidance system	A28	8/11/59	S	S	Test number 2003.
ATLAS	11C	Mark 2 Mod 1AE R/V with Mod 8 data capsule; MA-1 Propulsion System; Mod III R-IG system; Azusa B and S-band transponders	A29	8/24/59	S	P	Test number 2121.
ATLAS	10D	MA-2 Propulsion System; GE Mod III E Guidance System with Round Autopilot	A30	9/9/59	F	F	Test number 2119. Mercury payload.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
ATLAS	17D	GE Mark II Mod IIA re-entry vehicle with Sandia test package; 2-stage booster	A31	9/16/59	S	P	Test number 2106.
ATLAS	9C	Atlas; Able	A32	9/24/59	F	F	Not a launch. Missile blew up on the pad during static firing.
ATLAS	18D	Mark II Mod I re-entry vehicle; one stage Atlas booster	A33	10/6/59	S	S	Test number 2120.
ATLAS	22D	Mark 3 Mod I re-entry vehicle; one stage Atlas booster	A34	10/9/59	S	S	Test number 3503.
ATLAS	26D	GE MSVD Mark III Mod I re-entry vehicle; one-stage booster	A35	10/29/59	P	P	Test number 2344.
ATLAS	28D	GE MSVD Mark III Mod I re-entry vehicle; one-stage booster	A36	11/4/59	S	P	Noted that the remotely activated telemetry battery again needed replacing during countdown.
ATLAS	15D	GE MSVD Mark III Mod I re-entry vehicle; two-stage Atlas booster	A37	11/24/59	S	S	Test number 2105. Remote batteries in arming and fuzing system failed to activate.
ATLAS	20D	Four-stage rocket.	A38	11/26/59	F	F	Test number 4122. Able IV.
ATLAS	31D	Mark 3 Mod I re-entry vehicle; one stage Atlas booster	A39	12/8/59	S	S	Test number 4205.
ATLAS	40D	GE MVSD Mark II Mod IIA re-entry vehicle; two-stage Atlas booster	A40	12/18/59	S	S	Test number 16. First Atlas to deliver a standard re-entry vehicle over the 5500nm range.
ATLAS	43D	GE MSVD Mark III Mod IX re-entry vehicle; one stage Atlas booster	A41	1/6/60	S	S	Test number 32. A major transient occurred in battery voltage but no systems seriously interrupted.
ATLAS	44D	AVCO RVX-4A-2 re-entry vehicle; one stage Atlas booster	A42	1/26/60	S	S	Test number 54. Re-entry vehicle data cassette was not recovered.
ATLAS	49D	GE MVSD Mark 3 Mod IA re-entry vehicle; one stage Atlas booster	A43	2/11/60	S	S	Test number 320. Transients were observed in the missile AC voltage at BCO and SECO.
ATLAS	29D	Atlas D booster; Agena upperstage	A44	2/26/60	F	F	Test number 304. Midas I.
ATLAS	42D	Mark III Mod I X steel test unit re-entry vehicle; one stage booster	A45	3/8/60	S	P	Test number 17. A possible fire was noted in the thrust and engine compartments. Impact was placed 15 or 20 nm to the left and less than 1/2 nm downrange of target.
ATLAS	51D	Mark III Mod IA re-entry vehicle; one stage booster	A46	3/10/60	F	F	Test number 775. Test stand and facility were damaged.
ATLAS	48D	Mark III Mod IA re-entry vehicle; one stage booster	A47	4/7/60	F	F	Test number 301. A final explosion occurred at about 60 seconds with the missile never having left the pad.
ATLAS	56D	GE MSVD Mark 3 Mod IB re-entry vehicle; one stage Atlas booster	A48	5/20/60	S	S	A previous attempt to launch this missile on 5/12/60 was terminated by automatic cutoff.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
ATLAS	45D	Atlas D booster; Agena A upperstage	A49	5/24/60	S	S	The booster performed satisfactorily. The satellite was placed in the proper position for orbit.
ATLAS	54D	GE Mark III Mod IB re-entry vehicle; one stage booster	A50	6/11/60	S	P	First flight test for AIG system. Trajectory deviated grossly from planned.
ATLAS	62D	GE MSVD Mark III Mod IIB re-entry vehicle; one stage Atlas booster	A51	6/22/60	S	P	Test number 81. Guidance cutoff did not cause VECO, so the autopilot backup accomplished cutoff. Impact indicated 18nm downrange.
ATLAS	27D	GE Mark 3 Mod 2B re-entry vehicle; one stage Atlas booster	A52	6/27/60	S	S	Test number 1002. Missile lift off delayed 4.8 seconds to increase probability of shutting down missile if combustion instability developed.
ATLAS	60D	GE Mark III Mod IB re-entry vehicle; one stage Atlas booster	A53	7/2/60	F	F	Test number 803.
ATLAS	50D	Mercury capsule re-entry vehicle; one stage Atlas booster	A54	7/29/60	F	F	Test number 1505. Mercury.
ATLAS	32D	GE MSVD Mark III Mod IB re-entry vehicle; one stage Atlas booster	A55	8/9/60	S	S	Test number 1003. A previous attempt to launch this missile on 8/2/60 met with automatic engine cutoff 1.53 seconds after sustainer flight lockin.
ATLAS	66D	RVX-2A re-entry vehicle; one stage Atlas booster	A56	8/12/60	S	S	Test number 1004. A special test was performed involving the LO2 and fuel tank repressurization. This was done since one of the three previous attempts at launch failed because of the repressurization problem.
ATLAS	76D	RVX-2A re-entry vehicle; one stage Atlas booster	A57	9/16/60	S	S	Test number 2817. The missile was dry started with no additional hold-down time.
ATLAS	79D	Mark 3 Mod 1B re-entry vehicle; one stage Atlas booster	A58	9/19/60	S	S	Test number 802.
ATLAS	80D	Three stage rocket	A59	9/25/60	F	F	Test number 2801. Able V.
ATLAS	3E	AVCO Mark 4 Mod I nose cone; two-stage booster	A60	10/11/60	F	F	Test number 2508.
ATLAS	71D	RVX-2A re-entry vehicle; two-stage Atlas booster	A61	10/13/60	S	S	A slight drop in engine performance just before BCO was noted but with no adverse affects. Test number 1502.
ATLAS	55D	GE Mark III Mod 2B nose cone; two-stage Atlas booster	A62	10/22/60	S	S	Test number 613. Missile flown without insulation and supporting bulkhead at the intermediate bulkhead.
ATLAS	83D	AVCO Mark IV Mod 4 nose cone; two-stage Atlas booster	A63	11/15/60	S	S	Test number 3503.
ATLAS	4E	GE Mark 3 Mod IB nose cone; one stage Atlas booster	A64	11/29/60	F	F	Test number 2800.
ATLAS	91D	Three-stage rocket	A65	12/15/60	F	F	Test number 4508. ABLE 5B.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
ATLAS	90D	GE Mark III Mod IB nose cone; two-stage Atlas booster	A66	1/23/61	S	S	Test nubmer 3505.
ATLAS	8E	AVCO Mark 4 Mod 4 nose cone; one stage Atlas booster	A67	1/24/61	F	F	Test number 3504.
ATLAS	67D	Mercury MA-2 capsule; one-stage Atlas booster	A68	2/21/61	S	S	Test number 419. Mercury MA-2.
ATLAS	9E	GE Mark 3 Mod 2B re-entry vehicle; one-stage Atlas booster	A69	2/24/61	S	S	Test number 3803.
ATLAS	13E	GE Mark 3 Mod 1B re-entry vehicle; one stage Atlas booster	A70	3/13/61	F	F	Test number 403.
ATLAS	16E	Mark III Mod IIB re-entry vehicle; one-stage Atlas booster	A71	3/24/61	F	F	Test number 811.
ATLAS	100D	Mercury capsule; one stage Atlas booster	A72	4/25/61	F	F	Test number 835. After capsule separation the LO2 tank dome was ruptured and tank pressure was not maintained.
ATLAS	12E	AVCO Mark 5 Mod 1 re-entry vehicle; one-stage Atlas booster	A73	5/12/61	S	S	Test number 404. Two complete pre-flight checkouts ran due to previous troubles with "E" series. First test of ARMA Lot III equipment for automatic launch and checkout operations with ARMA Lot IV AIG.
ATLAS	18E	AVCO Mark 4 Mod IV 6 re-entry vehicle; one stage Atlas booster	A74	5/26/61	S	P	Test number 813. There were three problems which did not affect missile performance: - Azusa performance not good, - ADF package did not eject, retro-rockets did not fire although re-entry vehicle separation wasn't affected.
ATLAS	17E	GE Mark 3 Mod 1B re-entry vehicle; one stage Atlas booster	A75	6/22/61	F	F	Test number 812. Missile destroyed itself after 101.5 seconds.
ATLAS	22E	Mark 3 Mod 2B re-entry vehicle; one-stage Atlas booster	A76	7/7/61	S	S	Test number 1251. First "E" series missile to be flown successfully over the extended range of 7863nm.
ATLAS	21E	AVCO Mark 5 Mod I re-entry vehicle; one stage Atlas booster	A77	7/31/61	S	P	Test number 1360. All major systems operated properly with the exception of the propellant utilization system.
ATLAS	2F	AVCO Mark 5 Mod I re-entry vehicle; one-stage Atlas booster	A78	8/8/61	S	S	Test number 1805. The Acoustica PU System was flown closed-loop for the first time on an "E" or "F" series missile.
ATLAS	111D	Atlas D; Agena B	A79	8/23/61	P	P	Test number 2530. The flight was successful until the Agena second burn.
ATLAS	26E	AVCO Mark 4 Mod 2A re-entry vehicle; one stage Atlas booster	A80	9/8/61	F	F	Test number 1803.
ATLAS	88D	Mercury capsule; one-stage Atlas booster	A81	9/13/61	S	S	Test number 1254. The flight was successful with the Mercury capsule being placed in orbit. At sustainer cutoff guidance errors were all near the maximum allowable tolerances with the inertial velocity and flight path angle errors exceeding the t

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
ATLAS	25E	AVCO Mark 5 Mod I re-entry vehicle; one stage Atlas booster	A82	10/2/61	S	P	Test number 1252. Impact about 1.5 nm and 0.4 nm from intended target.
ATLAS	30E	Mark 4 Mod I re-entry vehicle; one-stage Atlas booster	A83	10/5/61	S	S	Test number 1804. Some information on performance sheet cutoff.
ATLAS	32E	RVX-2A re-entry vehicle; one stage Atlas booster	A84	11/10/61	F	F	Test number 3203.
ATLAS	117D	Atlas D booster; Agena B upperstage	A85	11/18/61	F	F	Test number 4507. Ranger RA-2.
ATLAS	4F	AVCO Mark 5 Mod 2 re-entry vehicle; one-stage Atlas booster	A86	11/22/61	S	S	Test number 3751. First "F" series to be flown with a lofted trajectory.
ATLAS	93D	Mercury capsule; one stage Atlas booster	A87	11/29/61	S	P	Test 1810. Mercury MA-5. Impact was approximately 8nm long and 8nm left of the nominal impact point.
ATLAS	35E	Mark 4 Mod 4 re-entry vehicle; one-stage Atlas booster	A88	12/1/61	S	S	Test number 5462.
ATLAS	5F	Mark 4 Mod 2A re-entry vehicle; one stage Atlas booster	A89	12/12/61	P	F	Test number 3752.
ATLAS	36E	Mark 5 Mod 1A re-entry vehicle; one-stage Atlas booster	A90	12/20/61	S	S	Test number 5464.
ATLAS	6F	Mark 5 Mod 2 re-entry vehicle; one stage Atlas booster	A91	12/20/61	F	F	Test number 4501.
ATLAS	121D		A92	1/26/62	F	F	Test number 125. Ranger RA-3.
ATLAS	40E	Mark 4 Mod 2A re-entry vehicle; one-stage Atlas booster	A93	2/13/62	S	S	Test number 101.
ATLAS	109D	Mercury Production model (Friendship); one-stage Atlas booster	A94	2/20/62	S	S	Test number 5460. Mercury capsule contained an astronaut. Mercury MA-6.
ATLAS	11F	Mark 4 Mod 1B re-entry vehicle; one stage Atlas booster	A95	4/9/62	F	F	Test number 71. An explosion in the thrust section at 0.9 seconds was followed by a propellant explosion and missile destruction at 1.19 seconds.
ATLAS	133D	Atlas D booster; Agena B upperstage; Ranger spacecraft	A96	4/23/62	S	S	Test number 821. The spacecraft command system failed.
ATLAS	104D	Atlas D booster; Centaur upperstage	A97	5/8/62	F	F	Test number 5461. Centaur F-1.
ATLAS	107D	Mercury Aurora 7 capsule; one stage Atlas booster	A98	5/24/62	S	P	Test number 65. Impact 250 nm beyond the planned impact area.
ATLAS •	145D	Atlas D booster; Agena B upperstage	A99	7/22/62	F	F	Test number 2900. Mariner R-I capsule.

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(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
ATLAS	7F	Mark 4 Mod 4 re-entry vehicle; one-stage Atlas booster	A100	8/13/62	S	S	Test number 102.
ATLAS	179D	Atlas D booster; Agena B upperstage; Mariner R	A101	8/27/62	S	P	Test number 3731. Mariner R-II.
ATLAS	8F	Mark 4 Mod I re-entry vehicle; one-stage Atlas booster	A102	9/19/62	S	S	Test number 103. Square autopilot system configured with rate and displacement gyro spin motor rotation detectors.
ATLAS	113D	Mercury Sigma 7 capsule; one-stage Atlas booster	A103	10/3/62	S	S	Test number 66. Mercury MA-8 (manned).
ATLAS	215D	Atlas D booster; Agena B upperstage; Ranger spacecraft	A104	10/18/62	S	S	Test number 5050. The airborne guidance rate beacon failure did not adversely affect the flight.
ATLAS	14F	Mark 4 Mod 1B re-entry vehicle; one-stage Atlas booster	A105	10/19/62	S	S	Test number 72.
ATLAS	16F	Mark 4 Mod 1B re-entry vehicle; one stage Atlas booster	A106	11/7/62	S	P	Test number 73. The suppression valve mispositioning had no adverse effect on engine performance.
ATLAS	21F	Mark 4 Mod 1B re-entry vehicle; one-stage Atlas booster	A107	12/5/62	S	S	Test number 1906.
ATLAS	134F	Atlas F booster; Chrysler REX-1 re-entry vehicle	A108	3/1/63	S	S	Test number 119. "Wet-start" ignition method used for the first time with the MA-3 propulsion system.
ATLAS	135F	CS-2FT REX-2 re-entry vehicle; Atlas F booster	A109	4/26/63	S	S	Test number 1501. "Wet" start ignition.
ATLAS	130D	Mercury Faith 7 capsule; Atlas D booster	A110	5/15/63	S	S	Test number 125. Mercury MA-9.
ATLAS	197D	Atlas LV-3A; Agena upperstage; S/N2 and S/N3 spacecrafts	A111	10/13/63	S	S	Test number 5145.
ATLAS	136F	Atlas F booster; WAC-1 re-entry vehicle	A112	10/28/63	F	F	Test number 3686. The first attempt at launching this vehicle was scrubbed on 10/26/63, due to loss of the R/V C-band transponder during the countdown.
ATLAS	126D	Atlas D booster; Centaur upperstage	A113	11/27/63	S	S	Test number 5175. Hypergolic ignition for boosters only.
ATLAS	199D	Atlas D booster; Agena upperstage	A114	1/30/64	S	S	Test number 250. Missile configuration information not provided.
ATLAS	5E	GE WAC-3 re-entry vehicle; Atlas booster	A115	2/25/64	S	S	Test number 150. First time Atlas used in the static test program (5E underwent equivalent of 5 flights prior to launch).
ATLAS	137F	GE WAC-2 re-entry vehicle; Atlas booster	A116	4/1/64	S	S	Test number 0575.
ATLAS	263D	Apollo-shaped re-entry vehicle; LV-3 Atlas booster	A117	4/14/64	S	S	Test number 0225. Launch site info not provided.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
ATLAS	135D	Atlas D booster; Centaur 1C upperstage	A118	6/30/64	F	F	Test number 0121. AC-3.
ATLAS	216D	Atlas LV-3A booster; Agena upperstage; S/C5 and S/C6 spacecrafts	A119	7/17/64	S	S	Test number 2925.
ATLAS	250D	Atlas D booster; Agena B upperstage; Ranger spacecraft	A120	7/28/64	S	S	The Ranger 7 spacecraft was placed in a circular 100nm parking orbit. The Agena 2nd burn placed it in a lunar transfer orbit.
ATLAS	195D	Atlas D booster; Agena B upperstage	A121	9/4/64	S	S	Test number 4307.
ATLAS	289D	Atlas D booster; Agena D upperstage; Mariner	A122	11/5/64	F	F	
ATLAS	288D	Atlas D booster; Agena upperstage; Mariner 2 spacecraft	A123	11/28/64	S	S	Test number 5099. Command destruct removed from Agena.
ATLAS	146D	Atlas D booster; Centaur upperstage	A124	12/12/64	S	S	Test number 9373. Performance record writing not too clear. Cannot make out spacecraft name.
ATLAS	169D	Atlas D booster; Agena B upperstage; Ranger spacecraft	A125	2/17/65	S	S	Test number 0235.
ATLAS	156D	Atlas D booster; Centaur 6C upperstage	A126	3/2/65	F	F	Test number 205. Launch pad explosion. Most debris remained within 500 feet of pad.
ATLAS	D	Atlas D booster; Agena upperstage	A127	3/21/65	S	S	
ATLAS	264D	Atlas LV-3A booster; Apollo shaped re-entry vehicle	A128	5/22/65	S	S	Test number 0501. Fire II.
ATLAS	SLV-3	Atlas D booster; Agena D upperstage	A129	7/20/65	S	S	Test number 1496. VELA satellite payload.
ATLAS	151D	Atlas D booster; Centaur upperstage; Inertial Guidance System	A130	8/11/65	S	S	Test number 1920. AC-6.
ATLAS	SLV-3	Atlas SLV-3 booster; Agena D upperstage	A131	10/25/65	F	F	Test number 4994. GATV.
ATLAS	184D	Atlas D booster; Centaur upperstage	A132	4/7/66	P	F	Test number 6812.
ATLAS	LV-3C	Atlas D booster; Centaur 1D upperstage; Surveyor spacecraft	A133	5/30/66	S	S	Test number 0184.
ATLAS	SLV-3	Atlas SLV-3 booster; Agena D upperstage; OGO-B spacecraft	A134	6/6/66	S	S	Test number 6423.
ATLAS	SLV-3	Atlas SLV-3 booster; Agena D upperstage; LO-A spacecraft	A135	8/10/66	S	S	Test number 4003.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
ATLAS	194D	Atlas D booster; Centaur upperstage; Surveyor spacecraft	A136	9/20/66	S	S	Test number 5739.
ATLAS	174D	Atlas D booster; Centaur D upperstage; Inert Mass Model of Surveyor spacecraft	A137	10/26/66	S	P	Test number 1906. No mission objectives compromised.
ATLAS	SLV-3	Atlas SLV-3 booster; Agena D upperstage; Lunar orbiter spacecraft	A138	11/6/66	S	S	Test number 1469.
ATLAS	SLV-3	Atlas SLV-3 booster; Agena D upperstage; ATS-B spacecraft	A139	12/6/66	S	S	Test number 8267.
ATLAS	SLV-3	Atlas SLV-3 booster; Agena D upperstage; Lunar Orbiter C spacecraft	A140	2/4/67	S	S	Test number 3424.
ATLAS	SLV-3	Atlas SLV-3 booster; Agena D upperstage; ATS-A spacecraft	A141	4/5/67	S	S	Test number 4570.
ATLAS	292D	Atlas SLV-3 booster; Centaur upperstage; Surveyor spacecraft	A142	4/17/67	S	S	Test number 6950. Uncorrected surveyor impact point.
ATLAS	SLV-3	Atlas SLV-3 booster; Agena D upperstage; Lunar Orbiter D spacecraft	A143	5/4/67	S	S	Test number 2935.
ATLAS	SLV-3	Atlas SLV-3 booster; Agena D upperstage; Mariner V spacecraft	A144	6/14/67	S	S	Test number 4102.
ATLAS	291D	Atlas SLV-3 booster; Centaur D upperstage; Surveyor spacecraft	A145	7/14/67	S	S	Test number 4213. Uncorrected Surveyor impact point.
ATLAS	SLV-3	Atlas SLV-3 booster; Agena D upperstage; Lunar Orbiter E spacecraft	A146	8/1/67	S	S	Test number 6622.
ATLAS	SLV-3C	Atlas SLV-3 booster; Centaur D upperstage; Surveyor spacecraft	A147	9/8/67	S	S	Test number 7231. Uncorrected Surveyor Impact Point.
ATLAS	SLV-3	Atlas SLV-3 booster; Agena D upperstage: ATS-C spacecraft	A148	11/5/67	S	S	Test number 2800.
ATLAS	SLV-3C	Atlas SLV-3C booster; Centaur D upperstage; Surveyor spacecraft	A149	11/7/67	S	S	Test number 2020. Uncorrected Surveyor Impact Point.
ATLAS	SLV-3C	Atlas SLV-3C booster; Centaur upperstage; Surveyor spacecraft	A150	1/7/68	S	S	Test number 1384.
ATLAS	SLV-3A	Atlas SLV-3A booster; Agena D upperstage; OGO-E spacecraft	A151	3/4/68	S	S	Test number 3366. Sparse data.
ATLAS	SLV-3A	Atlas SLV-3A booster; Agena upperstage; PRD 3880 spacecraft	A152	8/6/68	S	S	Test number 4920. Sparse data.
ATLAS	SLV-3C	Atlas SLV-3C booster; Centaur 14D; Applications Technology Satellite	A153	8/10/68	F	F	Test number 4089.

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(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
ATLAS	SLV-3C	Atlas SLV-3C booster; Centaur upperstage; Orbiting Astronomical Observatory spacecraft	A154	12/7/68	S	S	Test number 1979.
ATLAS	SLV-3C	Atlas SLV-3C booster; Centaur 17D upperstage; Mariner Mars M69-3	A155	2/25/69	S	P	Test number 0183.
ATLAS	SLV-3C	Atlas SLV-3C booster; Centaur upperstage; Mariner spacecraft	A156	3/27/69	S	S	Test number 6891.
ATLAS	SLV-3A	Atlas SLV-3A booster; Agena upperstage	A157	4/12/69	S	S	Test number 1069. Sparse data.
ATLAS	SLV-3C	Atlas SLV-3C booster; Centaur upperstage; Applications Technology Satellite spacecraft	A158	8/12/69	S	S	Test number 1711.
ATLAS	SLV-3C	Atlas SLV-3C booster; Centaur 18D upperstage; Orbiting Astronomical Observatory	A159	11/30/70	F	F	Test number 2969. Payload impacted in Africa.
ATLAS	SLV-3C	Atlas SLV-3C booster; Centaur upperstage	A160	1/25/71	S	S	Test number 2222. Flight delayed 3 days due to shearing winds at 30,000 feet.
ATLAS	SLV-3C	Atlas SLV-3C booster; Centaur D upperstage	A161	5/8/71	F	F	Test number 0366.
TLAS	SLV-3C	Atlas SLV-3C booster; Centaur upperstage; Mariner 9 spacecraft	A162	5/30/71	S	S	Test number 3156.
ATLAS	SLV-3C	Atlas SLV-3C booster; Centaur upperstage	A163	12/20/71	S	S	Test number 1473.
ATLAS	SLV-3C	Atlas SLV-3C booster; Centaur upperstage; Intelsat IV spacecraft	A164	1/22/72	S	S	Test number 0615.
ATLAS	SLV-3C	Atlas SLV-3C booster; Centaur upperstage; Spin Stabilized Delta (SRM)	A165	3/2/72	S	S	Test number 2104. Pioneer F.
ATLAS	SLV-3C	Atlas SLV-3C booster; Centaur upperstage	A166	6/13/72	S	S	Test number 1240.
ATLAS	SLV-3C	Atlas SLV-3C booster; Centaur upperstage; OAO-C spacecraft	A167	8/21/72	S	S	Test number 8508. Very sparse data.
ATLAS	SLV-3A	Atlas SLV-3A booster; Agena upperstage	A168	12/20/72	S	S	Test number 9228. Sparse data.
ATLAS	SLV-3D	Atlas SLV-3C booster; Centaur second stage; Delta third stage; Pioneer II spacecraft	A169	4/5/73	S	S	Test number 8088.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Intelsat IV spacecraft	A170	8/23/73	S	S	Test number 3207.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Mariner 10 spacecraft	A171	11/3/73	S	S	Test number 3369.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Intelsat IV	A172	11/21/74	S	S	Test number 3650.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur D-1AR upperstage; Intelsat IVA	A173	2/20/75	F	F	Test number 3737.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Intelsat IV	A174	5/22/75	S	S	Test number 6103.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Intelsat IVA	A175	1/29/76	S	S	Test number 4740.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Comstar I spacecraft	A176	5/13/76	S	S	Test number 2211.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Comstar I	A177	7/22/76	S	S	Test number 6909. No detrimental effect on vehicle performance was noted.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Intelsat IVA	A178	5/26/77	S	S	Test number 1666.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Intelsat IVA	A179	8/12/77	S	S	Test number 3133.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; HEAO-O Observatory spacecraft	A180	8/12/77	S	S	Test number 3133.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur D-1AR upperstage; Intelsat IVA	A181	9/29/77	F	F	Test number 2050.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Intelsat IVA	A182	1/6/78	S	S	Test number 3525.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; FLTSATCOM spacecraft	A183	2/9/78	S	S	Test number AFETR 2321.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Intelsat IVA	A184	3/31/78	S	S	Test number 2469.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Pioneer-Venus 78 spacecraft	A185	5/20/78	S	S	Test number 2444.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Comstar spacecraft	A186	6/29/78	S	S	Test number 3888.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; HEAO-B Observatory spacecraft	A187	11/13/78	S	S	Test number 4444.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; FLTSATCOM F2 spacecraft	A188	5/4/79	S	S	Test number 2513.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; HEAO-C Observatory spacecraft	A189	9/20/79	S	S	Test number 8130.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; FLTSATCOM F3 spacecraft	A190	1/17/80	S	S	Test number 8228.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; FLTSATCOM F4 spacecraft	A191	10/30/80	S	S	Test number 5335.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Intelsat V	A192	12/6/80	S	S	Test number 5550.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; COMSTAR D-4 spacecraft	A193	2/21/81	S	S	Test number 6767.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur D-1AR upperstage; Intelsat V	A194	5/23/81	S	P	Test number 6592.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur D-1AR upperstage; Fltsatcom F5	A195	8/6/81	S	P	Test number 8189. The flight was characterized by three increasingly severe shock events. Damage sustained during ascent severly limited on-orbit operations.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Intelsat V	A196	12/15/81	S	S	Test number 5674.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Intelsat V	A197	3/4/82	S	S	Test number 2014.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Intelsat V; Inmarsat	A198	9/28/82	S	S	Test number 5252.
ATLAS	SLV-3D	Atlas SLV-3D booster; Centaur upperstage; Intelsat V; Inmarsat	A199	5/19/83	S	S	Test number 3167.
ATLAS	G	Atlas G booster; Centaur D-1AR upperstage; Intelsat V	A200	6/9/84	S	P	Test number 6315. Abnormal shock event at Atlas/Centaur separation. S/C separation occurred after 500 seconds delay by DCU backup logic.
ATLAS	G	Atlas G booster; Centaur D upperstage; Intelsat VA	A201	3/22/85	S	S	Test number 5467.
ATLAS	G	Atlas G booster; Centaur D upperstage; Intelsat VA	A202	6/29/85	S	S	Test number 6805.
ATLAS	G	Atlas G booster; Centaur D upperstage; Intelsat VA	A203	9/28/85	S	S	Test number 7652.
ATLAS	G	Atlas G booster; Centaur D upperstage; FLTSATCOM F2 spacecraft	A204	12/4/86	S	S	Test number 0692.
ATLAS	G	Atlas G booster; Centaur D-1AR upperstage; FLLTSATCOM	A205	3/26/87	F	F	
ATLAS	I	Atlas I booster; Centaur upperstage; FLTSATCOM	A206	9/25/89	S	S	Test number 1257.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
ATLAS	I	Atlas I booster; Centaur upperstage; CRRES spacecraft	A207	7/25/90	S	S	Test number 2914.
ATLAS	II	Atlas II booster; Centaur upperstage; EUTELSAT spacecraft	A208	12/7/91	S	S	Test number 5562. Commercial launch.
ATLAS	II	Atlas II booster; Centaur upperstage; DSCS spacecraft	A209	2/11/92	S	S	Operation number 8488.
ATLAS	I	Atlas I booster; Centaur upperstage; BS-3H	A210	4/18/92	F	F	Operation number 9022. Destruct action taken by FSO. Discrepancy regarding launch date.
ATLAS	I	Atlas I booster; Centaur upperstage; Galaxy 5 spacecraft	A211	5/13/92	S	S	Operation number 2299. Commercial launch.
ATLAS	IIA	Atlas IIA booster; Centaur IIA upperstage; Intelsat K	A212	6/10/92	S	S	Operation number 6100. First Atlas IIA launch. Commercial launch.
ATLAS	II	Atlas II booster; Centaur upperstage; DSCS spacecraft	A213	7/3/92	S	S	Operation number 1935. Second DOD Atlas II launch.
ATLAS	I	Atlas I booster; Centaur upperstage; Galaxy 1R	A214	8/22/92	F	F	Operation number 1049. Destruct action taken by FSO at 480 seconds.
ATLAS	I	Atlas I booster; Centaur upperstage; UHF F/O F-1	A215	3/25/93	S	P	Operation number D1047. Spacecraft achieved a low orbit because the Atlas booster gave minimum performance.
DELTA	Delta 1	Echo 1	D3	5/13/60	F	F	Cause Unknown
DELTA	Delta 1	Echo 1	D3	5/13/60	F	F	3rd stage failed to fire - thought to be caused by solenoid switch along with DC Converter wiring system
DELTA	Delta 2	Echo 1A	D4	5/13/60	S	S	
DELTA	Delta 3	Tiros II	D5	11/23/60	S	S	
DELTA	Thor 295 - Thor Delt	P-14 (Explorer I)	D0	3/25/61	S	S	[illegible]
DELTA	Delta 5	Tiros III	D8	7/12/61	S	S	Actual orbit 440 x 401 nmi
DELTA	Delta 6	S-3 (Explorer XII)	D9	8/15/61	S	S	Actual Orbit 41,790 x 157 nmi
DELTA	Delta Big Shot #1		D10	1/15/62	S	P	1 stage thor block II DAC model-DSV-20 booster w/Azusa xponder
DELTA	Delta 7	Tiros (4)	D11	2/8/62	S	S	Actual orbit 457 x 384 nmi

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
DELTA	Delta 8	S-16 (OSO-A)	D12	3/7/62	S	S	Actual orbit 321 x 298 nmi
DELTA	Delta 9	P/L S-51	D13	4/26/62	S	S	1 hr delay due to incorrectly wired launch sequencer - rewired and successfully launched. Actaul orbit 655 x 210 nmi, 53.9° incl
DELTA	Delta 10		D14	6/19/92	S	S	First LC-17B launch . 3000 x 500 nmi, 45°
DELTA	Delta 11	Telstar	D15	7/10/62	S	S	254 x 85 nmi apogee
DELTA	Big Shot 2	Echo Balloon	D16	7/18/62	S	S	384.1 x 369.1 nmi
DELTA	Delta 12	1962 Alpha Psi/Tiros F	D17	9/18/62	S	S	Actual orbit 48174 x 150 nmi, 33.02°, First "A" configuration . DM-21 first stage used on Big Shots
DELTA	Delta 13	Explorer 14	D18	10/2/62	S	S	Actual orbit 3987 x 709 nmi, 47.24°, First "B" configuration, AJ-10-118A second stage
DELTA	Delta 14	S-3B SERB (Explorer 15)	D19	10/27/62	S	S	
DELTA	Delta 15	Relay 1	D20	12/13/62	S	S	
DELTA	Delta 16	Syncom	D21	2/14/63	S	P	
DELTA	Delta 17	Atmospheric Structures (S-6) (Explorer 16)	D24	4/3/63	S	S	Payload called Explorer 17 here, Explorer 16 in other sources (AIAA) , orbit 485 x 135 nmi
DELTA	Delta 18	Telstar (2)	D28	5/7/63	S	S	Orbit 5700 x 500 nmi
DELTA	Delta 19	Tiros (7)	D31	6/19/63	S	S	
DELTA	Delta 20	SYNCOM (2)	D34	7/26/63	S	S	
DELTA	Delta 21	IMP-A	D39	11/21/63	S	S	Actual orbit 165,688 x 105.7, 32.99°
DELTA	Delta 23	Relay (2)	D42	1/21/64	S	S	BTL is now called WECO (Western Electris Company system), P/L also called Relay (A-16)
DELTA	Delta 24	S-66 Ionosphere Beacon	D45	3/19/64	P	F	Commentary says burn interupted after 23 sec, but Trajectory/Flight Plan indicates nominal burn time for stage 3. Assumes commentary is correct for Database table.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
DELTA	Delta 25	SYNCOM (3)	D48	8/19/64	S	S	Missle perf. record sheet calls 3rd stg ABL-X258-B2, NASA write up calls it ABL-X258-A5(DM), B2 is consistent with other "D" launch records - will use B2 config summary. First "D" flt, first use of solid strap-ons. Actual orbit circular 19150 nmi 0
DELTA	Delta 26	IMP-B	D52	10/3/64	S	S	Missle performance record sheet calls 2nd stage AJ10-118A, NASA write up calls it AJ10-118D. 118D is consistent with AIAA; use 118D
DELTA	Delta 27	EPE-D (Energetic Particles Explorer)	D57	12/21/64	S	S	Actual orbit 15631x169 nmi, 20-02° incl
DELTA	Delta 28	Tiros -I (Tiros IX)	D59	1/22/65	S	P	Actual orbit 1392x378 nmi, 96°
DELTA	Delta 29	OSO B-2	D61	2/3/65	S	S	Actual orbit 341.0 x 297.5 nmi, 32.87° incl
DELTA	Delta 30	COMSAT 1 (HS 303 A)	D63		S	S	Actual GTO 19473 x 796 nmi, 18.28° incl
DELTA	Delta 31	IMP-C	D65	5/29/65	S	S	Actual orbit 111497 x 107 nmi, 33.0° incl
DELTA	Delta 32	TIROS OT-1	D67	7/1/65			Actual orbit 423 x 393, 98.57° incl
DELTA	Delta 33	OSO-C	D69	8/25/65	F	F	Weight of portions of spin table still attached resulted in less acceleration than nominal - orbit not achieved.
DELTA	Delta 34	GEOS A	D71	11/6/65	S	P	Actual orbit 1202 x 611 nmi, 59.28° - higher energy due to no 2nd stage cutoff. SEE Page 31
DELTA	Delta 35	Pioneer - A	D73	12/16/65	S	S	Helio - 2nd stage, 704.8 x 149.1, 30.2°
DELTA	Delta 36	TIROS OT-3	D75	2/3/66	S	S	Actual orbit 453.8 x 375.9 nmi, 97.892°
DELTA	Delta 37	TIROS OT-2	D77	2/28/66	S	S	Actual orbit 768.77 x 731.99, 100.98°
DELTA	Delta 38	AE-B	D79	5/25/66	S	P	See Page 31, 37
DELTA	Delta 39	AIMP-D	D80	7/1/66	S	P	
DELTA	Delta 40	Pioneer B	D81	8/17/66	S	S	Nominal

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
DELTA	Delta 42	INTELSAT (F-1)	D83	10/26/66	S	P	Apogee Kick Motor (AKM) [not considered part of Delta LV], gave partial thrust and GEO not achieved. * From P46 (Delta 44) "Problem with first Intelsat (F-1) determined to be cold apogee motor ---
DELTA	Delta 43	BIOS-A	D85	12/14/66	S	P	Reentry failure of payload probably not attributable to LV failure
DELTA	Delta 44	Intelsat (F-2)	D87	1/11/67	S	S	
DELTA	Delta 46	OSO-E	D89	3/8/67	S	S	
DELTA	Delta 47	Intelsat (F-3)	D91	3/23/67	S	S	
DELTA	Delta 50	AIMP-E	D93	7/19/67			
DELTA	Delta 51	BIOS B	D95	9/7/67	S	S	First Delta SII Restart. Capsule recovered 24 hours early due to weather in recovery area
DELTA	Delta 52	Intelsat II (F-4)	D97	9/27/67			
DELTA	Delta 53	OSO-D	D98	10/18/67	S	S	
DELTA	Delta 55	Pioneer-C	D100	12/13/67	S	S	
DELTA	Delta 56	GOES-B	D102	1/11/68	S	S	Thus is a WTR Launch (SLC-2)!
DELTA	THORAD/AGENA-9	NIMBUS-B	D103	5/18/68	F	F	This was a WTR launch (SLC-2) ! First RSO Destruct of Delta
DELTA	Delta 57	RAE-A	D105	7/4/68	S	S	WTR LAUNCH !
DELTA	Delta 58	TOS-E	D106	8/16/68	S	S	WTR LAUNCH! First Delta with explicit guidance equations onboard - flew slightly left of nominal till T+75 sec, then nominal
DELTA	Delta 59	Intelsat IIIA	D107	9/18/68	F	F	First M, Failure reminiscent of THORAD/AGENA 9 (P55)
DELTA	Delta 60	Pioneer D	D109	11/8/68	S	S	
DELTA	Delta 61	HEOS-A	D111	12/5/68	S	S	Actual Orbit 115,404 x 228nmi, 28.297° incl

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
DELTA	Delta 63	Intelsat III C	D115	12/19/68	S	S	
DELTA	Delta 64	OSO F	D116	1/22/69	S	S	
DELTA	Delta 65	ISIS-A	D118	1/29/69	S	S	WTR LAUNCH !
DELTA	Delta 66	Intelsat III B	D119	2/5/69	S	S	
DELTA	Delta 67	TOS-G (TIROS Operational Satellite)	D121	2/26/69	S	S	Actual orbit 820 x 786, 101.7° incl
DELTA	Delta 68	Intelsat III D	D123	5/21/69	S	S	
DELTA	THORAD/AGENA D	OGO-F	D124	6/5/69	S	S	WTR LAUNCH!
DELTA	Delta 70	BIOS-D	D125	6/28/69	S	S	Monkey aboard capsule died
DELTA	Delta 71	Intelsat III E	D127	7/25/69	F	F	
DELTA	Delta 72	OSO-G	D128	8/8/69	S	S	
DELTA	Delta 73	Pioneer E	D129	8/27/69	F	F	RSO destruct at T+481.9 sec
DELTA	Delta 74	IDCSP/A (see comments)	D131	11/21/69	S	S	Actual Orbit 19805 x 18733 nmi, 2.44° incl, Skynet A for initial Defense Communication Satellite Program
DELTA	Delta 75	Intelsat III F-6	D134	1/14/70	S	S	Launched on sixth attempt (see encoding sheet for first though fifth attempt launch aborts). Actual orbit 36,320.8 x 272.66 KM, 28.014° incl
DELTA	Delta 77	NATO A Communications Spacecraft	D136	3/20/70	S	S	RSO transmitted ARM signal incorrectly. Actual orbit 19607 x 18485 nmi, 2.64° incl
DELTA	Delta 78	Intelsat III F-7	D138	4/22/70	S	P	3rd attempt - first two attempts to investigate control system or instrumentation problems
DELTA	Delta 79	Intelsat III H	D140	7/23/70	S	S	Actual orbit 19532 x 110 nmi, 28.0° incl
DELTA	Delta 80	Skynet A and Skynet B	D141	8/19/70	S	S	
DELTA	Delta 82	NATO B Communications Satellite	D144	2/2/71	S	S	

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
DELTA	Delta 83	Explorer 43 SAT / IMP-I	D145		S	S	First time 6 SRMs used
DELTA	Delta 85	OSO-H (primary) TETR (secondary payload)	D146	9/29/71		P	
DELTA	Delta 90	Orbit Interplanetary Monitoring Platform	D147	9/22/72	S	S	
DELTA	Delta 92	Telesat A	D148	11/10/72	S	S	
DELTA	Delta 94	Telesat B	D149	4/20/73	S	S	
DELTA	Delta 95	RAE-B	D150	6/10/73	S	S	
DELTA	Delta 97	IMP-J	D151	10/25/73			No Documentation - Generation and Configuration from AIAA
DELTA	Delta 100	SKYNET II A	D153	1/19/74	F	F	See Data Page 154, also see Delta 106
DELTA	Delta 101	WESTAR A	D155	4/13/74			Although there is a Memo for Record attached, there is no reference to the actual launch
DELTA	Delta 102	SMS A	D158	5/17/74	S	U	Although there is a Memo for Record attached, there is no reference to the actual launch
DELTA	Delta 103	WESTAR B	D161	9/8/74	S	U	One abnormal event during launch, no effect on boosters performance. AIAA indicates launch on 10 OCT 74
DELTA	Delta 105	SKYNET II B	D162	11/23/74			Although there is a Memo for Record attached, there is no reference to the actual launch. Generation and Configuration from AIAA
DELTA	Delta 106	Symphonie A	D165	12/18/74			See Data page 154. No reference to actual launch
DELTA	Delta 108	SMS A	D167	2/6/75	S		No reference to launch provided. Generation and configuration from AIAA
DELTA	Delta 110	TELESAT C	D168	5/7/75			No reference to launch provided
DELTA	Delta 112	OSO I	D169	6/21/75			No reference to launch provided
DELTA	Delta 114	Symphonie B	D170	8/27/75			No reference to launch provided
DELTA	Delta 116	GOES A	D171	10/16/75	S	S	News article attached, it actually covers up information

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
DELTA	Delta 117	AE & E	D174	11/19/75			No reference to launch provided
DELTA	Delta 118	RCA-A	D176	12/13/75			No reference to launch provided
DELTA	Delta 119	CTS	D178	1/17/76			No reference to launch provided
DELTA	Delta 120	MARISAT A	D179	2/19/76			No reference to launch provided
DELTA	Delta 121	RCA B SATCOM	D181	3/26/76			No reference to launch provided
DELTA	Delta 122	NATO III A	D182	4/22/76			No reference to launch provided
DELTA	Delta 124	MARISAT B	D184	6/10/76			No reference to launch provided
DELTA	Delta 125	PALAPA-A	D186	7/8/76			No reference to launch provided
DELTA	Delta 127	MARISAT C	D188	10/14/76			No reference to launch provided
DELTA	Delta 128	NATO III B	D190	1/27/77	S	S	
DELTA	Delta 130	ESRO - GOES	D191	4/20/77	F	F	a short circuit in 2nd stage may have triggered premature separation. "One of two explosive bolts used in connecting the 2nd stage to the third stage fired prematurely." (See Data Page 195)
DELTA	Delta 129	PALAPA-B	D193	3/10/77			
DELTA	Delta 131	GOES B	D194	6/16/77			Appears to have been originally scheduled for 25 May 77 - no reason for delay given. 2 Postponements related to two previous Delta failures.
DELTA	Delta 132	GMS	D196	7/14/77			Memo for record only! Most information from AIAA
DELTA	Delta 133	SIRIO	D197	4/28/77			Memo for record only! Most information from AIAA
DELTA	Delta 134	OTS	D198	9/13/77	F	F	
DELTA	Delta 135	ISEE A/B	D199	10/22/77	S	S	"Flawless"

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
DELTA	Delta 136	METEOSAT	D201	11/22/77	S	S	Scrub on 20 NOV and 21 NOV due to REDSTONE transmitting arm and destruct signals
DELTA	Delta 137	CS (Japan COMMSAT)	D202	12/14/77	S	S	
DELTA	Delta 138	IUE	D203	1/26/78	S	S	Delay for faulty seal on nose fairing door, Interesting launch (GSE) electrical power problem -Florida Power & Light backup generator. AIAA has launch on 16 Jan 78.
DELTA	Delta 140	BSE	D204	4/7/78	S	S	Memo for record - News clips
DELTA	Delta 141	OTS-B	D206	5/11/78	S	S	Five (5) delays - Two records on one page : OTS-B and GOES-C
DELTA	Delta 142	GOES-C	D206	6/16/78	S	S	Two records on one page : OTS-B and GOES-C
DELTA	Delta 143	ESRO GOES 2	D207	7/14/78	S	S	
DELTA	Delta 144	ISEE-C	D208	8/12/78	S	S	
DELTA	Delta 146	NATO III C	D208	11/18/78	S	S	
DELTA	Delta 147	TELESAT D	D209	12/15/78	S	S	
DELTA	Delta 148	SCATHA	D210	1/30/79	S	S	Five days late
DELTA	Delta 149	WESTAR-C	D210	8/9/79	S	S	50 minute delay due to "A" Cyber Computer
DELTA	Delta 150	RCA-C	D211	12/6/79	S		
DELTA	Delta 151	SMM	D212	2/14/80	S	S	
DELTA	Delta 152	GOES-D	D213	9/9/80			
DELTA	Delta 153	SBS-A	D214	11/15/80			
DELTA	Delta 154	GOES-E	D214	5/22/81			
DELTA	Delta 156	SBS-B	D214	9/24/81	S	S	

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
DELTA	Delta 158	RCA-D	D215	11/19/81	S	S	
DELTA	Delta 159	RCA-C PRIME	D215	1/15/82			
DELTA	Delta 160	WESTAR IV	D216	2/25/82			
DELTA	Delta 161	INSAT 1-A	D217	4/10/82	S	S	
DELTA	Delta 162	WESTAR V	D218	6/9/82	S	U	"BOOSTER ANOMALY"
DELTA	Delta 164	ANIK D-1	D219	8/26/82			
DELTA	Delta 165	RCA-E	D220	10/27/82	S		
DELTA	Delta 168	GOES-F	D221	4/28/83	S		
DELTA	Delta 170	Galaxy-A	D222	6/28/83			1 planned hold - 2 Cosmonauts aboard Salyut. 1 unplanned hold - breakdown of RSDS "A" system
DELTA	Delta 171	TELSTAR-3A	D223	7/28/83	S		28 minute hold - Radar 91.14 failed
DELTA	Delta 172	RCA-G	D224	9/8/83	S		
DELTA	Delta 173	Galaxy-B	D225	9/22/83	S		
DELTA	Delta 175	AMPTE	D227	8/16/84	S		2 scrubs and a 6 minute delay (shrimp boat)
DELTA	Delta 176	Galaxy-C	D229	9/21/84	S		
DELTA	Delta 177	NATO III D	D231	11/13/84	S		Many postponements and last minute scrub on 12 NOV 84
DELTA	Delta 178	GOES-G	D233	5/3/86		F	Stage 1 lost power due to electrical short -FROM AIAA-! The RSO data does not reflect a failure !!
DELTA	Delta 179 (?)	SP1/SP2	D234	11/20/86			Missing from AIAA
DELTA	Delta 180	GOES-H	D235	2/26/87			

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
DELTA	Delta 181	PALAPA (B2P)	D236	3/19/87	S	S	
DELTA	Delta 182	Thrusted Vector	D237	2/8/88	S	S	
DELTA	Delta 183	Delta Star	D238	2/14/89			
DELTA	Delta 184	GPS Block II - 1	D239	2/14/89	S		First of 21 GPS satellites. Postponed from 30 Dec 88.
DELTA	Delta 185	II GPS	D241	6/10/89	S	P	5 delays, 4 for weather. 1 main engine failed at T=0 on 24 May 89; Non-Catastrophic - refueled and launched 10 JUN 89
DELTA	Delta 186	II GPS-3	D242	8/17/89	S	P	Insulation from one of the castors dropped out due to weakened bond near castor burnout
DELTA	Delta II - 193	GPS-7	D243	3/22/90	S	S	
DELTA	Delta II - 194	PALAPA B-25	D245	4/13/90	S	S	
DELTA	Delta II - 195	ROSAT	D247	6/1/90	S	S	Page 248 does not exist, 10 foot fairing
DELTA	Delta II - 196	INSAT 1D	D250	6/11/90	S	S	
DELTA	Delta II - 197	GPS-8	D252	8/2/90	S	S	
DELTA	Delta II - 198	BSB-R2	D254	8/18/90			
DELTA	Delta II - 199	GPS-9	D256	10/1/90	S	S	T-40 hold due to B/U CMD XMITR @ BDA down (incorrectly identified as Antiqua asset mandatory for launch)
DELTA	Delta II - 200	INMARSAT-2	D258	10/30/90	S	S	
DELTA	Delta II - 201	GPS-10	D260	11/26/90	S	S	
DELTA	Delta 202		D262	1/7/91	S	S	
DELTA	Delta 203	INMARSAT-2 (F-2)	D265	3/8/91	S	S	
DELTA	Delta 204	ASC-2	D268	4/12/91	S	S	

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
DELTA	Delta 205	AURORA-2	D271	5/29/91	S	S	
DELTA	Delta 206	GPS-11, LOSAT II (secondary)	D274	7/3/91	S	S	1 day slip due to problem w/ data relay station in VA for s/c data from ASC. (A mandatory user item)
DELTA	Delta 207	EUVE	D276	6/7/92	S	S	
DELTA	Delta 208	GPS-14	D278	7/7/92	S	S	
DELTA	Delta II - 209	GEOTAIL/DUVE	D280	7/24/92	S		
DELTA	Delta 210	SATCOM-C4	D282	8/31/92			
DELTA	Delta 211	KOPERNIKUS	D284	10/12/92			
DELTA	Delta 212	GPS-12	D286	2/23/92	S	S	
DELTA	Delta 213	GPS-13	D288	4/9/92	S	S	
DELTA	Delta 214	PALAPA B-4	D290	5/13/92			2 minute delay due to COLA. No data page #291
DELTA	Delta 215	GPS-15	D293	8/9/92			
DELTA	Delta 216	GPS-16	D295	11/22/92	S	S	
DELTA	Delta 217	GPS-17	D297	12/18/92	S	S	
GEMINI	GT	Nominal GT, GT-3, 1st Stage 430,000 lbs of thrust, 2nd Stage 100,000 lbs of thrust	G3	3/23/65	S	S	4 launches from 1965 not included, 5 launches form 1966 not included
GEMINI	GT	2 liquid fuel stages using Hydrazine and UDMH, GT-2	G4	1/19/65	S	S	
GEMINI	GT	1st Stage-Aerojet XLR 87-7, 2nd Stage XLR 91-7, Re-Enry Module, Retrograde adapter, Equipment adapter	G5	4/8/64	S	S	
JUPITER	Proto-Jupiter C	Stage 1: Rocketdyne S-3D engine, 135K thrust. Airframe & attitude control test. No staging, no guidance system.	JJ1	3/1/57	F	F	Not clear if design or fabrication problem. Seems to recur occasionally - see pp 11, 18.
JUPITER	Proto-Jupiter C	Stage 1: Rocketdyne S-3D engine, 135K thrust. Airframe & attitude control test. No staging, no guidance system.	JJ2	4/26/57	F	F	Tanks were enlarged from parent redstone.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
JUPITER	Proto-Jupiter C	Stage 1: Rocketdyne S-3D engine, upgraded, 139K thrust. Airframe & attitude control test. No staging, no guidance system. "Can-Type" anti-fuel sloshing device added, maybe better thermal insulation in tail.	JJ3	5/31/57	S	S	Fuel sloshing seems to have been eliminated.
JUPITER	Proto-Jupiter C	Stage 1: Rocketdyne S-3D engine, upgraded, 139K thrust. Airframe & attitude control test. No staging, no guidance system. "Can-Type" anti-fuel sloshing device added, maybe better thermal insulation in tail. Fisrt Stage separtation added.	JJ4	8/27/57	S	S	
JUPITER	Proto-Jupiter C	139K thrust s-3D engine, both stage separations, heat-protected nose cone, partial-closed-loop ST-90 Guidance system.	JJ5	10/22/57	S	P	
JUPITER	Proto-Jupiter C	139K thrust S-3D engine, both stage separations, heat-protected nose cone, partial-closed-loop ST-90 Guidance system.	JJ6	11/26/57	F	F	Same thing reoccured on next flight.
JUPITER	Proto-Jupiter C	150K thrust S-3D engine, both stage separations, heat-protected nose cone with dummy warhead and adapter kit, partial-closed-loop ST-90 Guidance system active local angle of attack control added.	JJ7	12/18/57	F	F	Similar to previous Jupiter Mission.
JUPITER	Jupiter C	150K thrust S-3D engine, both stage separations, heat-protected nose cone with dummy warhead and adapter kit, partial-closed-loop ST-90 Guidance system active local angle of attack control added, interim cut-off computer added to G&C	JJ8	5/18/58	S	S	
JUPITER	Jupiter C	Same as last except H202 vernier engine full-scale nose cone with lightweight dummy warhead.	JJ9	7/17/58	S	P	No info on cause or fix of "collision". Vernier engine cutoff problems reoccurred later (see pp14-15) but involved late rather than early cutoff.
JUPITER	Jupiter C	Same as last except small solid motor replaced H202 - powered vernier engine.	JJ10	8/27/58	F	P	
JUPITER	Production Prototype	Same as last except first test of "ico" production prototype Jupiter.	JJ11	10/8/58	F	F	Possibly a recurrence of the thermal insulation failure. See p1.
JUNO	Juno II	Jupiter-based Juno. Late model Juptier with guidance per p.9, tank lengthened 36", 2nd cluster of II descaled sergent solids, 3rd stage=1 descaled sergent poineer III moon probe payload.	JJ12	12/6/58	F	P	
JUPITER	Jupiter C	Same as 9 except small solid motor replaced H202 - powered vernier engine.	JJ13	12/13/58	F	P	
JUPITER	Production Prototype	See p.10 2nd production missle	JJ14	1/5/59	F	P	This or similar failure recurred on next flight-see p.15
JUPITER	Production Prototype	See p.10 3rd production missle	JJ15	2/27/59	F	P	Seems to be recurrence of failure in previous flight. Nose cone may have broken up during reentry.
JUNO	Juno II	See p12 Poineer 4 moon probe payload, passed moon at 35000 mi and entered solar orbit.	JJ16	3/3/59	S	S	

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
JUPITER	Production Prototype	See p.10	JJ17	4/3/59	F	P	
JUPITER	Production Prototype	See p.10	JJ18	5/6/59	F	F	Multiple failures. See continuation page 18A. Unclear whether failures are linked, tail section fire may be a reccurrence of earlier problem. See pp1&11.
JUPITER	Production Prototype	See p.10	JJ19	5/14/59	S	S	
JUPITER	Production Prototype	See p.10	JJ20	5/28/59	S	S	
JUPITER	Production Prototype	See p.10	JJ21	7/9/59	S	S	
JUNO	Production Prototype	See p12 Payload was scientific satellite.	JJ22	7/16/59	F	F	
JUNO	Juno II	See p12 without 4th stage. Payload was baloon satellite	JJ24	8/14/59	F	F	See continuation page 24a. Multiple failures.
JUPITER	Production Prototype	See p.10 Testing at 300nm min. specified range, hence short main engine burn and low apogee.	JJ26	8/26/59	F	P	Apparently a fundametnal design flaw aeordynamics plus limited control range of guidance system.
JUPITER	Production Prototype	See p.10	JJ27	9/16/59	F	F	Considerable damage to pad and adjacent structures, including launch vehicle on adjoinning pad 26a (probably Jupiter 31 launched 10/21/59- see p. 30)
JUPITER	Production Prototype	See p.10, extra guidance system carried "as a passenger".	JJ28	9/30/59	S	S	
JUNO	Juno II	See p12. Payload was Explorer VII	JJ29	10/13/59	S	S	Orbit (Circular?) was about 6 mi. higher than planned
JUPITER	Jupiter C Block III	See p.10, first test of "Block III" features with 1600nm range. Long range warhead.	JJ30	10/21/59	S	S	First full production Jupiter C(?) probably same vehicle that got tank punctures from exploding Jupiter on adjacent pad 26a - see p.26
JUPITER	Production Prototype	See p.10, new pitch program designed to eliminate control problems on short flights (see p25) installed.	JJ31	11/4/59	S	S	Fix for control problem identified earlier(p.25). However, note that this 1200mi flight did not test the new program at short range and high pitch rates.
JUPITER	Production Prototype	See p.10	JJ32	11/18/59	S	P	May be a reccurence of tail section overheating. See pp1,11.
JUPITER	Jupiter C Block III	Per p.29 except without long range warhead	JJ33	12/9/59	S	P	
JUPITER	Production Prototype	Per p.10 except with new pitch program and attitude control systems to prevent control loss on short missions.	JJ34	12/16/59	S	S	Apparently a successful fix for the control problem experienced during earlier 300nm flight(seep.25).
JUPITER	Production Prototype	See p.10	JJ35	1/25/60	S	P	Not clear if hot instrument compartment also caused guidance error.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
JUPITER	Production Prototype	See p.10. This was the last flight in the Jupiter R&D series.	JJ36	2/4/60	S	S	
JUNO	Juno II	See p.12. Payload was LEO scientific satellite.	JJ37	3/23/60	F	F	
JUPITER	Operational Juptier C	Standard operational missle. Test objective: show tactical GSE compatibility for 15- min tactical countdown. Minimum Telemetry.	JJ38	10/20/60	S	S	First operational missle test.
JUNO	Juno II	See p12. Payload was S-30 Radiation Satellite (90lbs)	JJ39	11/3/60	S	S	Minor guidance error in stage1 (1 deg) apparently corrected.
JUNO	Juno II	See p12. Payload was communications Satellite (73lbs)	JJ40	2/24/61	F	F	
JUPITER	Operational Juptier C	Standard operational Jupiter w/ dummy tactical warhead. Test objective: 15 min countdown w/ operational crew.	JJ41	4/22/61	S	S	
JUNO	Juno II	Per p12. Payload: 76.5 lb scientific staellite, Explorer XI	JJ42	4/27/61	S	S	Orbit 304 x 113 mi vs. planned 295 x 1138.
JUNO	Juno II	Per p12. Payload: S-45 science package	JJ43	5/24/61	F	F	
JUPITER	Operational Juptier C	Per p. 40	JJ44	8/4/61	S	S	
JUPITER	Operational Juptier C	Per p. 40	JJ45	12/6/61	S	S	
JUPITER	Operational Juptier C	Per p. 40	JJ46	4/18/62	F	F	This is the only clearly identified human-error failure in the Jupiter / Juno series.
JUPITER	Operational Juptier C	Per p. 40	JJ47	8/1/62	S	S	
JUPITER	Operational Juptier C	Per p. 41	JJ48	1/22/63	F	P	
STARDBIRD		4 stages, TALOS, Sergeant, and 2 Orbus I Stages. The Starbird is ballistic through TALOS burn, then inertailly guided (gyro)	OTR1	12/17/90	U	U	
TMD COUNTERMEASURE MI	TCMP1A	TALOS, Aries(M56A)	OTR2	2/11/93	F	F	
TMD COUNTERMEASURE MI	TCMP1B	TALOS, Aries(M56A)	OTR3	1/23/93	S	S	
BRILLANT PEBBLES LAUNC		1st stage - CASTOR IV, 2nd stage - Orbus	OTR4	10/16/92	F	F	Destruct command transmitted when antenna reached 5 degree elevation
PROSPECTOR	Joust	Single stage Castor IV-A solid propellant ricket motor with a redesigned aft-skirt / control system. C-Band beacon, and LR-81 INS was used for guidance.	OTR7	6/18/91	F	F	Command destruct was sent at T+25 seconds.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
PERSHING II	II	Modernized Pershing 1A; 2 stages; terminally guided warhead	PE1	7/22/82	F	F	Test number 4235. Destruct signal sent at 17 seconds by RSO. Debris impacted along the flight path on the beach and in the ocean.
PERSHING II	II	Pershing II: 2 stages; terminally guided r/v.	PE4	1/22/83	S	S	Test number 6693. Engineering Development Flight.
PERSHING II	II	Pershing II: 2 stages; terminally guided r/v.	PE6	2/9/83	S	S	Test number 1675. Engineering Development Flight.
PERSHING II	II	Pershing II: 2 stages; terminally guided r/v.	PE8	3/28/83	S	S	Test number 2139. Engineering Development Model.
PERSHING II	II	Pershing II: 2 stages; terminally guided r/v.	PE9	4/10/83	S	S	Test number 4147. Engineering Development Flight.
PERSHING II	II	Pershing II: 2 stages; terminally guided r/v.	PE10	5/27/83	S	S	Test number 3685. Engineering Development Fligtht.
PERSHING II	II	Pershing II: 2 stages; terminally guided r/v.	PE12	6/2/83	S	S	Engineering Development Flight.
PERSHING II	II	Pershing II: 2 stages; terminally guided r/v.	PE14	7/27/83	F	F	Test number 1825. Precautionary destruct action sent at T + 90 seconds. Engineering Development Flight. Steel ring later found not to have been installed properly.
PERSHING II	II	Pershing II: 2 stages; terminally guided r/v.	PE17	9/7/83	S	S	Test number 5947. Engineering Development Flight.
PERSHING II	II	Pershing II: 2 stages	PE19	5/16/84	S	P	Test number 4163. Engineering Development Flight. "Cold shot" launch.
PERSHING II	II	Pershing II: 2 stages.	PE20	8/7/84	S	S	Test number 5361. Engineering Development Flight.
PERSHING II	II	Pershing II: 2 stages.	PE21	9/20/84	S	S	Test number 4202. "Hot Shot" Flight.
PERSHING II	II	Standard Pershing II.	PE24	10/3/84	S	S	Test number 5437. The test was originally scheduled for 9/27/84 but developed onboard computer trouble. Significantly bad weather (tropical storm Isidore) on 9/27/84. "Hot Shot" Launch.
PERSHING II	II	Pershing II: 2 stages; terminally guided rv.	PE27	12/16/85	S	S	Test number 2649. "Operational Efficiency" Launch.
PERSHING II	II	Pershing II: 2 stages; terminally guided rv.	PE28	12/17/85	S	S	Test number 4530. "Operational Efficiency" Launch.
PERSHING II	II	Pershing II: 2 stages; terminally guided rv.	PE29	12/17/85	S	S	Test number 6502. "Operational Efficiency" Launch.
PERSHING II	II	Pershing II: 2 stages; terminally guided rv.	PE30	6/24/86	S	S	Test number 2573. "Operational Efficiency" Launch.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
PERSHING II	II	Pershing II: 2 stages; terminally guided rv.	PE31	6/24/86	S	S	Test number 3064. "Operational Efficiency" Launch.
PERSHING II	II	Pershing II: 2 stages; terminally guided rv.	PE32	6/24/86	S	S	Test number 3282. "Operational Efficiency" Launch.
PERSHING II	II	Pershing II: 2 stages; terminally guided rv.	PE33	6/26/86	S	S	Test number 7247. Operational Test.
PERSHING II	II	Pershing II: 2 stages; terminally guided rv.	PE35	6/26/86	S	S	Test number 7893. Operational Test.
PERSHING II	II	Pershing II: 2 stages; terminally guided rv.	PE38	3/24/87	S	S	Test number 3445. Operational Test.
PERSHING II	II	Pershing II: 2 stages; terminally guided rv.	PE39	3/24/87	S	S	Test number 2223. Operational Test.
PERSHING II	II	Pershing II: 2 stages; terminally guided rv.	PE40	3/24/87	S	S	Test number 2186. Operational Test.
PERSHING II	II	Pershing II: 2 stages; terminally guided rv.	PE41	3/24/87	S	S	Test number 6723. Operational Test.
PERSHING II	II	Pershing II: 2 stages; terminally guided rv.	PE42	3/24/87	S	S	Test number 5427. Operational Test.
PERSHING II	II	Pershing II: 2 stages; terminally guided rv.	PE43	3/24/87	S	S	Test number 3780. Operational Test.
PERSHING II	II	Pershing II: 2 stages; terminally guided rv.	PE45	5/20/87	S	S	Test number 6747. Operational Test. First Pershing II launched w/o range safety destruct system attached to R/V.
PERSHING II	II	Standard Pershing II: 2 stages; terminally guided rv.	PE46	5/20/87	S	S	Test number 5724. Operational Test.
PERSHING II	II	Standard Pershing II: 2 stages; terminally guided rv.	PE47	5/20/87	S	S	Test number 5561. Operational Test.
PERSHING II	II	Standard Pershing II: 2 stages; terminally guided rv.	PE48	5/20/87	S	S	Test number 4941. Operational Test.
PERSHING II	II	Standard Pershing II: 2 stages; terminally guided rv.	PE50	5/20/87	S	S	Test number 2746. Operational Test.
PERSHING II	II	Standard Pershing II: 2 stages; terminally guided rv.	PE52	7/27/87	S	S	Test number 8249. Operational Test.
PERSHING II	II A-0	Standard Pershing II: 2 stages; terminally guided rv.	PE57	1/13/88	S	S	Test number 3106. One of four missiles scheduled. Two misfired and one re-scheduled.
PERSHING II	II FOT	Standard Pershing II: 2 stages; terminally guided rv.	PE58	2/15/88	S	S	Test number 7620. Operational Test.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
PERSHING II	II FOT	Standard Pershing II: 2 stages; terminally guided rv.	PE59	2/15/88	S	S	Test number 7601. Operational Test.
PERSHING II	II FOT	Standard Pershing II: 2 stages; terminally guided rv.	PE60	2/15/88	S	S	Test number 4917. Operational Test.
PERSHING II	II FOT	Standard Pershing II: 2 stages; terminally guided rv.	PE61	2/15/88	S	S	Test number 7635. Operational Test.
PERSHING II	II FOT	Standard Pershing II: 2 stages; terminally guided rv.	PE62	2/15/88	S	S	Test number 5431. Operational Test.
PERSHING II	II FOT	Standard Pershing II: 2 stages; terminally guided rv.	PE63	2/15/88	S	S	Test number 4402. Operational Test.
PERSHING II	II A-0	Standard Pershing II: 2 stages; terminally guided rv.	PE66	3/21/88	S	S	Test number 3676. Operational Test.
PERSHING II	II A-0	Standard Pershing II: 2 stages; terminally guided rv.	PE67	3/21/88	S	S	Test number 3847. Operational Test.
PERSHING II	II A-0	Standard Pershing II: 2 stages; terminally guided rv.	PE68	3/21/88	S	S	Test number 6564. Operational Test.
OLARIS	c2x-1	The STAPP vehicle consists of a Polaris A1 two stage propulsion system plus a special test system mounted in place of re-entry system	P08	4/14/65	F	F	MISSLE WENT OUT OF CONTROL AT FIRST STAGE SEPARATION AND WAS DESTROYED @ 73.8 SEC
POLARIS	A1 ORRT	ORRT	P011	9/4/63		S	ASSUMED SUCCESS FROM IMAPCT COORDINATE ERRORS
POLARIS	A1 ORRT	ORRT	P012	9/4/63	F	F	FIRST STAGE (F/S) FRONT END FAILED AT 24 SEC
POLARIS	A1 ORRT		P013	9/4/63		F	SECOND STAGE (S/S)NOZZLE BURNED OUT NEAR END OF POWERED FLIGHT "WHICH IS ON AVERAGE ABOUT T+120 SEC" - ANALYST'S QUOTES
POLARIS	A1 ORRT	ORRT	P014	9/4/63	F	F	F/S FRONT END FAILED AT 23 SEC
POLARIS	A1 ORRT	ORRT	P015	9/4/63		S	ASSUMED SUCCESS FROM IMAPCT COORDINATE ERRORS
POLARIS	A1 ORRT	ORRT	P016	9/4/63		S	ASSUMED SUCCESS FROM IMAPCT COORDINATE ERRORS
POLARIS	A1 ORRT	ORRT	P017	6/4/63	S	S	GOOD
POLARIS	A1 ORRT	ORRT	P018	6/4/63	S	S	GOOD

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
POLARIS	A1 ORRT	ORRT	P019	6/4/63	F	U	THE ONLY COMMENT PROVIDED IS THE WORD "FAILURE", ASSUME FAILURE
POLARIS	A1 ORRT	ORRT	P020	6/4/63	S	S	GOOD
POLARIS	A1 ORRT	ORRT	P021	6/4/63	S	S	GOOD
POLARIS	A1 ORRT	ORRT	P022	6/4/63	S	S	GOOD
POLARIS	A1 ORRT	ORRT	P023	3/14/63	S	S	GOOD
POLARIS	A1 ORRT	ORRT	P024	3/14/63	S	S	GOOD
POLARIS	A1 ORRT	ORRT	P025	3/14/63	F	U	THE ONLY INFORMATION GIVEN IS THAT THE IMPACT WAS 100NM SHORT & 12NM LEFT BUT INFO ON LV PROVIDED - THE MISSED TARGET COULD BE RESULT OF RE-ENTRY VEHILCE OR OTHER.
POLARIS	A1 ORRT	ORRT	P026	2/5/63	F	U	FALIURE DID LAND IN MILS, ASSUME FAILURE
POLARIS	A1 ORRT	ORRT	P027	2/5/63	F	U	FALIURE DID NOT LAND IN MILS, ASSUME FAILURE
POLARIS	A1 ORRT	ORRT	P028	2/4/63	S	S	GOOD SUCCESS
POLARIS	A1 ORRT	ORRT	P029	2/4/63	F	U	FALIURE DID NOT LAND IN MILS, ASSUME FAILURE
POLARIS	A1 ORRT	ORRT	P030	7/27/62	U	U	UNKNOWN, PROBABLY FAILURE DID NOT LAND IN MILS, ASSUME FAILURE
POLARIS	A1 ORRT	ORRT	P031	7/27/62	S	S	SUCCESS
POLARIS	A1 ORRT	ORRT	P032	7/27/62	S	S	SUCCESS
POLARIS	A1 ORRT	ORRT	P034	7/27/62	U	U	UNKNOWN, PROBABLY FAILURE DID NOT LAND IN MILS, ASSUME FAILURE
POLARIS	A1T-8	TEST ARTICLE, PX PROGRAM PHASE II - SAME AS A1T-7	P035	10/14/62	S	S	ALL MISSLE SYSTEMS PERFORMED PROPERLY DURING FLIGHT AND IMPACT WAS WITHIN THE PREDICTED AREA
POLARIS	A1T-7	TEST ARTICLE, PX PROGRAM PHASE II - SAME AS A1T-8	P036	10/14/62	F	F	

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
POLARIS	A1T-5	TEST ARTICLE, OBTAIN PX-1 DEVELOPMENT INFORMATION	P037	9/15/62	F	F	THE FIRST STAGE FOLLOWED PLANNED TRAJECTORY AS DID THE SECOND UNTIL 100.3 SEC. SECOND SEPARATION DID NOT OCCUR AND NO PRIMARY TEST OBJECTIVES WERE ACHIEVED
POLARIS	A1T-6	TEST ARTICLE, OBTAIN PX-1 DEVELOPMENT INFORMATION	P038	9/14/62	S	S	THE MISSLE STABILIZED ON TRAJECTORY WITHIN 1.3 SECONDS AFTER IGNITION AND CORRECTED THE INTIAL ROLL DISPLACEMENT OF 31.5 DEG CLOCKWISE THRUST TERMINATION AND RE-ENTRY BODY SEPARATION SYSTEMS FUNCTIONED PROPERLY
POLARIS	A1E-15 /A1P-23	TEST ARTICLE (GUIDED)	P039	1/11/61	F	F	EJECTION FROM SUBMARINE, BROACH AND 1ST STAGE IGNITION OCCURRED NORMALLY, A FLIGHT CONTROL MALFUNCTION EARLY IN 1ST STAGE FLIGHT NECESSITATED DESTRUCTION @ 48SEC
POLARIS	A1P-24 / A1E-14	TEST ARTICLE (GUIDED)	P040	1/14/61	F	F	EJECTION FROM LAUNCH TUBE, BROACH AND 1ST STAGE IGNITION NORMAL - MISSILE STABILIZED IN PLANNED TRAJECTORY. 1ST STAGE POWERED FLIGHT AND GUIDANCE WERE NORMAL UNTIL 40 SEC WHEN MISSLE FLIGHT BECAME ERRATIC, DESTRUCT @ 79.1
POLARIS	A1P-64 / A1E-16	TEST ARTICLE (GUIDED)	P042	3/24/61	F	F	
POLARIS	A1P-40 / A1E-17	TEST ARTICLE (GUIDED)	P044	3/23/61	S	S	SPURIOUS JETEVATOR COMMANDS TO JETEVATOR NOTED BETWEEN 36 & 48 SEC PRODUCED(?) NONDIVERGENT BODY MOTION PREDOMINANTLY IN YAW AND ROLL. DAMPING IN YAW DURING ROLL-OUT AND PITCH OVER TRANSIENT NOT AS MUCH AS USUALLY SEEN
POLARIS	A1P-39 / A1E-18	TEST ARTICLE (FULLY GUIDED), 1ST TO BE LAUNCHED BY AN ALL NAVY CREW	P046	3/23/61	F	F	LAUNCH, BROACH, IGNITION AND STABILIZATION OCCURRED NORMALLY UNTIL 20 SEC WHEN A FLIGHT CONTROL MALFUCNTION OCCURRED AND DESTRUCTED @ 51 SEC
POLARIS	A1P-65 / A1E-19	TEST ARTICLE (GUIDED)	P048	4/6/61	S	S	SOAP (SUB) AT APPROX. 103 SEC JETEVATOR #1 & #3 POSITIONS INDICATED A CORRECTION FOR A (?) DOWN FORCE. LAUNCH, BROAH IGNITION, & STABILIZATION AND MISSLE OPERATION DURING POWERED FLIGHT WERE NORMAL
POLARIS	A1P-57 / A1E-20	TEST ARTICLE (GUIDED)	P050	4/19/61	S	S	LAUNCH, BROAH IGNITION, & STABILIZATION AND MISSLE OPERATION DURING POWERED FLIGHT WERE NORMAL
POLARIS	A1P-71 / A1E-22	TEST ARTICLE (GUIDED), PRODUCTION LINE TACTICAL A1 VEHICLE WITH EXERCISE WARHEAD	P051	5/3/61	S	S	LAUNCH, BROAH IGNITION, & STABILIZATION AND MISSLE OPERATION DURING POWERED FLIGHT WERE NORMAL
POLARIS	A1P-26 / A1E-70	TEST ARTICLE REV WT 841 LBS	P052	5/17/61	F	F	
POLARIS	A1P-27 / A1E-55	TEST ARTICLE REV WT 841 LBS	P053	5/17/61	S	S	ALL SYSTEM OPERATED NORMALLY
POLARIS	A1P-28 / A1E-56	TEST ARTICLE REV WT 841 LBS	P054	5/17/61	P	F	"STAGING OCCURS @ 110 SEC" ANALYST
POLARIS	A1E-29	TEST ARTICLE REV WT 841 LBS	P055	5/17/61	S	S	THE FLIGHT WS SUCCESSFUL

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
POLARIS	A1E-33 / A1P-66	TEST ARTICLE	P056	5/17/61	F	F	
POLARIS	A1E-37 / A1P-98	TEST ARTICLE (GUIDED)	P057	8/12/61	S	S	ALL SYSTEM OPERATED NORMALLY
POLARIS	A1E-36 / A1P-105	TEST ARTICLE (GUIDED)	P059	8/12/61	S	S	ALL SYSTEM OPERATED NORMALLY
POLARIS	A1E-35 / A1P-58	TEST ARTICLE (GUIDED)	P061	8/12/61	S	S	ALL SYSTEM OPERATED NORMALLY
POLARIS	A1E-34 / A1P-103	TEST ARTICLE (GUIDED)	P063	8/12/61	S	S	ALL SYSTEM OPERATED NORMALLY
POLARIS	A1E-43 / A1P-9	TEST ARTICLE (GUIDED)	P065	8/12/61	F	F	
POLARIS	A1E-42 / A1P-97	TEST ARTICLE (GUIDED)	P067	8/12/61	F	F	
POLARIS	A1E-38 / A1P-100	TEST ARTICLE	P069	10/16/61	S	S	
OLARIS	A1E-39	TEST ARTICLE	P070	11/3/61	S	S	ALL SYSTEM OPERATED NORMALLY
POLARIS	A1E-40	TEST ARTICLE	P071	11/3/61	S	S	ALL SYSTEM OPERATED NORMALLY
POLARIS	A1E-41 / A1P-12	TEST ARTICLE	P072	11/3/61	S	S	ALL SYSTEM OPERATED NORMALLY
POLARIS	A1X-51	TEST ARTICLE	P074	12/5/61	S	S	ALL TEST OBJECTIVE ACHIEVED, THE FLIGHT WAS SUCCESSFUL WITH ALL MAJOR SYSTEMS PERFORMING SASTISFACTORY, TESTING 2ND STAGE FLUID INJECTION TVC 2ND STAGE BASE THERMAL ENVIRONMENT
POLARIS	A1X-50	TEST ARTICLE, "THRUST TERMINATION INTENTIALLY WIRED OUT"	P076	9/29/61	S	S	TEST 2ND STAGE FLUID INJECTION TVC DURING POWERED FLIGHT
POLARIS	A1E-13 / A1P-19	TEST ARTICLE (GUIDED)	P078	12/22/60	S	P	DEMONSTRATE CAPABILITY OF FBM WEAPONS SYSTEM TO STRIKE A PRESCRIBED TARGET. "NOT COUNTED AS LV FAILURE"
POLARIS	A1E-9	TEST ARTICLE (GUIDED), SUPER SDAP	P079		S	S	4 TESTS @ SEA 15 -18 NOV 60 " ALL TESTS SUCCSSFUL"
POLARIS	A1E-10	TEST ARTICLE (GUIDED), SUPER SDAP	P079		S	S	4 TESTS @ SEA 15 -18 NOV 60 " ALL TESTS SUCCSSFUL"
POLARIS	A1E-11	TEST ARTICLE (GUIDED), SUPER SDAP	P079		S	S	4 TESTS @ SEA 15 -18 NOV 60 " ALL TESTS SUCCSSFUL"

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
POLARIS	A1E-12	TEST ARTICLE (GUIDED), SUPER SDAP	P079		S	S	4 TESTS @ SEA 15 -18 NOV 60 " ALL TESTS SUCCSSFUL"
POLARIS	A1FP-4 / A1E-8	TEST ARTICLE (GUIDED), TACTICAL VERSION WITH EXCERSISE WARHEAD	P080	9/22/60	F	F	EJECTION OF MISSLE FROM SUB NORMAL MISSILE FELL BACK INTO WATER W/IN 10 SEC AFTER IGNITION. DESTRUCT TRANSMITTED BUT MISSILE ALREADY IN WATER.
POLARIS	A1FP-3 / A1E-7	TEST ARTICLE (GUIDED)	P081	9/22/60	F	F	MISSILE FAILED TO IGNITE AND FELL BACK IN WATER
POLARIS	A1FP-1 / A1E-6	TEST ARTICLE (FULLY INERTIAL GUIDANCE)	P082	9/15/60	S	S	MISSLE SUCCESSFULLLY PROGRAMED BY SUB SUPPORT EQUIPMETN. EJECTION OF MISSLE FROM SUB SUCSEEFUL IGNITION, POWERED FLIGHT & GUIDACNCE INTIATED THRUST TERMINATION WERE NORMAL
POLARIS	AIXP-7 / AIE-5	TEST ARTICLE FBM SYSTEMS / IMPACT	P083	9/13/60	F	F	EJECTION FROM SUBMARINE NORMAL, 2ND STAGE WHICH HAD IGNITED UNDERWATER EMERGED @ 24.6 SEC AND FOLLOWED AN ERRATIC PATH UNITL IMPACT @ 49.2 SEC
POLARIS	A1EP-2 / A1E-3	TEST ARTICLE (GUIDED), TACTICAL VERSION OF A1X WITH EXCERSIZE LOAD AZUSA, TELEMETRY AND DESTRUCT EQUIPMENT	P084	8/1/60	F	F	CHECKOUT SUB, EJECTION, IGNITION AND POWERED FLIGHT TO 25.5 SEC APPEARED NORMAL
POLARIS	A1XP-4 / A1E-4	TEST ARTICLE (GUIDED), DEMONSTATE CAPIBILITY OF FBM WEAPONS SYSTEM	P085	7/30/60	S	S	MISSLE SUCCESSFULLY PROGRAMMED FOR LAUNCH BY SUBMARINE SUPPORT EQUIPMENT. EJECTION, POWERED FLIGHT, & GUIDANCE NORMAL. NO REB SPIN-UP
OLARIS	A1XP-8 / A1E-2	TEST ARTICLE (GUIDED), GUIDED TEST OF FBM WEAPONS SYSTEM	P086	7/20/60	S	S	MISSLE SUCCESSFULLY PROGRAMMED FOR LAUNCH BY AUTOMATIC CHECKOUT EQUIPMENT ON SUBMARINE SUPPORT EQUIPMENT. EJECTION, POWERED FLIGHT, NORMAL. UNUSUALLY LARGE BROACH ANGLE AND PITCHOSCILLATION DURING FLIGHT.
POLARIS	A1XP-5 / A1E-1	TEST ARTICLE (GUIDED), TEST OF FBM WEAPONS SYSTEM TO HIT TARGET	P087	7/20/60	S	S	
POLARIS	A1X-52	TEST ARTICLE (GUIDED), 2ND STAGE AGC MOTOR	P088	10/17/60	P	F	IGNITION AND LIFT OFF NORMAL SHORTLY AFTER SEPARATION, 2ND STAGE MOTOR PRESSURE INCREASED TO A POINT WHICH EXCEEDED DESIGN CONDITIONS AND THE MOTOR BOTTLE RUPTURED.
POLARIS	A1X-46	TEST ARTICLE (GUIDED)	P090	11/7/60	S	F	POWERED FLIGHT NORMAL EXCEPT FOR AN ANOMALY IN THE CONTROL OF ONE JETEVATOR DURING THE EARLY PERIOD OF 2ND STAGE BURNING - THIS DID NOT INTERFERE WITH TEST OBJECTIVES
POLARIS	A1X-53	TEST ARTICLE FULLY GUIDED AND UNPOWERED RE-ENTRY BODY 2ND MISSLE IMPACT IN GROUND TARGET	P092	10/10/60	S	S	FULLY GUIDED FLIGHT NORMAL
POLARIS	A1X-49	TEST ARTICLE UNGUIDED	P094	10/5/60	S	S	IGNITION AND POWERED FLIGHT NORMAL, ALL ARMING AND FIRING SIGNALS RECIEVED AN TELEMETRY. ALL TEST OBJECTIVES ACCOMPLISHED
POLARIS	A1X-45	TEST ARTICLE UNGUIDED, AEC WARHEAD(SANDIA)	P096	9/2/60	S	S	IGNITION AND POWERED FLIGHT , AND THRUST TERMINATION NORMAL
POLARIS	A1X-48	TEST ARTICLE FULLY GUIDED FIRST POLARIS IMPACT IN GROUND TURK	P097	9/23/60	S	S	FULLY GUIDED FLIGHT NORMAL

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
POLARIS	A1X-44	TEST ARTICLE UNGUIDED INERT AEC DEVELOPMENT WARHEAD	P098	8/4/60	S	S	IGNITION AND POWERED FLIGHT , AND THRUST TERMINATION NORMAL
POLARIS	A1X-37	TEST ARTICLE (GUIDED)	P099	8/2/60	P	F	EJECTION NORMAL, POWERED FLIGHT NORMAL EXCEPT FOR EXCESSIVE AZIMUTH TRAJ. ERROR DUE TO GUIDANCE MALFUNCTION LARGE G\RIGHT DEVIATION BEGAN SHORTLY AFTER LAUNCH
POLARIS	A1X-47	TEST ARTICLE (FULLY GUIDED)	P0101	8/12/60			AFTER LIFT OFF MISSLE ROLLED 150 DEG TO FLIGHT AZIMUTH, POWERED FLIGHT & GUIDANCE INITIATED THRUST TERMINATION NORMAL
POLARIS	A1X-43	TEST ARTICLE UNGUIDED, INERT AEC WARHEAD	P0103	8/18/60	S	S	IGNITION AND POWERED FLIGHT, AND THRUST TERMINATION NORMAL
POLARIS	A1X-41	TEST ARTICLE UNGUIDED, INERT AEC WARHEAD	P0105	8/19/60	S	S	IGNITION AND POWERED FLIGHT GUIDANCE INITIATED THRUST TERMINATION NORMAL. tHIS INDICATES USE OF SHIP MOTION SIMULATOR
POLARIS		TEST ARTICLE FULLY GUIDED	P0107	7/14/60	S	S	
POLARIS	A1X-39	TEST ARTICLE (GUIDED)	P0108	7/7/60	F	F	COMMENT FOR AIX-39 NOTED ON P.46 (AIP-39) WHICH WAS INCORRECT
POLARIS	A1X-40	TEST ARTICLE (UNGUIDED) AED WARHEAD	P0110	7/6/60	P	F	RUPTURE OF 2ND STAGE LIGHT WEIGHT MOTOR CASE
POLARIS	A1X-34	TEST ARTICLE (GUIDED)	P0111	6/23/60	S	S	IGNITION, POWERED FLIGHT,GUIDANCE INITIATED THRUST TERMINATION, NORMAL - AEC WARHEAD IMPACTED NORMALLY. lATERAL ERROR TRACED TO GUIDANCE GROUND SUPPORT EQUIPMENT
POLARIS		TEST ARTICLE (GUIDED)	P0112	6/22/60	S	S	FORCED AIR EJECTION, POWERED FLIGHT AND GUIDANCE INITIATED THRUST TERMINATION NORMAL
POLARIS	A1X-27	TEST ARTICLE (GUIDED)	P0113	6/7/60	P	F	AEC WARHEAD IMPACTED ABNORMALLY APPROX 61 NM FROM CAPE
POLARIS	A1X-17	TEST ARTICLE (GUIDED)	P0114	5/23/60	P	F	FORCED AIR EJECTION FROM TUBE AND ALL MISSLE SUBSYSTEMS OPERATED NORMALLY DURING FLIGHT EXCEPT GUIDANCE WHICH FAILED TO SUPPLY A THRUST TERMINATION SIGNAL
POLARIS	A1X-30	TEST ARTICLE (FULLY GUIDED)	P0116	5/18/60	S	S	FORCED AIR EJECTION FORM TUBE AND ALL MISSLE SUBSYSTEMS DURING FLIGHT INCLUDING THRUST TERMINATION SIGNAL OPERATED NORMALLY
POLARIS	A1X-25	TEST ARTICLE (UNGUIDED) AEC WARHEAD	P0117	4/29/60	S	S	IGNITION AND POWERED FLIGHT-NORMAL RE-ENTRY SEPARATION AND IMPACT NORMAL ALL TEST OBJECTIVES MET
POLARIS	A1X-23	TEST ARTICLE (UNGUIDED) AEC WARHEAD AUTOPILOT	P0118	4/29/60	S	S	IGNITION, POWERED FLIGHT, RE-ENRTY SEPARATION AND IMPACT NORMAL
POLARIS	A1X-22	TEST ARTICLE (UNGUIDED) AEC WARHEAD AUTOPILOT	P0119	4/25/60	S	S	POWERED FLIGHT UNDER AUTOPILOT - NORMAL, REV SEPARATION AND IMPACT - NORMAL

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
POLARIS	A1X-19	TEST ARTICLE (GUIDED)	P0120	4/8/60	P	F	
POLARIS	A1X-18	TEST ARTICLE (GUIDED) 1ST POLARIS IN GRAND TURK	P0121	3/29/60	P	F	SHIPS FIRE CONTROL SYSTEM SUCCESSFULLY INSERTED AN AT SEA PLATFORM ORIENTATION, AND LOCATION INTO MISILLE GUIDANCE SYSTEM. AIR EJECTION, IGNITION AND POWERED FLIGHT OF MISSLE APPARENTLY NORMAL TO 112 SEC
POLARIS	A1X-16	TEST ARTICLE (GUIDED)	P0122	3/25/60	F	F	EARLY TERMINATION - ALL PORTS DID NOT BLOW - MALFUNCTION AT TIME OF REV SEPARATION
POLARIS	A1X-15	TEST ARTICLE (UNGUIDED), AUTOPILOT CONTROL-NEWLY MODIFIED HYDRAULIC SYSTEM AND AFT END HEAT SHIELD	P0123	3/17/60	S	F	
POLARIS	A1X-14	TEST ARTICLE (UNGUIDED), FIRST TACTICAL CONFIGURATION -AUTOPILOT STEERING ONLY	P0124	3/9/60	F	F	TEST NUMEROUS FUNCTIONS HYDRAULIC SYSTEM CONTROL, REV DYNAMICS & THERMAL DYNAMICS, THERMAL DESIGN, 2ND STAGE MOTOR FRONT END
POLARIS	A1X-13	TEST ARTICLE (GUIDED, FULLY INERTIAL GUIDANCE SYSTEM)	P0125	2/26/60	P	F	MISSILE SUCCESSFULLY ACCOMPLISHED 78.6 ROLL AND DESIRED FLIGHT CONTROL (NOT GUIDANCE) MALFUNCTION OCCURRED - DESTRYOYED @ 104 SEC. MALFUNCTION OF CONTROL SYSTEM CAUSED JETEVATOR TO GO HEAD OVER.
POLARIS	A1X-11	TEST ARTICLE (GUIDED)	P0127	2/10/60	S	S	MISSLE PERFROMACE & REV DYNAMICS & THERMO DYNAMICS, AFTER LAUNCH MISSLE ROLLED 89 DEG TO DESIRED AZIMUTH, GUIDANCE FUNCTIONAL NORMALLY
POLARIS	A1X-12	TEST ARTICLE (UNGUIDED), AUTOPILOT STEERING	P0128	2/4/60	S	S	TEST MISSLE PERFROMANCE, RE-ENTRY BODY FLIGHT DYNAMICS, AND THERMO DYNAMICS. LAUNCH AND POWERED FLIGHT NORMAL
POLARIS	A1X-10	TEST ARTICLE (GUIDED, FULLY INERTIAL GUIDANCE SYSTEM)	P0129	1/27/60	S	S	TEST PERFROMANCE AND CONTROL - REV DYNAMICS AND THERMO DYNAMICS, GUIDANCE EVAL, ABILITY OF FIRE CONTROL SYSTEM
POLARIS	A1X-9	TEST ARTICLE (GUIDED)	P0130	1/20/60	S	S	30 ROLL MANUEVER SUCCESSFUL, GUIDED FLIGHT NORMAL
POLARIS	A1X-8	TEST ARTICLE (GUIDED)	P0131	1/13/60	S	S	ONLY DOCUMENTATION IS "SUCCESSFUL"
POLARIS	A1X-7	TEST ARTICLE (GUIDED) 1ST FULLY GUIDED MISSLE	P0132	1/7/60	S	S	NO ANOMALIES, DEVELOPMENT TEST OF - BASIC MISSION, RE-ENTRY BODY, GUIDANCE SYSTEM, FIRE CONTROL
POLARIS	A1X-5	TEST ARTICLE (PARTIALLY GUIDED)	P0133	12/23/59	P	F	LOSS OF CONTROL DURING 1ST STAGE SEPARATION - MISSLE NORMAL TILL 6 SEC AFTER STAGING
POLARIS	A1X-6	TEST ARTICLE (UNGUIDED)	P0134	12/15/59	P	F	NIGHT LAUNCH
POLARIS	A1X-4	TEST ARTICLE (UNGUIDED)	P0135	12/7/59	S	F	13.5 NM TARGET ERROR, ABNORMAL 2ND STAGE SEPARATION
POLARIS	A1X-3	TEST ARTICLE (UNGUIDED)	P0136	11/20/59	S	S	

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
POLARIS	A1X-2	TEST ARTICLE (UNGUIDED)	P0137	10/12/59	P	F	
POLARIS	A1X-1	TEST ARTICLE (UNGUIDED)	P0138	9/21/59	S	S	NOT ENOUGH INFO TO MAKE VALID DETERMINATION, EXCEPT"SUCCESSFUL". IMPACT 75NM RIGHT& 3.5 NM LONG
POLARIS	AX-20	TEST ARTICLE	P0139	10/2/59	P	F	
POLARIS	AX-14	TEST ARTICLE	P0140	9/28/59	P	F	2ND STAGE DESTROYED BY RSO, 1ST STAGE NOT DESTROYED BECAUSE INSTRUMENTATION GONE
POLARIS	AX-22	TEST ARTICLE - FIRST SHIP LAUNCH	P0141	8/27/59	S	S	IMPACT COORDINATES CORRESPOND TO AIMING POINT COORDINATES
POLARIS	AX-18	TEST ARTICLE	P0142	8/25/59	P	F	2ND STAGE BURNED ONLY 3 SEC
POLARIS	AX-13	TEST ARTICLE	P0143	8/14/59	S	S	NO DOCUMENTATION EXCEPT "SUCCESSFUL"
POLARIS	AX-15	TEST ARTICLE	P0144	8/6/59	P	F	
POLARIS	AX-11	TEST ARTICLE	P0146	7/15/59	P	F	MISSILE HAD GUIDANCE PACKAGE BUT WAS NOT USED JUST MONITORED
POLARIS	AX-9	TEST ARTICLE	P0148	6/29/59	S	S	"IMPACT - 15NM SHORT, 9NM RIGHT (SOURCE UNKNOWN) "SUCCESSFUL", NOMINAL IMPACT"
POLARIS	AX-10	TEST ARTICLE	P0149	6/12/59	P	F	IMPACT 58NM DOWNRANGE, 1NM LEFT
POLARIS	AX-7	TEST ARTICLE	P0150	5/18/59	P	F	
POLARIS	AX-8	TEST ARTICLE	P0151	5/8/59	S	S	THE ONLY COMMENTS GIVEN ARE:"IMPACT - 45NM SHORT, 15NM LEFT - IN PROPOSED AREA (SOURCE UNKNOWN) SUCCESSFUL"
POLARIS	AX-6	TEST ARTICLE	P0153	4/20/59	S	S	BASCI MISSLE DEVELOPMENT TESTS soic EVAL BASED ON rso NOTES" PROVIDED SUFFICIENT DATA TO MEET 90% OF PRIMARY OBJECTIVES & 75% OF SECONDARY OBJ. - WHAT HAPPENED?
POLARIS	AX-5	TEST ARTICLE	P0154	2/27/59	P	F	
POLARIS	AX-4	TEST ARTICLE	P0155	1/19/59	P	F	TEST FOR BASIC MISSILE DEVELOPMENT RSO ESTIMATED THAT 80% OF PRIMARY TEST OBJECTIVE WAS ATTAINED
POLARIS	AX-3	TEST ARTICLE	P0158	12/30/58	P	F	TESTS FOR BASIC MISSILE DEVELOPMENT, MISSILE PERFORMANCE AND RESPONSE TO CONTROL ACTION AND EVALUATION OF SEPARATION

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
POLARIS	AX-2	TEST ARTICLE	P0159	10/15/58	F	F	AS A RESULT OF 1ST STAGE FAILURE 2ND STAGE IGNITED AND LIFTED OFF - RSO TOOK DESTRUCT ACTION FOR 2ND STAGE, 1ST STAGE REMAINED ON THE PAD.
POLARIS	AX-1	TEST ARTICLE	P0161	9/24/58	P	F	TEST TO DETERMINE PROPULSION SYSTEM PERFROMANCE, AIRFRAME INTEGRITY AND FLIGHT CONTROL SYSTEM PERFROMANCE. RSO TOOK DESTRUCT ACTION AT 25 SEC, NO TEST OBJECTIVES ACHIEVED
POLARIS	1-204-14 / FTV 1-	TEST ARTICLE	P0162	6/24/58	S	S	TO EVALUATE ABILITY OF VEHICLE TO RESPOND TO A 76 DEG LAUNCH ATTITUDE TO 14 DEG PITCH UP STEP COMMAND FOLLOWED BY A 14 DEG PITCH OVER COMMAND. PORGRAM WAS APPLIED AS PLANNED AND VEHILCE RESPONSE , IMPACT 66 DEG 39000FT
POLARIS	1-204-13 / FTV 1-	TEST ARTICLE	P0163	6/6/58	S	S	TEST TO EVALUATE ABILITY OF VEHICLE TO FOLLOW A PROGRAMMED PITCH OVER TRAJ., THE PITCH OVER PROGRAM WAS APPLIED AS PLANNED AND THE VEHICLE RESPONSE WAS SATISFACTORY. IMPACT 105 DEG, 18000FT IN PROPOSED AREA
POLARIS	1-204-12 / FTV 1-	TEST ARTICLE	P0164	5/8/58	S	F	TEST TO EVALUATE ABILITY OF VEHICLE TO FOLLOW A PROGRAMMED PITCH OVER TRAJ., THE PITCH OVER PROGRAM WAS APPLIED AS PLANNED AND THE VEHICLE RESPONSE WAS SATISFACTORY. IMPACT 100 DEG, 33000FT IN PROPOSED AREA
OLARIS	1-204-11 / FTV 1-	TEST ARTICLE	P0165	4/18/58	S	F	TEST - EVALUATE ABILITY TO FOLLOW A CONSTANT ATTITUDE TRAJ. RADAR PLOTS AND PRELIM. ANALYSIS - STABLE FLIGHT ON THE INTENDED TRAJ."TEST OBJECTIVES APPEAR TO HAVE BEEN ACHIEVED" MISSILE EXPLODED @ THURST REVERSAL- IMPACT 88 DEG, 31000FT IN PROPOSE
POLARIS	1-204-10 / FTV 1-	TEST ARTICLE	P0166	1/17/58	S	S	TEST - DEVELOPMENTAL POLARIS FLIGHT CONTROL SYS. INCORPORATING ANGLE OF ATTACK LIMITING SYS, AND EVAL OF AIRFRAME RESPONSE TO CONTROL ACTUATOR. IMPACT 110 DEG 45000FT IN PROPOSED AREA
POLARIS	1-204-9 / FTV 1-9	TEST ARTICLE	P0167	12/10/57		S	TEST - DEVELOPMENTAL POLARIS FLIGHT CONTROL SYS. INCORPORATING ANGLE OF ATTACK LIMITING SYS, AND EVAL OF AIRFRAME RESPONSE TO CONTROL ACTUATOR. IMPACT 97 DEG 31000FT IN PROPOSED AREA
POLARIS	1-204-8 / FTV 1-8	TEST ARTICLE	P0169	11/15/57		S	TEST - DEVELOPMENTAL POLARIS FLIGHT CONTROL SYS. INCORPORATING ANGLE OF ATTACK LIMITING SYS, AND EVAL OF AIRFRAME RESPONSE TO CONTROL ACTUATION."TEST OBJ. WERE APPARENTLY MET" - THIS MAY INIDICATE A FIALURE BUT SPECIFICS ARE NOT NOTED
POLARIS	3-204-4	TEST ARTICLE	P0171	11/8/57		S	RE-ENTRY BODY TESTS, IMPACT 106 DEG, 132NM IN PROPOSED AREA
POLARIS	3-204-3	TEST ARTICLE	P0173	10/24/57		S	RE-ENTRY BODY TESTS, IMPACT 85 DEG, 118NM IN PROPOSED AREA, TELEMETRY TRACKING PROBLEMS

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
POLARIS	3-204-7	TEST ARTICLE	P0175	10/22/57		S	EVAL. OF FLIGHT CONTROL SYSTEM AND THRUST TERMINATION SYS. POWERED FLIGHT OK - AFTER T.T MISSLE OBSERVED CORK SCREW AND CONTINUED TO CORKSCREW TO IMPACT CHUFFING OBSERVED FROM T.T. TO IMPACT
POLARIS	3-204-6	TEST ARTICLE	P0177	9/9/57		S	TO TEST THRUST TERMINATION SYSTEM IN LARAGE (XM36) SOLID ROCKET ENGINE. IMPACT OUT OF PROPOSED AREA-PROGRAMMED LOW
POLARIS	5-204-1	TEST ARTICLE	P0178	8/16/57		S	TO TEST FORWARD POSISTIONED THRUST TERMINATION DEVICE AT HIGH ATTITUDE MAX ALTITUDE 2ND STAGE - 555000FT IMPACT 79 DEG 220 NM
POLARIS	5-204-2	TEST ARTICLE	P0179	8/9/57		S	TEST .4 SCALE RE-ENTRY BODY MAX ALTITUDE 380000 FT 2ND STG SEP 311.4 SEC IMPACT 94 DEG, 136 NM
POLARIS	3-204-1	TEST ARTICLE	P0180	7/19/57	S	S	TEST .4 SCALE RE-ENTRY AZIMUTH 96 DEG. MAX ALTITUDE 427000 FT IMPACT 95 DEG, 120 NM
POLARIS	4-204-2	TEST ARTICLE	P0181	7/16/57		S	TEST FORWARD END THRUST REVERSAL
POLARIS	4-204-1	TEST ARTICLE	P0182	6/27/57		S	TO TEST PERFROMACE OF END THRUST REVERSAL DEVICE
POLARIS	PAHSE VI-1	TEST ARTICLE	P0183	4/13/57	F	F	TEST TO DETERMINE TIME REQUIRED TO ACHIEVE THRUST REVERSAL AND TO DETERMINE MAJOR FORCES APPLIED TO THE VEHICLE DURING THRUST REVERSAL
RED TIGRESS	I		RT5	8/20/91	F	P	The missile was destroyed at T+23.38 sec on a 159 degree heading. Note: A review board found that the failure was attributed to an erroneously selected guidance table alone.
RED TIGRESS	II		RT8	10/14/91	S	S	A staus and control panel went NMC due to power supply failure. No mission impact.
RED TIGRESS	II(A)	1st stage - TALOS, 2nd stage - Sergant, 3rd stage - M57A1	RT9A	5/23/93	S	S	
RED TIGRESS	II(B)	1st stage - TALOS, 2nd stage - Sergant, 3rd stage - M57A1	RT9B	5/28/93	S	S	
SATURN	SATURN 1 BOOSTER	S-1 BOOSTER W/ 8 X H-1 ENGINES (LOX-RP-1 165KLB THRUST) PLUS DUMMY S-4 2ND STAGE, DUMMY S-5 3RD STAGE DUMMY PAYLOAD BODY. INTERTIAL GUIDANCE SYS. BASED ON ST-90 STAB. PLATFORM USED IN JUPITER, LIFTOFF WEIGHT 926KLB	SAT1	10/27/61	S	P	
SATURN	SATURN 1 BOOSTER	SEE P.1. UPPER STAGES INTENTIONALLY RUPTURED BY FTS COMMAND AT 105 KM ALTITUDE FOR WATER CLOUD EXPERIMENT ("PROJECT HIGH WATER"). LIFTOFF WEIGHT 926KLB.	SAT5	4/25/62	S	S	
SATURN	SATURN 1 BOOSTER	SEE P.1. LIFTOFF WEIGHT 1086KLB. REPEAT PROJECT HIGH WATER -SEE P.2 - AT 167KM.	SAT7	11/16/62	S	S	

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
SATURN	SATURN 1 BOOSTER	SEE P.1. SHORT BURN TO DEMONSTRATE CAPABILITY WITH PREMATURE MAIN ENGINE CUTOFF / FAILURE. REPEAT PROJECT HIGH WATER -SEE P.1 - AT 167KM.	SAT9	3/28/63			
SATURN	SATURN 1 BOOSTER	STG 1:S-1, 8-ROCKETDYNE H-1, LOX/RP-1, 188KLB THRUST (NOTE:UPGRADED FROM 165KLB OF PREVIOUS SATURN 1 FLIGHTS). STG 2 : S-IV, 6-P&W RL-10A-3, LOX/LH2, 15KLB THRUST INSTRUMENTATION UNIT. BALLASTED JUPITER NOSECONE. GUIDANCE: ST-124 ..SEE CONTINUATION PG 5A	SAT11	1/29/64	S	P	
SATURN	SATURN 1 BOOSTER	PER P.5 EXCEPT WITH DUMMY APOLLO SPACECRAFT, ST-90S STABILIZED PLATFORM GUIDANCE SYSTEM IN ADDITION TO ST-124	SAT12	5/28/64	P	P	TURBOPUMP-CATASTROPHIC
SATURN	SATURN 1	SEE P.6	SAT13	9/18/64	S	S	
SATURN	SATURN 1	PER P.6 EXCEPT APOLLO SPACECRAFT DUMMY CONTAINED PEGASIS SATELLITE.	SAT14	2/16/65	S	S	
SATURN	SATURN 1B	STG1: S-1, 8 ROCKETDYNE H-1, LOX/RP-1, 200KLB THRUST(NOTE:UPRATED FROM 188KLB OF PREVIOUS FLIGHTS), STG 2: S-IVB, 1-ROCKETDYNE J-2, LOX/LH2, 200KLB THRUST (NOTE:REPALCES 6 - RL10S IN SIV USED ON PREVOUS FLIGHTS), INSTRUMENTATION UNIT, PROTOTYPE APOLLO.	SAT15	2/26/66	S	S	FIRST FLIGHT OF THE J-2 ENGINE
SATURN	SATURN 1B	PER P.9 EXCEPT WITH AERODYNAMIC FAIRING INSTEAD OF APOLLO SPACECRAFT	SAT16	7/5/66	S	S	
SATURN	SATURN 1B	SEE P.9	SAT17	8/25/66	S	P	
SATURN	SATURN 5	STG1 S-IC, 5-ROCKETDYNE F-1, LOX/RP-1, 1502KLB THRUST;STG2:S-II, 5-ROCKETDYNE J-2, LOX/LH2, 200KLB THRUST, STG3 S-IV, 1-ROCKETDYNE J-2, LOX/LH2 200KLB THRUST. APOLLO SPACECRAFT: COMMAND MODUEL, SERVICE MODULE, LEM ADAPTER	SAT18	11/9/67	S	S	1ST SATURN V "MOON ROCKET" FLIGHT
SATURN	SATURN 1B	PER P.9 EXCEPT WITH LEMAND LEM ADAPTER ONLY INSTAED OF FULL APPOLLO SPACECRAFT	SAT19	1/22/68	S	S	
SATURN	SATURN 5	SEE P.12	SAT20	4/4/68	F	F	THE MAIN MISSION OBJECTIVE, CHECKING OUT APOLLO SPACECRAFT ON ORBIT AND REENTRY, SEEMS TO HAVE BEEN ACCOMPLISHED ANYWAY.
SATURN	SATURN 1B	PER P.9 EXCEPT WITH MANNEDD APPOLO SPACECRAFT, NO LEM OR LEM ADAPTER.	SAT22	10/11/68	S	S	FIRST MANNED APOLLO MISSION
SATURN	SATURN 5	SEE P.15 LUNAR ORBITAL MISSION APPOLO 8.	SAT23	12/21/68	S	S	FIRST MANNED LUNAR ORBIT.
SATURN	SATURN 5	SEE P.12 FULL APPOLO WITH LEM. OBJECTIVE:LEM CHECKOUT IN L.E.O. APOLLO 9 MISSION	SAT24	3/4/69	S	S	

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
SATURN	SATURN 5	SEE P. 12 OBJECTIVE: CHECKOUT LEM IN LUNAR ORBIT AND DESCENT NEAR SURFACE APPOLO 10 MISSION	SAT25	5/18/69	S	S	
SATURN	SATURN 5	SEE P. 12 APPOLO 11 MISSION	SAT26	7/16/69	S	S	FIRST MANNED LUNAR LANDING.
SATURN	SATURN 5	SEE P. 12 APOLLO 13 MISSION	SAT28	4/11/70	P	P	APOLLO 13 SPACECRAFT FAILED DURING EARTHMOON LEG AND HAD TO RETURN.
SPACE SHUTTLE	Columbia	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS1	4/12/81	S	S	CMEV1 failure during the minus count. CMEV2 was made prime for the launch. At T+34 sec,CMEV2 halted and switchover to CMEV1 occurred.
SPACE SHUTTLE	Columbia	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS2	11/12/81	S	S	
SPACE SHUTTLE	Columbia	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS3	3/22/82	S	S	
SPACE SHUTTLE	Columbia	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS4	6/27/82	S	S	Radar 19.14 inoperative for launch (faulty servo)
SPACE SHUTTLE	Columbia	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS5	11/11/82	S	S	
SPACE SHUTTLE	Columbia	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS6	6/18/83	S	S	
SPACE SHUTTLE	Challenger	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS7	8/30/83	S	S	
SPACE SHUTTLE	Columbia	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS8	11/28/83	S	S	
SPACE SHUTTLE	Challenger	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS9	4/24/84	S	S	
SPACE SHUTTLE	Discovery	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS10	4/30/84	S	S	
SPACE SHUTTLE		Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS11	10/5/84	S	S	
SPACE SHUTTLE	Discovery	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS12	11/8/84	S	S	

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
SPACE SHUTTLE	Discovery	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS13	4/28/85	S	S	
SPACE SHUTTLE	Challenger	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS14	4/12/85	S	S	
SPACE SHUTTLE	Discovery	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS15	6/17/85	S	S	
SPACE SHUTTLE	Challenger	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS16	7/29/85	P	P	SSME out at 345 sec, resulting in approx. 100fs underspeed at MECO
SPACE SHUTTLE	Discovery	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS17	8/27/85	S	S	
SPACE SHUTTLE	Challenger	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS18	10/30/85	S	S	
SPACE SHUTTLE	Atlantis	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS19	11/26/85	S	S	
SPACE SHUTTLE	Columbia	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS20	1/12/86	S	S	
SPACE SHUTTLE	Challenger	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS21	1/28/86	F	F	SRB's broke away and continued thrusting until functions were sent by Range. Subject under investigation. Note first launch from 39B.
SPACE SHUTTLE	Discovery	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS22	9/29/88	S	S	
SPACE SHUTTLE	Discovery	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS23	3/13/89	S	S	
SPACE SHUTTLE	Atlantis	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS24	10/18/89	S	S	
SPACE SHUTTLE	Columbia	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS25	1/9/90	S	S	
SPACE SHUTTLE	Discovery	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters	STS26	4/24/90	S	S	
SPACE SHUTTLE	Discovery	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons.	STS27	10/6/90	S	S	Many records stop providing the range inclination after this launch.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
SPACE SHUTTLE	Columbia	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons.	STS28	12/2/90	S	S	2 SRB's have 2.65 million lbs of thrust, 1 ET contains 1.58 million lbs of CO2 and LH2, 3 main engines with 375,000 lbs of thrust
SPACE SHUTTLE	Atlantis	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons.	STS29	4/5/91	S	S	
SPACE SHUTTLE	Discovery	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons.	STS30	4/28/91	S	S	A flight recorder was activated without the appropriate signal from controllers. This caused a 30 min. launch delay.
SPACE SHUTTLE	Columbia	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons.	STS31	6/5/91	S	S	The "B" charts were used.
SPACE SHUTTLE	Atlantis	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons.	STS32	8/2/91	S	S	
SPACE SHUTTLE	Discovery	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons.	STS33	9/12/91	S	S	1st launch using DOLILU by NASA, C wind charts used
SPACE SHUTTLE	Atlantis	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons.	STS34	11/24/91	S	S	
SPACE SHUTTLE	Discovery	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons.	STS35	1/22/92	S	S	B charts used, This was the first time the adjust trajectory (DOLILU) was used on the display.
SPACE SHUTTLE	Atlantis	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons. Tumble Value Inhibited.	STS36	3/22/92	S	S	A charts used, TRSS was used for the first time on any launch and 59 sec of data.
SPACE SHUTTLE	Endevour	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons. Tumble Value Inhibited.	STS37	5/7/92	S	S	A charts used, large deviation between theoretical and post - MECO ET impact points due mainly to launch occurring late in window and partly to 5 fps underspeed.
SPACE SHUTTLE	Columbia	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons. Tumble Value Inhibited.	STS38	6/25/92	S	S	A charts used.The range between the actual and theoretical ET impact points is 1.1nm
SPACE SHUTTLE	Atlantis	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons. Tumble Value Inhibited.	STS39	7/31/92	S	S	A charts used.
SPACE SHUTTLE	Endevour	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons. Tumble Value Inhibited.	STS40	9/12/92	S	S	B charts used.
SPACE SHUTTLE	Discovery	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons. Tumble Value Inhibited.	STS41	10/22/92	S	S	C charts used.

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
SPACE SHUTTLE	Discovery	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons. Tumble Value Inhibited.	STS42	12/2/92	S	S	A charts used.
SPACE SHUTTLE	Endevour	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons. Tumble Value Inhibited.	STS43	1/13/93	S	S	B charts used.
SPACE SHUTTLE	Discovery	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons. Tumble Value Inhibited.	STS44	4/8/93	S	S	B charts used. Radar 19.17 became NMC in the minus count and was not used. Dolilu transmission lines were not working, hence the DOLILU adjust trajectory was not presented on the RSD's. (Assume ground tracking - not STS)
SPACE SHUTTLE	Columbia	Integrated Shuttle Vehicle: Orbiter-2 OMS engines / 3 main engines; ET-Liquid propellant external tank; 2 solid rocket boosters, SRB's are equipped with beacons. Tumble Value Inhibited.	STS45	4/26/93	P	S	B charts used. Data was corrupted at about 40 sec causing track to stray significantly to the left for a short time. (Assumed STS instruments)
VANGUARD	TV	Nominal SLV with a new 3rd stage Allegheny Ballistics Laboratory X248 A2 solid propellent, TV-4BU.	V9	9/18/59	S	S	The estimated orbit is 50 years, for the payload and third stage motor case. This orbit is significantly less than the 1000 year orbit first attained with launch vehicle TV-4
VANGUARD	SLV	Nominal SLV, SLV-6	V10	6/22/59	F	F	This launch had the same problem as the previous launch. Obviously the second stage problem had not been identified and corrected.
VANGUARD	SLV	Nominal SLV, SLV-5	V11	4/13/59	F	F	The back of the missle performance sheet is missing. From the first page it is not clear that a specific problem has not been identified and corrected.
VANGUARD	SLV	Nominal SLV, SLV-4	V12	2/17/59	S	P	Second stage performance was low, due to a low propane fuel flow rate.
VANGUARD	SLV	Nominal SLV, SLV-3	V13	9/26/58	F	F	It appears that the contamination problem was either misdiagnosed or not properly corrected. The back of the missle performance record is missing.
VANGUARD	SLV	Nominal SLV, SLV-2	V14	6/26/58	F	F	
VANGUARD	SLV	Minor instrument changes from TV, SLV-1	V15	5/27/58	F	F	This was the 1st production satellite launching vehicle. Back of missle performance record sheet missing. ** 1.5 sec removed from 2nd stage cutoff of 261.5
VANGUARD	TV	Nominal TV, TV-5	V16	4/28/58	F	F	
VANGUARD	TV	Nominal TV, TV-4	V17	3/17/58	S	F	
VANGUARD	TV	1st Stage - GE X-405 propulsion using kerosene and LOX, 2nd Stage - Areojet General AJ10-37 propulsion using WINFNA and UDMH, 3rd stage - Grand Central 33-KS-2800 solid propellant, TV-3BU	V18	2/5/58	F	F	

Data Encoding Database Records

(Partial Viewing)

Vehicle	Generation	Configuration	Data Page	Launch Date	RSO Eval.	DI Eval.	Remarks
VANGUARD	TV	1st Stage - GE X-405 propulsion using kerosene and LOX, 2nd Stage - Areojet General AJ10-37 propulsion using WINFNA and UDMH, 3rd stage - Grand Central 33-KS-2800 solid propellant, TV-3	V19	12/6/57	F	F	
VANGUARD	Prototype-TV	1st Stage - GE X-405 propulsion using kerosene and LOX, 2nd Stage& 3rd stage -simulated but inert. Guidance and control Minneapolis - Honeywell strapped down gyroscope reference system and a gimbled inertial platform, TV-2	V20	10/23/57	S	S	
VANGUARD	Prototype-TV	1st Stage - Martin Viking No. 14, 2nd Stage - prototype of solid 3rd stage, 3rd Stage - Grand Central 33-KS-2800, TV-1	V21	5/1/57	S	S	
VANGUARD	Prototype-TV	1st Stage - Martin Viking No. 13 Liquid - Propellant single stage rocket, TV-0	V22	12/8/56	S	P	Mark 51 was faulty and indicated a red condition.

APPENDIX B

RISK AND RELIABILITY DATABASE

Space Flight Risk and Reliability Data

Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Atlas	A	Component	Beacon	Catastrophic		A6, A10, A11, A36, A92, A104	6	215	0.0279	0.0310	0.0551	0.0122	2.08
Atlas	A	Component	Beacon	Degraded		A7, A8, A99	3	215	0.0140	0.0171	0.0361	0.0038	2.66
Atlas	A	Component	Beacon	Incipient		A8	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Component	Beacon	Total		A6, A7,A8, A10, A11, A12, A36, A92, A99	11	215	0.0512	0.0543	0.0847	0.0287	1.78
Atlas	A	Component	Beacon	Unknown		A12	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Component	Engine	Catastrophic	High frequency combustion instability; No ignition	A5, A46, A47, A126, A210, A214	6	215	0.0279	0.0310	0.0551	0.0122	2.08
Atlas	A	Component	Engine	Degraded		A22	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Component	Engine	Incipient		A90, A96, A101, A177	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	Component	Engine	Total	High frequency combustion instability; No ignition	A5, A22, A46, A47, A90, A96, A101, A126, A177, A201, A214	11	215	0.0512	0.0543	0.0847	0.0287	1.78
Atlas	A	Component	Gyro	Catastrophic		A9	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Component	Gyro	Degraded		A14, A16, A75	3	215	0.0140	0.0171	0.0361	0.0038	2.66
Atlas	A	Component	Gyro	Total		A9, A14, A16, A54, A75	5	215	0.0233	0.0264	0.0489	0.0092	2.20
Atlas	A	Component	Gyro	Unknown		A54	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Component	Joint	Catastrophic	Leak	A181	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Component	Joint	Total	Leak	A181	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Component	Other	Catastrophic		A5, A19, A38, A60, A64, A65, A67, A72, A74, A87, A89	11	215	0.0512	0.0543	0.0847	0.0287	1.78
Atlas	A	Component	Other	Degraded		A51, A77, A155, A205	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	Component	Other	Incipient		A5, A41, A53	3	215	0.0140	0.0171	0.0361	0.0038	2.66
Atlas	A	Component	Other	Total		A5, A19, A19, A38, A41,A51, A53, A60, A64, A65, A67, A72, A74, A77 A87, A89, A155, A205	18	215	0.0837	0.0868	0.1240	0.0541	1.63
Atlas	A	Component	Pump	Catastrophic		A7, A12, A13, A153	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	Component	Pump	Degraded		A154	1	215	0.0047	0.0078	0.0221	0.0002	4.73

Space Flight Risk and Reliability Data

Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Atlas	A	Component	Pump	Total		A7, A12, A13, A153, A154	5	215	0.0233	0.0264	0.0489	0.0092	2.20
Atlas	A	Component	Switch	Catastrophic	Normally closed, failed to open	A79	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Component	Switch	Total	Normally closed, failed to open	A79	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Component	Tank	Catastrophic	Rupture; Leak	A21, A53, A54, A200	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	Component	Tank	Degraded		A11	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Component	Tank	Total	Rupture; Leak	A11, A19, A21, A53, A54, A200	6	215	0.0279	0.0310	0.0551	0.0122	2.08
Atlas	A	Component	Tank	Unknown		A19	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Component	Transducer	Catastrophic	Premature depletion; Improper installation	A6, A38, A84	3	215	0.0140	0.0171	0.0361	0.0038	2.66
Atlas	A	Component	Transducer	Total	Premature depletion; Improper installation	A6, A38, A84	3	215	0.0140	0.0171	0.0361	0.0038	2.66
Atlas	A	Component	Unknown	Catastrophic		A1, A2, A14, A24, A37, A44, A91, A95, A118, A131, A132	11	215	0.0512	0.0543	0.0847	0.0287	1.78
Atlas	A	Component	Unknown	Total		A1, A2, A14, A18, A22, A24, A32, A37, A38, A44, A45, A59, A85, A91, A95, A97, A118, A122, A131, A132, A159, A161, A173, A195, A215	25	215	0.1160	0.1194	0.1620	0.0808	1.55
Atlas	A	Component	Unknown	Unknown		A18, A22, A32, A38, A45, A59, A85, A97, A122, A159, A161, A173, A195, A215	14	215	0.0651	0.0682	0.1020	0.0394	1.70
Atlas	A	Component	Valve	Catastrophic	Seal Leak	A25, A70	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	Component	Valve	Degraded	Normally closed, failed open; Normally open, failed to close	A23, A29	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	Component	Valve	Incipient		A20, A39, A82, A106	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	Component	Valve	Total	Normally closed, failed open; Normally open, failed to close; Seal leak	A20, A23, A25, A29, A39, A70, A82, A106	8	215	0.0372	0.0403	0.0671	0.0185	1.92
Atlas	A	Component	Wiring	Catastrophic	Reversed wiring	A71	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Component	Wiring	Degraded		A30	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Component	Wiring	Total	Reversed wiring	A30, A71	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	Configuration	A	Catastrophic	Explosion; Deviated flight trajectory	A1, A2, A5, A6	4	215	0.0186	0.0217	0.0426	0.0064	2.38

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Atlas	A	Configuration	A	Degraded		A7	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Configuration	A	Total	Explosion; Deviated flight trajectory	A1, A2, A5, A6, A7	5	215	0.0233	0.0264	0.0489	0.0092	2.20
Atlas	A	Configuration	B	Catastrophic	Instability and breakup; Deviated flight trajectory	A9, A13, A14, A18	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	Configuration	B	Incipient		A11, A12	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	Configuration	B	Total	Instability and breakup; Deviated flight trajectory	A9, A11, A12, A13, A14, A18	6	215	0.0279	0.0310	0.0551	0.0122	2.08
Atlas	A	Configuration	C	Catastrophic	Explosion; No lift	A19, A21, A22, A32	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	Configuration	C	Incipient		A29	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Configuration	C	Total	Explosion; No lift	A19, A21, A22, A29, A32	5	215	0.0233	0.0264	0.0489	0.0092	2.20
Atlas	A	Configuration	D	Catastrophic	Explosion; Loss of attitude and lift; Fire; No lift	A23, A24, A25, A30, A38, A44, A46, A47, A53, A54, A59, A65, A72, A85, A92, A97, A99, A118, A122, A126, A132	21	215	0.0977	0.1008	0.1410	0.0655	1.59
Atlas	A	Configuration	D	Degraded	Fire; Deviated flight trajectory	A31, A35, A45, A50, A51, A79, A87	7	215	0.0326	0.0357	0.0612	0.0153	1.99
Atlas	A	Configuration	D	Incipient	Loss of telemetry; Missile instability; Deviated flight trajectory	A36, A98, A101, A137	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	Configuration	D	Total	Explosion; Loss of attitude and lift; Fire; No lift; Deviated flight trajectory; Loss of telemetry; Missile instability	A23, A24, A25, A30, A31, A35, A36, A38, A44, A45, A46, A47, A50, A51, A53, A54, A59, A65, A72, A79, A85, A87, A92, A97, A98, A99, A101, A118, A122, A126, A132, A137	32	215	0.1490	0.1519	0.2000	0.1080	1.50
Atlas	A	Configuration	E	Catastrophic	Missile instability; Improper angle of attack	A60, A64, A67, A70, A71, A75, A80, A84	8	215	0.0372	0.0403	0.0671	0.0185	1.92
Atlas	A	Configuration	E	Incipient		A74, A77, A82	3	215	0.0140	0.0171	0.0361	0.0038	2.66
Atlas	A	Configuration	E	Total	Missile instability; Improper angle of attack	A60, A64, A67, A70, A71, A74, A75, A77, A80, A82, A84	11	215	0.0512	0.0543	0.0847	0.0287	1.78
Atlas	A	Configuration	F	Catastrophic	Explosion	A89, A91, A95, A112	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	Configuration	F	Incipient		A106	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Configuration	F	Total	Explosion	A89, A91, A95, A102, A112	5	215	0.0233	0.0264	0.0489	0.0092	2.20
Atlas	A	Configuration	G	Catastrophic	Instability and breakup	A205	1	215	0.0047	0.0078	0.0221	0.0002	4.73

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Atlas	A	Configuration	G	Degraded	Severe shock	A200	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Configuration	G	Total	Instability and breakup; Severe shock	A200, A205	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	Configuration	I	Catastrophic		A210, A214	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	Configuration	I	Degraded		A215	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Configuration	I	Total		A210, A214, A215	3	215	0.0140	0.0171	0.0361	0.0038	2.66
Atlas	A	Configuration	SLV-3	Catastrophic	Explosion	A131	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Configuration	SLV-3	Total	Explosion	A131	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Configuration	SLV-3C	Catastrophic	Loss of attitude and lift	A153, A159, A161	3	215	0.0140	0.0171	0.0361	0.0038	2.66
Atlas	A	Configuration	SLV-3C	Incipient		A155	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Configuration	SLV-3C	Total	Loss of attitude and lift	A153, A155, A159, A161	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	Configuration	SLV-3D	Catastrophic	Explosion	A173, A181	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	Configuration	SLV-3D	Degraded		A195	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Configuration	SLV-3D	Incipient	Severe shock	A194	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Configuration	SLV-3D	Total	Explosion; Severe shock	A173, A181, A194, A195	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	Launch Vehicle	Rocket	Catastrophic	Deviated flight trajectory; Explosion; Instability and breakup; Loss of attitude and lift; No lift; Fire; Improper angle of attack	A1, A2, A5, A6, A9, A13, A14, A18, A19, A21, A22, A23, A24, A25, A30, A33, A38, A44, A46, A47, A53, A54, A59, A60, A64, A65, A67, A70, A71, A72, A75, A80, A84, A85, A89, A91, A92, A95, A97, A99, A112, A118, A122, A126, A131, A132, A153, A159, A161, A173, A181, A205, A210, A214	54	215	0.2510	0.2543	0.3050	0.2030	1.40
Atlas	A	Launch Vehicle	Rocket	Degraded	Fire; Deviated flight trajectory; Severe shock	A7, A31, A35, A45, A50, A51, A79, A87, A195, A200, A215	11	215	0.0512	0.0543	0.0847	0.0287	1.78
Atlas	A	Launch Vehicle	Rocket	Incipient	Loss of telemetry; Loss of payload; Partial loss of attitude control; Severe shock	A11, A12, A29, A36, A74, A77, A82, A98, A101, A106, A137, A155, A194	13	215	0.0605	0.0636	0.0961	0.0358	1.72

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Atlas	A	Launch Vehicle	Rocket	Total	Deviated flight trajectory; Explosion; Instability and breakup; Loss of attitude and lift; No lift; Fire; Improper angle of attack; Deviated flight trajectory; Severe shock; Loss of telemetry; Loss of payload; Partial loss of attitude control	A1, A2, A5, A6, A7, A9, A11, A12, A13, A14, A18, A19, A21, A22, A23, A24, A25, A29, A30, A31, A33, A35, A36, A38, A44, A45, A46, A47, A50, A51, A53, A54, A59, A60, A64, A65, A67, A70, A71, A72, A74, A75, A77, A79, A80, A82, A84, A85, A87, A89, A91, A92, A95, A97, A98, A99, A101, A106, A112, A118, A122, A126, A131, A132, A137, A153, A155, A159, A161, A173, A181, A194, A195, A200, A205, A210, A214, A215	78	215	0.3630	0.3653	0.4200	0.3080	1.35
Atlas	A	Stage	First	Catastrophic	Propulsion failure; Flight control failure; Structural failure; Separation failure; Electrical failure	A1, A2, A5, A6, A9, A13, A14, A18, A19, A21, A22, A23, A24, A25, A30, A46, A47, A53, A54, A60, A64, A65, A67, A70, A71, A72, A75, A80, A84, A89, A91, A92, A95, A99, A112, A126, A173, A181, A205	39	215	0.1810	0.1842	0.2300	0.1390	1.44
Atlas	A	Stage	First	Degraded	Flight control partial failure; Guidance partial failure	A7, A31, A35, A45, A50, A51, A195, A215	8	215	0.0372	0.0403	0.0671	0.0185	1.92
Atlas	A	Stage	First	Incipient	Low hydraulic pressure	A11, A12, A29, A77, A82, A98, A101, A106, A137, A155	10	215	0.0465	0.0496	0.0789	0.0252	1.82
Atlas	A	Stage	First	Total	Propulsion failure; Flight control failure; Structural failure; Separation failure; Electrical failure	A1, A2, A5, A6, A7, A9, A13, A14, A18, A19, A21, A22, A23, A24, A25, A29, A30, A35, A46, A47, A53, A54, A60, A64, A65, A67, A70, A71, A72, A74, A75, A77, A79, A80, A82, A84, A89, A91, A92, A95, A98, A99, A106, A112, A126, A137, A155, A173, A181, A194, A195, A200, A205, A215	57	215	0.2650	0.2678	0.3190	0.2160	1.39
Atlas	A	Stage	Re-entry	Catastrophic	Separation failure; Structural failure; Loss of attitude and lift	A44	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Stage	Re-entry	Degraded	Overshoot impact; Electrical partial failure	A87	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Stage	Re-entry	Incipient	Overshoot impact; Undershoot impact; Off target impact; Loss of payload	A36	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Stage	Re-entry	Total	Separation failure; Structural failure; Loss of attitude and lift; Overshoot impact; Electrical partial failure; Undershoot impact; Off target impact; Loss of payload	A36, A44, A87	3	215	0.0140	0.0171	0.0361	0.0038	2.66
Atlas	A	Stage	Second	Catastrophic	Flight Control failrue; Structural failure	A59, A85, A97, A118, A122, A131, A132, A153, A159, A161, A210, A214	12	215	0.0558	0.0589	0.0904	0.0322	1.75
Atlas	A	Stage	Second	Degraded		A79, A200	2	215	0.0093	0.0124	0.0293	0.0017	3.21

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Atlas	A	Stage	Second	Incipient		A74, A194	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	Stage	Second	Total	Flight Control failrue; Structural failure	A59, A74, A79, A85, A97, A118, A122, A131, A132, A153, A159, A161, A194, A200, A210, A214	16	215	0.0744	0.0775	0.1130	0.0467	1.66
Atlas	A	Stage	Unknown	Catastrophic		A32, A38	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	Stage	Unknown	Total		A32, A38	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	Subsystem	Destruct	Catastrophic	Premature operation; Blast band failure	A44, A65	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	Subsystem	Destruct	Total	Premature operation; Blast band failure	A44, A65	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	Subsystem	Fuel	Catastrophic	Inhibited fuel flow; Loss of fuel; Low fuel pressure; Fill and drain valve failure	A1, A2, A5, A14, A21, A29, A46, A70, A79, A80, A84, A95, A118, A131, A132, A153, A200	17	215	0.0791	0.0822	0.1190	0.0504	1.65
Atlas	A	Subsystem	Fuel	Degraded		A6, A10, A23, A35, A77	5	215	0.0233	0.0264	0.0489	0.0092	2.20
Atlas	A	Subsystem	Fuel	Incipient	Head suppression valve partial failure; Fuel leak	A40, A82, A98	3	215	0.0140	0.0171	0.0361	0.0038	2.66
Atlas	A	Subsystem	Fuel	Total	Inhibited fuel flow; Loss of fuel; Low fuel pressure; Fill and drain valve failure; Head suppression valve partial failure	A1, A2, A5, A6, A10, A14, A21, A23, A29, A35, A40, A46, A70, A77, A79, A80, A82, A84, A95, A98, A118, A131, A132, A153, A200	25	215	0.1610	0.1194	0.1620	0.0808	1.12
Atlas	A	Subsystem	Hydraulic	Catastrophic	Low pressure	A11, A45, A60, A64, A91, A112	6	215	0.0279	0.0310	0.0551	0.0122	2.08
Atlas	A	Subsystem	Hydraulic	Degraded		A31	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Subsystem	Hydraulic	Total	Low pressure	A11, A31, A45, A60, A64, A91, A112	7	215	0.0326	0.0357	0.0612	0.0153	1.99
Atlas	A	Subsystem	Other	Catastrophic		A19, A37, A72, A89	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	Subsystem	Other	Degraded		A8	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	Subsystem	Other	Total		A8, A19, A37, A72, A89	6	215	0.0279	0.0310	0.0551	0.0122	2.08
Atlas	A	Subsystem	Pneumatic	Catastrophic	Overstress	A24	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Subsystem	Pneumatic	Total		A24	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Subsystem	Pressurization	Degraded		A137	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Subsystem	Pressurization	Total	Overstress	A137	1	215	0.0047	0.0078	0.0221	0.0002	4.73

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Atlas	A	Subsystem	Telemetry	Catastrophic		A6, A11, A36, A92, A104	5	215	0.0233	0.0264	0.0489	0.0092	2.20
Atlas	A	Subsystem	Telemetry	Degraded	Beacon failure	A7, A8, A17, A99	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	Subsystem	Telemetry	Total	Beacon failure	A6, A7, A8, A11, A12, A17, A34, A36, A92, A99, A104	11	215	0.0512	0.0543	0.0847	0.0287	1.78
Atlas	A	Subsystem	Telemetry	Unknown		A12, A34	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	Subsystem	Unknown	Catastrophic		A7, A9, A13, A25, A30, A47, A53, A54, A67, A71, A75, A126, A161, A181	14	215	0.0651	0.0682	0.1020	0.0394	1.70
Atlas	A	Subsystem	Unknown	Degraded		A122	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	Subsystem	Unknown	Total		A7, A9, A13, A22, A25, A30, A32, A38, A47, A53, A54, A59, A67, A71, A75, A85, A97, A122, A126, A155, A159,A161, A173, A181, A195, A205, A210, A214, A215	29	215	0.1350	0.1380	0.1840	0.0965	1.52
Atlas	A	Subsystem	Unknown	Unknown		A22, A32, A38, A59, A85, A97, A155, A159, A173, A195, A205, A210, A214, A215	14	215	0.0651	0.0682	0.1020	0.0394	1.70
Atlas	A	System	Electrical	Catastrophic	Intermittent short; Decreased DC voltage	A53, A70	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	System	Electrical	Degraded		A87	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	System	Electrical	Incipient	Telemetry failure	A36	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	System	Electrical	Total	Intermittent short; Decreased DC voltage; Telemetry failure	A36, A53, A70, A87	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	System	Flight Control	Catastrophic	Faulty relay; Low pressure; Loss of servo control; Autopilot failure; Excessive pitch program	A5, A6, A59, A60, A64, A67, A72, A75, A112, A161	10	215	0.0465	0.0496	0.0789	0.0252	1.82
Atlas	A	System	Flight Control	Degraded	Vernier hydraulic failure	A31, A45	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	System	Flight Control	Incipient		A12, A101	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	System	Flight Control	Total	Faulty relay; Low pressure; Loss of servo control; Autopilot failure; Excessive pitch program; Vernier hydraulic failure	A5, A6, A12, A31, A45, A59, A60, A64, A67, A72, A75, A101, A112, A161	14	215	0.0651	0.0682	0.1020	0.0394	1.70
Atlas	A	System	Guidance	Catastrophic	Hydraulic failure; Conical Tracker failure; Program fault; Improper guidance commands	A9, A18, A19, A85, A89, A92, A99, A205	8	215	0.0372	0.0403	0.0671	0.0185	1.92
Atlas	A	System	Guidance	Degraded	Inconsistent operation	A50, A51	2	215	0.0093	0.0124	0.0293	0.0017	3.21
Atlas	A	System	Guidance	Incipient		A11	1	215	0.0047	0.0078	0.0221	0.0002	4.73

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Atlas	A	System	Guidance	Total	Hydraulic failure; Conical Tracker failure; Program fault; Improper guidance commands; Inconsistent operation	A9, A11, A18, A19, A50, A51, A85, A89, A92, A99, A205	11	215	0.0512	0.0543	0.0847	0.0287	1.78
Atlas	A	System	Propulsion	Catastrophic	Premature booster shutdown; Fuel system failure	A1, A2, A13, A14, A21, A22, A23, A46, A47, A54, A80, A84, A91, A95, A118, A122, A126, A131, A132, A153, A181, A210, A214	23	215	0.1070	0.1108	0.1520	0.0731	1.57
Atlas	A	System	Propulsion	Degraded	Turbopump failure	A7, A35, A79, A195, A200, A215	6	215	0.0279	0.0310	0.0551	0.0122	2.08
Atlas	A	System	Propulsion	Incipient		A29, A74, A77, A82, A98, A106, A137, A155, A194	9	215	0.0419	0.0450	0.0730	0.0218	1.86
Atlas	A	System	Propulsion	Total	Premature booster shutdown; Fuel system failure; Turbopump failure	A1, A2, A7, A13, A14, A21, A22, A23, A29, A35, A40, A46, A47, A54, A74, A77, A79, A80, A82, A84, A91, A95, A98, A106, A118, A122, A126, A131, A132, A137, A153, A155, A181, A194, A195, A200, A210, A214, A215	39	215	0.1810	0.1842	0.2300	0.1390	1.44
Atlas	A	System	Propulsion	Unknown		A40	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	System	Separation	Catastrophic	No separation; Destruct system failure	A30, A44, A65, A71, A159, A173	6	215	0.0279	0.0310	0.0551	0.0122	2.08
Atlas	A	System	Separation	Total	No separation; Destruct system failure	A30, A44, A65, A71, A159, A173	6	215	0.0279	0.0310	0.0551	0.0122	2.08
Atlas	A	System	Structural	Catastrophic	Overstress	A24, A25, A38, A97	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	System	Structural	Total	Overstress	A24, A25, A38, A97	4	215	0.0186	0.0217	0.0426	0.0064	2.38
Atlas	A	System	Unknown	Catastrophic		A32	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Atlas	A	System	Unknown	Total		A32	1	215	0.0047	0.0078	0.0221	0.0002	4.73
Brilliant Pebbles	BP	Launch Vehicle	Rocket	Catastrophic	Loss of lift	OTR4	1	1					
Brilliant Pebbles	BP	Launch Vehicle	Rocket	Total	Loss of lift	OTR4	1	1					
Brilliant Pebbles	BP	Stage	Second	Catastrophic	No ignition	OTR4	1	1					
Brilliant Pebbles	BP	Stage	Second	Total	No ignition	OTR4	1	1					
Brilliant Pebbles	BP	System	Propulsion	Catastrophic	Loss of thrust	OTR4	1	1					
Brilliant Pebbles	BP	System	Propulsion	Total	Loss of thrust	OTR4	1	1					

Space Flight Risk and Reliability Data

Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Delta	D	Component	Booster Shroud	Catastrophic		D158	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Component	Booster Shroud	Total		D158	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Component	LOX Pressure Line	Catastrophic		D158	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Component	LOX Pressure Line	Total		D158	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Component	Propellant Grain	Catastrophic	Interrupted Burn/Loss of thrust	D45	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Component	Propellant Grain	Total	Interrupted Burn/Loss of thrust	D45	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Component	Retro Rocket Control	Catastrophic	Improper function.	D85	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Component	Retro Rocket Control	Total	Improper function.	D85	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Component	Sequencer	Catastrophic	Premature ignition	D69	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Component	Sequencer	Total	Premature ignition	D69	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Component	Solenoid Switch	Catastrophic	Failed to operate.	D3	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Component	Solenoid Switch	Total	Failed to operate.	D3	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Component	Thrust Chamber	Catastrophic	Leak	D138	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Component	Thrust Chamber	Total	Leak	D138	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Component	Unknown	Total		D3, D10, D18, D59, D71, D79, D80, D83, D103, D107, D127, D129, D146, D153, D161, D191, D198, D218, D241	19	179	0.1060	0.1030	0.1560	0.0679	1.50
Delta	D	Component	Unknown	Unknown		D3, D10, D18, D59, D71, D79, D80, D83, D103, D107, D127, D129, D146, D153, D161, D191, D198, D218, D241	19	179	0.1060	0.1030	0.1560	0.0679	1.50
Delta	D	Launch Vehicle	Rocket	Catastrophic	Explosion; Deviated flight trajectory; Erratic flight	D3, D45, D69, D80, D103, D107, D129, D153, D191, D198	11	179	0.0615	0.0580	0.1020	0.0330	1.80
Delta	D	Launch Vehicle	Rocket	Degraded	Excessive velocity	D10, D18, D59, D71, D79, D83, D85, D127, D138, D146	10	179	0.0559	0.0523	0.0948	0.0289	1.80
Delta	D	Launch Vehicle	Rocket	Incipient	No telemetry; Low specific impulse	D241	1	179	0.0056	0.0022	0.0208	0.0002	9.60

Space Flight Risk and Reliability Data

Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Delta	D	Launch Vehicle	Rocket	Total	Explosion; Deviated flight trajectory; Erratic flight; Excessive velocity; No telemetry; Low specific impulse	D3, D10, D18, D45, D59, D69, D71, D79, D80, D83, D85, D103, D107, D127, D129, D138, D146, D153, D158, D161, D191, D198, D218, D241	26	179	0.1450	0.1420	0.2020	0.1000	1.40
Delta	D	Launch Vehicle	Rocket	Unknown		D158, D161, D218	4	179	0.0223	0.0184	0.0511	0.0066	2.80
Delta	D	Stage	First	Catastrophic	Guidance failure; Propulsion failure	D103, D107, D129	3	179	0.0168	0.0127	0.0433	0.0037	3.40
Delta	D	Stage	First	Degraded		D138	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Stage	First	Incipient		D241	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Stage	First	Total	Guidance failure; Propulsion failure	D103, D107, D129, D138, D158, D241	6	179	0.0335	0.0298	0.0662	0.0134	2.20
Delta	D	Stage	First	Unknown		D158	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Stage	Other	Catastrophic		D198	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Stage	Other	Degraded	Payload wrong orbit	D10, D18, D83	3	179	0.0168	0.0127	0.0433	0.0037	3.40
Delta	D	Stage	Other	Total	Payload wrong orbit	D10, D18, D83, D198	4	179	0.0223	0.0184	0.0511	0.0066	2.80
Delta	D	Stage	Re-entry	Degraded	Failed to reenter	D85	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Stage	Re-entry	Total	Failed to reenter	D85	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Stage	Second	Catastrophic		D3, D153, D191	3	179	0.0168	0.0127	0.0433	0.0037	3.40
Delta	D	Stage	Second	Degraded	Burn past cut-off; Flight control partial failure; Separation failure	D59, D71, D79, D146	4	179	0.0223	0.0184	0.0511	0.0066	2.80
Delta	D	Stage	Second	Total	Burn past cut-off; Flight control partial failure; Separation failure	D3, D59, D71, D79, D146, D153, D191	7	179	0.0391	0.0355	0.0735	0.0171	2.10
Delta	D	Stage	Third	Catastrophic	Propulsion failure	D3, D45, D69, D80	4	179	0.0223	0.0184	0.0511	0.0066	2.80
Delta	D	Stage	Third	Degraded	Guidance partial failure	D127	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Stage	Third	Total	Propulsion failure; Guidance partial failure	D3, D45, D69, D80, D127	5	179	0.0279	0.0241	0.0587	0.0099	2.40
Delta	D	Stage	Unknown	Total		D158, D161, D218	3	179	0.0168	0.0127	0.0433	0.0037	3.40
Delta	D	Stage	Unknown	Unknown		D158, D161, D218	3	179	0.0168	0.0127	0.0433	0.0037	3.40

Space Flight Risk and Reliability Data

Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Delta	D	Subsystem	Attitude Control	Catastrophic		D3	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	Attitude Control	Total		D3	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	CASTOR IV	Catastrophic	Explosion	D198	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	CASTOR IV	Total	Explosion	D198	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	Coast Control	Catastrophic	Excessive velocity	D80	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	Coast Control	Total	Excessive velocity	D80	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	Hydraulic	Catastrophic	Undamped oscillations	D129	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	Hydraulic	Total	Undamped oscillations	D129	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	Liquid Engine	Catastrophic		D138	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	Liquid Engine	Total		D138	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	Main Engine	Catastrophic		D241	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	Main Engine	Total		D241	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	Re-entry retro rocket	Catastrophic		D85	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	Re-entry retro rocket	Total		D85	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	Unknown	Catastrophic		D3, D10, D18, D45, D69, D83, D103, D107, D127, D146, D153, D158, D161, D191, D218	16	179	0.0894	0.0860	0.1360	0.0545	1.30
Delta	D	Subsystem	Unknown	Total		D3, D10, D18, D45, D69, D83, D103, D107, D127, D146, D153, D158, D161, D191, D218	16	179	0.0894	0.0860	0.1360	0.0545	1.30
Delta	D	Subsystem	WECO/BTL	Degraded		D59	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	WECO/BTL	Total		D59	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	Subsystem	WECO/COMM	Catastrophic		D71, D79	2	179	0.0112	0.0068	0.0352	0.0013	5.20
Delta	D	Subsystem	WECO/COMM	Total		D71, D79	2	179	0.0112	0.0068	0.0352	0.0013	5.20
Delta	D	System	Electrical	Catastrophic	Short	D127	1	179	0.0056	0.0022	0.0208	0.0002	9.60

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Delta	D	System	Electrical	Total	Short	D127, D153	2	179	0.0112	0.0068	0.0352	0.0013	5.20
Delta	D	System	Electrical	Unknown		D153	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	System	Flight Control	Catastrophic		D146	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	System	Flight Control	Total		D146	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	System	Guidance	Catastrophic	Gyro misalignment; Erratic rate control; Hydraulic failure	D3, D80, D103, D107, D129	5	179	0.0279	0.0241	0.0587	0.0099	2.40
Delta	D	System	Guidance	Degraded	Coast control failure	D59, D71, D79	3	179	0.0168	0.0127	0.0433	0.0037	3.40
Delta	D	System	Guidance	Total	Gyro misalignment; Erratic rate control; Hydraulic failure; Coast control failure	D3, D59, D71, D79, D80, D103, D107, D129	8	179	0.0447	0.0411	0.0806	0.0209	2.00
Delta	D	System	Other	Catastrophic		D10	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	System	Other	Degraded		D18, D85	2	179	0.0112	0.0068	0.0352	0.0013	5.20
Delta	D	System	Other	Total		D10, D18, D85	3	179	0.0168	0.0127	0.0433	0.0037	3.40
Delta	D	System	Propulsion	Catastrophic	Loss of thrust	D3, D45, D69, D198, D241	5	179	0.0279	0.0241	0.0587	0.0099	2.40
Delta	D	System	Propulsion	Degraded		D138, D158	3	179	0.0168	0.0127	0.0433	0.0037	3.40
Delta	D	System	Propulsion	Total	Loss of thrust	D3 D45, D69, D138, D158, D198, D241	8	179	0.0447	0.0411	0.0806	0.0209	2.00
Delta	D	System	Separation	Catastrophic	Premature separation	D191	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	System	Separation	Total	Premature separation	D191	1	179	0.0056	0.0022	0.0208	0.0002	9.60
Delta	D	System	Unknown	Total		D83, D161, D218	3	179	0.0168	0.0127	0.0433	0.0037	3.40
Delta	D	System	Unknown	Unknown		D83, D161, D218	3	179	0.0168	0.0127	0.0433	0.0037	3.40
Jupiter/Juno	J	Component	Battery D5	Catastrophic		JJ43	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Battery D5	Total		JJ43	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Fiberglass Skirt/Heat B	Catastrophic	Loose skirt	JJ35	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Fiberglass Skirt/Heat B	Total	Loose skirt	JJ35	1	46	0.0217	0.0086	0.0808	0.0009	9.40

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Jupiter/Juno	J	Component	Fuel Flow Control Valve	Degraded	Overshoot opening	JJ46	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Fuel Flow Control Valve	Total	Overshoot opening	JJ46	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Ignitor	Catastrophic	No ignition	JJ37	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Ignitor	Total	No ignition	JJ37	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Inter-stage Cable Conn	Catastrophic	Stuck position	JJ13	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Inter-stage Cable Conn	Total	Stuck position	JJ13	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Inverter	Catastrophic		JJ22	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Inverter	Total		JJ22	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Main LOX Cutoff Valve	Catastrophic	Overshoot opening	JJ48	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Main LOX Cutoff Valve	Total	Overshoot opening	JJ48	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	N2 Supply Connection	Catastrophic	Broken connection	JJ27	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	N2 Supply Connection	Total	Broken connection	JJ27	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Stablized Platform	Catastrophic	Drift	JJ17	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Stablized Platform	Incipient	Drift	JJ33	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Stablized Platform	Total	Drift	JJ17, JJ33	2	46	0.0435	0.0281	0.1310	0.0060	4.60
Jupiter/Juno	J	Component	Tube	Catastrophic		JJ24	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Tube	Total		JJ24	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Component	Turbopump Gearbox	Catastrophic	Overstress; Premature cut-off	JJ6, JJ7	2	46	0.0435	0.0281	0.1310	0.0060	4.60
Jupiter/Juno	J	Component	Turbopump Gearbox	Total	Overstress; Premature cut-off	JJ6, JJ7	2	46	0.0435	0.0281	0.1310	0.0060	4.60
Jupiter/Juno	J	Component	Unknown	Total		JJ11, JJ12, JJ18, JJ40	4	46	0.0870	0.0741	0.1880	0.0292	2.50
Jupiter/Juno	J	Component	Unknown	Unknown		JJ11, JJ12, JJ18, JJ40	4	46	0.0870	0.0741	0.1880	0.0292	2.50

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Jupiter/Juno	J	Component	Vernier Engine	Total		JJ14, JJ15	2	46	0.0435	0.0281	0.1310	0.0060	4.60
Jupiter/Juno	J	Component	Vernier Engine	Unknown		JJ14, JJ15	2	46	0.0435	0.0281	0.1310	0.0060	4.60
Jupiter/Juno	J	Launch Vehicle	Rocket	Catastrophic	Explosion; Fire; Insufficient velocity; Deviated flight trajectory	JJ1, JJ2, JJ6, JJ7, JJ9, JJ11, JJ12, JJ13, JJ18, JJ22, JJ24, JJ27, JJ37, JJ40, JJ43	15	46	0.3260	0.3180	0.4570	0.2220	1.40
Jupiter/Juno	J	Launch Vehicle	Rocket	Degraded	Undershoot; Lateral trajectory error; Loss of telemetry; Low velocity; Overshoot	JJ10, JJ14, JJ15, JJ17, JJ26, JJ46, JJ49	7	46	0.1520	0.1410	0.2670	0.0747	1.90
Jupiter/Juno	J	Launch Vehicle	Rocket	Incipient	Inconsistent telemetry; Trajectory cross-range error	JJ5, JJ32, JJ33, JJ35	4	46	0.0870	0.0741	0.1880	0.0292	2.50
Jupiter/Juno	J	Launch Vehicle	Rocket	Total	Explosion; Fire; Insufficient velocity; Deviated flight trajectory; Undershoot; Loss of telemetry; Low velocity; Overshoot; Inconsistent telemetry; Trajectory cross-range error	JJ1, JJ2, JJ5, JJ6, JJ7, JJ9, JJ10, JJ11, JJ12, JJ13, JJ14, JJ15, JJ17, JJ18, JJ22, JJ24, JJ26, JJ27, JJ32, JJ33, JJ35, JJ37, JJ40, JJ43, JJ46, JJ49	26	46	0.5650	0.5610	0.6900	0.4560	1.20
Jupiter/Juno	J	Stage	First	Catastrophic	Thermal failure; Propulsion failure; Flight control failure; Guidance failure; Structural failure	JJ1, JJ2, JJ6, JJ7, JJ11, JJ12, JJ13, JJ18, JJ27	9	46	0.1960	0.1860	0.3170	0.1090	1.70
Jupiter/Juno	J	Stage	First	Degraded		JJ10, JJ17, JJ22, JJ24, JJ46, JJ48	6	46	0.1300	0.1190	0.2410	0.0586	2.00
Jupiter/Juno	J	Stage	First	Incipient		JJ32, JJ33, JJ35	3	46	0.0652	0.0514	0.1600	0.0165	3.10
Jupiter/Juno	J	Stage	First	Total	Thermal failure; Propulsion failure; Flight control failure; Guidance failure; Structural failure	JJ1, JJ2, JJ6, JJ7, JJ10, JJ11, JJ12, JJ13, JJ17, JJ18, JJ22, JJ24, JJ27, JJ32, JJ33, JJ35, JJ46, JJ48	18	46	0.3910	0.3850	0.5230	0.2830	1.40
Jupiter/Juno	J	Stage	Other	Degraded		JJ26	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Stage	Other	Total		JJ26	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Stage	Re-entry	Degraded	Overshoot impact; Instability and breakup; Off target impact	JJ5	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Stage	Re-entry	Total	Overshoot impact; Instability and breakup; Off target impact	JJ5	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Stage	Second	Catastrophic	Overshoot; Attitude oscillations; Flight control failure; Propulsion failure	JJ14, JJ15, JJ37, JJ40, JJ43	5	46	0.1090	0.0965	0.2150	0.0433	2.20
Jupiter/Juno	J	Stage	Second	Total	Overshoot; Attitude oscillations; Flight control failure; Propulsion failure	JJ14, JJ15, JJ37, JJ40, JJ43	5	46	0.1090	0.0965	0.2150	0.0433	2.20
Jupiter/Juno	J	Stage	Unknown	Total		JJ9	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Stage	Unknown	Unknown		JJ9	1	46	0.0217	0.0086	0.0808	0.0009	9.40

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Jupiter/Juno	J	Subsystem	Booster Body Seperati	Catastrophic		JJ13	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	Booster Body Seperati	Total		JJ13	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	Combustion Chamber	Catastrophic		JJ24	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	Combustion Chamber	Total		JJ24	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	Engine	Catastrophic	Premature cut-off; Premature fuel depletion	JJ6, JJ7	2	46	0.0435	0.0281	0.1310	0.0060	4.60
Jupiter/Juno	J	Subsystem	Engine	Incipient		JJ10	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	Engine	Total	Premature cut-off; Premature fuel depletion	JJ6, JJ7, JJ10	3	46	0.0652	0.0514	0.1600	0.0165	3.10
Jupiter/Juno	J	Subsystem	Fuel Feed	Degraded		JJ46	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	Fuel Feed	Total		JJ46	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	High Pressure N2 Sup	Catastrophic		JJ27	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	High Pressure N2 Sup	Total		JJ27'	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	Inertial Guidance	Catastrophic		JJ15	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	Inertial Guidance	Incipient	Cross-range velocity error	JJ33	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	Inertial Guidance	Total	Cross-range velocity error	JJ15, JJ33	2	46	0.0435	0.0281	0.1310	0.0060	4.60
Jupiter/Juno	J	Subsystem	LOX Feed	Degraded		JJ48	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	LOX Feed	Total		JJ48	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	Nose Cone Separation	Catastrophic		JJ5	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	Nose Cone Separation	Total		JJ5	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	Propellant Tank	Catastrophic	Propellant sloshing	JJ2	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	Propellant Tank	Total	Propellant sloshing	JJ2	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	Range Computer	Catastrophic	No ignition command	JJ9	1	46	0.0217	0.0086	0.0808	0.0009	9.40

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Jupiter/Juno	J	Subsystem	Range Computer	Total	No ignition command	JJ9	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	SRM	Catastrophic	Failed to ignite	JJ37	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	SRM	Total	Failed to ignite	JJ37	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	TVC Control	Catastrophic		JJ22	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	TVC Control	Total		JJ22	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	Subsystem	Tail Section Insulation	Catastrophic		JJ1, JJ32, JJ35	3	46	0.0652	0.0514	0.1600	0.0165	3.10
Jupiter/Juno	J	Subsystem	Tail Section Insulation	Total		JJ1, JJ32, JJ35	3	46	0.0652	0.0514	0.1600	0.0165	3.10
Jupiter/Juno	J	Subsystem	Unknown	Total		JJ11, JJ12, J14, JJ15, JJ18, JJ40	6	46	0.1300	0.1190	0.2410	0.0586	2.00
Jupiter/Juno	J	Subsystem	Unknown	Unknown		JJ11, JJ12, J14, JJ15, JJ18, JJ40	6	46	0.1300	0.1190	0.2410	0.0586	2.00
Jupiter/Juno	J	System	Electrical	Catastrophic		JJ43	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	System	Electrical	Total		JJ43	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	System	Flight Control	Catastrophic	Engine oscillation	JJ11	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	System	Flight Control	Total	Engine oscillation	JJ11	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	System	Guidance	Catastrophic	Guidance error	JJ9, JJ17, JJ22, JJ27	4	46	0.0870	0.0741	0.1880	0.0292	2.50
Jupiter/Juno	J	System	Guidance	Degraded	Beyond reference frame	JJ26	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	System	Guidance	Incipient	Target error	JJ33	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	System	Guidance	Total	Guidance error; Beyond reference frame; Target error	JJ9, JJ17, JJ22, JJ26, JJ27, JJ33	6	46	0.1300	0.1190	0.2410	0.0586	2.00
Jupiter/Juno	J	System	Other	Catastrophic		JJ1, JJ40	2	46	0.0435	0.0281	0.1310	0.0060	4.60
Jupiter/Juno	J	System	Other	Degraded	Guidance failure	JJ32, JJ35	2	46	0.0435	0.0281	0.1310	0.0060	4.60
Jupiter/Juno	J	System	Other	Total	Guidance failure	JJ1, JJ32, JJ35, JJ40	4	46	0.0870	0.0741	0.1880	0.0292	2.50
Jupiter/Juno	J	System	Propulsion	Catastrophic	Loss of thrust; Engine failure; Early fuel depletion; Trajectory error; Delayed ignition; Delayed cut-off	JJ2, JJ6, JJ7, JJ12, JJ14, JJ15, JJ24, JJ37	8	46	0.1740	0.1630	0.2920	0.0915	1.80

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Jupiter/Juno	J	System	Propulsion	Degraded		JJ18, JJ46, JJ48	3	46	0.0652	0.0514	0.1600	0.0165	3.10
Jupiter/Juno	J	System	Propulsion	Incipient		JJ10	1	46	0.0217	0.0086	0.0808	0.0009	9.40
Jupiter/Juno	J	System	Propulsion	Total	Loss of thrust; Engine failure; Early fuel depletion; Trajectory error; Delayed ignition; Delayed cut-off	JJ2, JJ6, JJ7, JJ10, JJ12, JJ14, JJ15, JJ18, JJ24, JJ37, JJ46, JJ48	12	46	0.2610	0.2520	0.3880	0.1640	1.50
Jupiter/Juno	J	System	Separation	Catastrophic		JJ5, JJ13	2	46	0.0435	0.0281	0.1310	0.0060	4.60
Jupiter/Juno	J	System	Separation	Total		JJ5, JJ13	2	46	0.0435	0.0281	0.1310	0.0060	4.60
Pershing II	PE	Component	Casing	Catastrophic	Leak	PE1	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Component	Casing	Total	Leak	PE1	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Component	RSTDS	Catastrophic		PE27, PE28, PE29	3	43	0.0698	0.0847	0.1710	0.0193	2.54
Pershing II	PE	Component	RSTDS	Total		PE27, PE28, PE29	3	43	0.0698	0.0847	0.1710	0.0193	2.54
Pershing II	PE	Component	Radar Tracking	Incipient		PE19	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Component	Radar Tracking	Total		PE19	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Component	Snap Ring	Catastrophic	Loose	PE14	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Component	Snap Ring	Total	Loose	PE14	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Launch Vehicle	Rocket	Catastrophic	Explosion; Instability and breakup	PE1, PE14	2	43	0.0465	0.0617	0.1390	0.0083	3.06
Pershing II	PE	Launch Vehicle	Rocket	Incipient		PE19	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Launch Vehicle	Rocket	Total	Explosion; Instability and breakup	PE1, PE14, PE19	3	43	0.0698	0.0847	0.1710	0.0193	2.54
Pershing II	PE	Stage	First	Catastrophic	Propulsion failure	PE1	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Stage	First	Total	Propulsion failure	PE1	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Stage	Re-entry	Incipient		PE19	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Stage	Re-entry	Total		PE19	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Stage	Second	Catastrophic		PE14	1	43	0.0233	0.0387	0.1060	0.0012	4.59

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Pershing II	PE	Stage	Second	Total		PE14	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Subsystem	Solid Rocket Motor	Catastrophic	Burn through	PE1	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Subsystem	Solid Rocket Motor	Incipient		PE14	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Subsystem	Solid Rocket Motor	Total	Burn through	PE1, PE14	2	43	0.0465	0.0617	0.1390	0.0083	3.06
Pershing II	PE	Subsystem	Telemetry	Catastrophic		PE27	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Subsystem	Telemetry	Incipient		PE28, PE29	2	43	0.0465	0.0617	0.1390	0.0083	3.06
Pershing II	PE	Subsystem	Telemetry	Total		PE27, PE28, PE29	3	43	0.0698	0.0847	0.1710	0.0193	2.54
Pershing II	PE	Subsystem	Unknown	Incipient		PE19	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	Subsystem	Unknown	Total		PE19	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	System	Guidance	Degraded	Guidance error	PE19	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	System	Guidance	Total	Guidance error	PE19	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	System	Propulsion	Catastrophic		PE1	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	System	Propulsion	Total		PE1	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	System	Structural	Incipient		PE14	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Pershing II	PE	System	Structural	Total		PE14	1	43	0.0233	0.0387	0.1060	0.0012	4.59
Polaris	PO	Component	Aft Closure	Catastrophic		PO139	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Component	Aft Closure	Total		PO139	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Component	Gimbal	Degraded		PO99	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Component	Gimbal	Total		PO99	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Component	Hydraulic Servo	Catastrophic		PO40	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Component	Hydraulic Servo	Total		PO40	1	140	0.0071	0.0028	0.0266	0.0003	9.60

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Polaris	PO	Component	Ignitor	Catastrophic		PO80	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Component	Ignitor	Total		PO80	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Component	Interlock II Guidance P	Catastrophic		PO120	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Component	Interlock II Guidance P	Total		PO120	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Component	Jetevator	Catastrophic		PO39, PO46, PO80, PO84, PO133, PO140, PO146, PO154	8	140	0.0571	0.0522	0.1030	0.0268	2.00
Polaris	PO	Component	Jetevator	Total		PO39, PO46, PO80, PO84, PO133, PO140, PO146, PO154	8	140	0.0571	0.0522	0.1030	0.0268	2.00
Polaris	PO	Component	Motor Case	Catastrophic	Rupture	PO142, PO149	2	140	0.0143	0.0086	0.0450	0.0017	5.20
Polaris	PO	Component	Motor Case	Total	Rupture	PO142, PO149	2	140	0.0143	0.0086	0.0450	0.0017	5.20
Polaris	PO	Component	Motor Head Clamp	Catastrophic	Normally closed, failed open	PO159	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Component	Motor Head Clamp	Total	Normally closed, failed open	PO159	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Component	Nozzle	Catastrophic	Burn out	PO54, PO56	2	140	0.0143	0.0086	0.0450	0.0017	5.20
Polaris	PO	Component	Nozzle	Degraded		PO13	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Component	Nozzle	Total		PO13, PO54, PO56	3	140	0.0214	0.0162	0.0554	0.0047	3.40
Polaris	PO	Component	Servo Actuator Valve	Catastrophic	Wiring short	PO156, PO158	2	140	0.0143	0.0086	0.0450	0.0017	5.20
Polaris	PO	Component	Servo Actuator Valve	Total	Wiring short	PO156, PO158	2	140	0.0143	0.0086	0.0450	0.0017	5.20
Polaris	PO	Component	Thrust Termination Por	Catastrophic	Premature opening	PO121, PO124, PO137	3	140	0.0214	0.0162	0.0554	0.0047	3.40
Polaris	PO	Component	Thrust Termination Por	Degraded	Premature opening	PO123	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Component	Thrust Termination Por	Total		PO121, PO123, PO124, PO137	4	140	0.0286	0.0236	0.0654	0.0085	2.80
Polaris	PO	Component	Unknown	Total		PO8, PO12, PO14, PO19, PO25, PO26, PO27, PO29, PO30, PO36, PO37, PO42, PO52, PO65, PO67, PO81, PO83, PO88, PO108, PO110, PO113, PO114, PO122, PO125, PO134, PO135, PO144, PO150, PO161, PO164, PO165, PO183	33	140	0.2360	0.2320	0.3150	0.1700	1.40

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Polaris	PO	Component	Unknown	Unknown		PO8, PO12, PO14, PO19, PO25, PO26, PO27, PO29, PO30, PO36, PO37, PO42, PO52, PO65, PO67, PO81, PO83, PO88, PO108, PO110, PO113, PO114, PO122, PO125, PO134, PO135, PO144, PO150, PO161, PO164, PO165, PO183	33	140	0.2360	0.2320	0.3150	0.1700	1.40
Polaris	PO	Launch Vehicle	Rocket	Catastrophic	Erratic flight; Deviated flight trajectory; Loss of Flight and lift; Instability and breakup	PO8, PO12, PO14, PO19, PO26, PO27, PO29, PO30, PO34,PO36, PO39, PO40, PO42, PO46, PO52, PO54, PO56, PO65, PO67, PO80, PO81, PO83, PO84, PO88, PO108, PO110, PO113, PO114, PO120, PO121, PO122, PO124, PO125, PO133, PO134, PO137, PO139, PO140, PO142, PO144, PO146, PO149, PO150, PO154, PO156, PO158, PO159, PO161, PO164, PO165, PO183	51	140	0.3640	0.3620	0.4360	0.3000	1.20
Polaris	PO	Launch Vehicle	Rocket	Degraded	Loss of reentry vehicle	PO13, PO25, PO37, PO90, PO99, PO123, PO135	7	140	0.0500	0.0453	0.0939	0.0219	2.10
Polaris	PO	Launch Vehicle	Rocket	Total	Erratic flight; Deviated flight trajectory; Loss of Flight and lift; Instability and breakup; Loss of reentry vehicle	PO8, PO12, PO13, PO14, PO19, PO25, PO26, PO27, PO29, PO30, PO34,PO36, PO37, PO39, PO40, PO42, PO46, PO52, PO54, PO56, PO65, PO67, PO80, PO81, PO83, PO84, PO88, PO90, PO99, PO108, PO110, PO113, PO114, PO120, PO121, PO122, PO123, PO124, PO125, PO133, PO134, PO135, PO137, PO139, PO140, PO142, PO144, PO146, PO149, PO150, PO154, PO156, PO158, PO159, PO161, PO164, PO165, PO183	58	140	0.4140	0.4120	0.4870	0.3490	1.20
Polaris	PO	Stage	First	Catastrophic	Flight control failure; Divergent oscillations; Electrical failure; Propulsion failure	PO12, PO14, PO36, PO39, PO40, PO42, PO46, PO80, PO81, PO83, PO84, PO108, PO139, PO140, PO146, PO154, PO156, PO158, PO159, PO161	20	140	0.1430	0.1390	0.2080	0.0926	1.50
Polaris	PO	Stage	First	Degraded		PO99	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Stage	First	Total	Flight control failure; Divergent oscillations; Electrical failure; Propulsion failure	PO12, PO14, PO36, PO39, PO40, PO42, PO46, PO80, PO81, PO83, PO84, PO99, PO108, PO139, PO140, PO146, PO154, PO156, PO158, PO159, PO161	21	140	0.1500	0.1460	0.2160	0.0948	1.50
Polaris	PO	Stage	Other	Catastrophic		PO114	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Stage	Other	Total		PO114	1	140	0.0071	0.0028	0.0266	0.0003	9.60

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Polaris	PO	Stage	Second	Catastrophic	Propulsion failure; Guidance failure; Flight control failure; Separation failure	PO8, PO52, PO54, PO56, PO88, PO110, PO113, PO121, PO122, PO124, PO125, PO133, PO134, PO137, PO142, PO144, PO149, PO150, PO183	19	140	0.1360	0.1310	0.1990	0.0868	1.50
Polaris	PO	Stage	Second	Degraded		PO13, PO90, PO123, PO135	4	140	0.0286	0.0236	0.0654	0.0085	2.80
Polaris	PO	Stage	Second	Total	Propulsion failure; Guidance failure; Flight control failure; Separation failure	PO8, PO13, PO52, PO54, PO56, PO88, PO90, PO110, PO113, PO121, PO122, PO123, PO124, PO125, PO133, PO134, PO135, PO137, PO142, PO144, PO149, PO150, PO183	23	140	0.1640	0.1600	0.2330	0.1100	1.50
Polaris	PO	Stage	Unknown	Total		PO19, PO25, PO26, PO27, PO29, PO30, PO34, PO37, PO65, PO67, PO120, PO164, PO165	13	140	0.0929	0.0885	0.1480	0.0530	1.70
Polaris	PO	Stage	Unknown	Unknown		PO19, PO25, PO26, PO27, PO29, PO30, PO34, PO37, PO65, PO67, PO120, PO164, PO165	13	140	0.0929	0.0885	0.1480	0.0530	1.70
Polaris	PO	Subsystem	Fire Control	Catastrophic	Electrical failure	PO65, PO67	2	140	0.0143	0.0086	0.0450	0.0017	5.20
Polaris	PO	Subsystem	Fire Control	Total	Electrical failure	PO65, PO67	2	140	0.0143	0.0086	0.0450	0.0017	5.20
Polaris	PO	Subsystem	Thrust Termination	Catastrophic	Early termination; Ports failed to blow on command	PO121, PO122, PO124, PO137, PO144	5	140	0.0357	0.0309	0.0751	0.0127	2.40
Polaris	PO	Subsystem	Thrust Termination	Degraded		PO123	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	Subsystem	Thrust Termination	Total	Early termination; Ports failed to blow on command	PO121, PO122, PO123, PO124, PO137, PO144	6	140	0.0429	0.0381	0.0846	0.0172	2.20
Polaris	PO	Subsystem	Unknown	Total		PO8, PO12, PO13, PO14, PO19, PO25, PO26, PO27, PO29, PO30, PO34, PO36, PO37, PO39, PO40, PO42, PO46, PO52, PO56, PO65, PO67, PO80, PO81, PO83, PO84, PO88, PO90, PO99, PO108, PO110, PO113, PO114, PO120, PO125, PO133, PO134, PO135, PO139, PO140, PO142, PO146, PO149, PO150, PO154, PO156, PO158, PO159, PO161, PO164, PO165, PO183	50	140	0.3570	0.3550	0.4290	0.2930	1.20

Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Polaris	PO	Subsystem	Unknown	Unknown		PO8, PO12, PO13, PO14, PO19, PO25, PO26, PO27, PO29, PO30, PO34, PO36, PO37, PO39, PO40, PO42, PO46, PO52, PO56, PO65, PO67, PO80, PO81, PO83, PO84, PO88, PO90, PO99, PO108, PO110, PO113, PO114, PO120, PO125, PO133, PO134, PO135, PO139, PO140, PO142, PO146, PO149, PO150, PO154, PO156, PO158, PO159, PO161, PO164, PO165, PO183	50	140	0.3570	0.3550	0.4290	0.2930	1.20
Polaris	PO	System	Electrical	Catastrophic	Loss of feedback voltage	PO40, PO65, PO67	3	140	0.0214	0.0162	0.0554	0.0047	3.40
Polaris	PO	System	Electrical	Total	Loss of feedback voltage	PO40, PO65, PO67	3	140	0.0214	0.0162	0.0554	0.0047	3.40
Polaris	PO	System	Flight Control	Catastrophic	Loss of control	PO39, PO42, PO46, PO52, PO84, PO125, PO133, PO140, PO146, PO150, PO154, PO156, PO158	13	140	0.0929	0.0885	0.1480	0.0530	1.70
Polaris	PO	System	Flight Control	Degraded		PO90	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	System	Flight Control	Total	Loss of control	PO39, PO42, PO46, PO52, PO84, PO90, PO125, PO133, PO140, PO146, PO150, PO154, PO156, PO158	14	140	0.1000	0.0956	0.1560	0.0585	1.60
Polaris	PO	System	Guidance	Catastrophic	Loss of guidance reference; Guidance error; No thrust termination; Transient; Programmer failure	PO36, PO114, PO120	3	140	0.0214	0.0162	0.0554	0.0047	3.40
Polaris	PO	System	Guidance	Degraded	Target error	PO99	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	System	Guidance	Total	Loss of guidance reference; Guidance error; No thrust termination; Transient; Programmer failure; Target error	PO36, PO99, PO114, PO120	4	140	0.0286	0.0236	0.0654	0.0085	2.80
Polaris	PO	System	Other	Catastrophic		PO161	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	System	Other	Total		PO161	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	System	Propulsion	Catastrophic	Failed to ignite; Premature cutoff; Loss of thrust; Excessive vibration	PO54, PO56, PO80, PO81, PO83, PO88, PO108, PO110, PO113, PO121, PO122, PO124, PO134, PO137, PO139, PO142, PO144, PO149, PO159	19	140	0.1360	0.1310	0.1990	0.0868	1.50
Polaris	PO	System	Propulsion	Degraded		PO13, PO123	2	140	0.0143	0.0086	0.0450	0.0017	5.20

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Polaris	PO	System	Propulsion	Total	Failed to ignite; Premature cutoff; Loss of thrust; Excessive vibration	PO13, PO54, PO56, PO80, PO81, PO83, PO88, PO108, PO110, PO113, PO121, PO122, PO123, PO124, PO134, PO137, PO139, PO142, PO144, PO149, PO159	21	140	0.1500	0.1460	0.2160	0.0984	1.50
Polaris	PO	System	Separation	Degraded	No separation; Abnormal separation	PO37, PO135	2	140	0.0143	0.0086	0.0450	0.0017	5.20
Polaris	PO	System	Separation	Total	No separation; Abnormal separation	PO37, PO135	2	140	0.0143	0.0086	0.0450	0.0017	5.20
Polaris	PO	System	Structural	Catastrophic	Overstress	PO183	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	System	Structural	Total	Overstress	PO183	1	140	0.0071	0.0028	0.0266	0.0003	9.60
Polaris	PO	System	Unknown	Total		PO8, PO12, PO14, PO19, PO25, PO26, PO27, PO29, PO30, PO34, PO164, PO165	12	140	0.0857	0.0813	0.1390	0.0476	1.70
Polaris	PO	System	Unknown	Unknown		PO8, PO12, PO14, PO19, PO25, PO26, PO27, PO29, PO30, PO34, PO164, PO165	12	140	0.0857	0.0813	0.1390	0.0476	1.70
Prospector (Joust)	PJ	Launch Vehicle	Rocket	Catastrophic	Erratic flight	OTR7	1	1					
Prospector (Joust)	PJ	Launch Vehicle	Rocket	Total	Erratic flight	OTR7	1	1					
Prospector (Joust)	PJ	Stage	First	Catastrophic		OTR7	1	1					
Prospector (Joust)	PJ	Stage	First	Total		OTR7	1	1					
Prospector (Joust)	PJ	Subsystem	Aft-skirt	Catastrophic		OTR7	1	1					
Prospector (Joust)	PJ	Subsystem	Aft-skirt	Total		OTR7	1	1					
Prospector (Joust)	PJ	System	Structural	Catastrophic		OTR7	1	1					
Prospector (Joust)	PJ	System	Structural	Total		OTR7	1	1					
Red Tigress I	RT	Launch Vehicle	Rocket	Catastrophic	Deviated flight trajectory	RT5	1	1					
Red Tigress I	RT	Launch Vehicle	Rocket	Total	Deviated flight trajectory	RT5	1	1					
Red Tigress I	RT	System	Guidance	Catastrophic	Guidance error	RT5	1	1					
Red Tigress I	RT	System	Guidance	Total	Guidance error	RT5							
Saturn	S	Component	Electrical Control & Wiri	Catastrophic		SAT118	1	20	0.0500	0.0129	0.1930	0.0009	15.00

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Saturn	S	Component	Electrical Control & Wiri	Total		SAT118	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Component	Fuel Tank Ullage/Baffl	Degraded	Fuel sloshing	SAT101	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Component	Fuel Tank Ullage/Baffl	Total	Fuel sloshing	SAT101	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Component	LOX Plumbing	Catastrophic		SAT118	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Component	LOX Plumbing	Total		SAT118	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Component	Turbo Pump	Catastrophic	Low combustion chamber pressure	SAT107	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Component	Turbo Pump	Total	Low combustion chamber pressure	SAT107	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Component	Unknown	Total		SAT101, SAT105, SAT107, SAT114, SAT118, SAT125	6	20	0.3000	0.2810	0.5080	0.1560	2.00
Saturn	S	Component	Unknown	Unknown		SAT101, SAT105, SAT107, SAT114, SAT118, SAT125	6	20	0.3000	0.2810	0.5080	0.1560	2.00
Saturn	S	Launch Vehicle	Rocket	Degraded	Low velocity	SAT107, SAT114, SAT118, SAT125	7	20	0.3500	0.3330	0.5580	0.1990	2.00
Saturn	S	Launch Vehicle	Rocket	Incipient	Fire	SAT101, SAT105	3	20	0.1500	0.1240	0.3440	0.0445	3.00
Saturn	S	Launch Vehicle	Rocket	Total	Low velocity; Fire	SAT101, SAT105, SAT107, SAT114, SAT118, SAT125	10	20	0.5000	0.4880	0.6980	0.3420	1.00
Saturn	S	Stage	First	Degraded		SAT107, SAT118	3	20	0.1500	0.1240	0.3440	0.0445	3.00
Saturn	S	Stage	First	Incipient	Propulsion partial failure	SAT101, SAT105	3	20	0.1500	0.1240	0.3440	0.0445	3.00
Saturn	S	Stage	First	Total	Propulsion partial failure	SAT101, SAT105, SAT107, SAT118	6	20	0.3000	0.2810	0.5080	0.1560	2.00
Saturn	S	Stage	Second	Catastrophic		SAT118	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Stage	Second	Degraded		SAT114, SAT125	2	20	0.1000	0.0695	0.2830	0.0171	4.00
Saturn	S	Stage	Second	Total		SAT114, SAT118, SAT125	3	20	0.1500	0.1240	0.3440	0.0445	3.00
Saturn	S	Subsystem	Engine	Catastrophic	Premature cutoff	SAT107	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Subsystem	Engine	Incipient		SAT125	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Subsystem	Engine	Total	Premature cutoff	SAT107, SAT125	2	20	0.1000	0.0695	0.2830	0.0171	4.00

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Saturn	S	Subsystem	Fuel Feed	Degraded		SAT101	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Subsystem	Fuel Feed	Total		SAT101	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Subsystem	Outboard Engine Shro	Incipient		SAT101	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Subsystem	Outboard Engine Shro	Total		SAT101	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Subsystem	S-II Engine	Catastrophic		SAT118	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Subsystem	S-II Engine	Total		SAT118	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Subsystem	S-IV Jettison	Catastrophic		SAT107	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Subsystem	S-IV Jettison	Total		SAT107	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Subsystem	S-IVB Ignition	Catastrophic		SAT118	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Subsystem	S-IVB Ignition	Total		SAT118	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Subsystem	TVC	Incipient		SAT105	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Subsystem	TVC	Total		SAT105	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	Subsystem	Unknown	Total		SAT114, SAT118	2	20	0.1000	0.0129	0.2830	0.0171	4.00
Saturn	S	Subsystem	Unknown	Unknown		SAT114, SAT118	2	20	0.1000	0.0129	0.2830	0.0171	4.00
Saturn	S	System	Flight Control	Incipient		SAT105	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	System	Flight Control	Total		SAT105	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	System	Propulsion	Catastrophic	Delayed cutoff	SAT118, SAT125	3	20	0.1500	0.1240	0.3440	0.0445	3.00
Saturn	S	System	Propulsion	Degraded	Premature cutoff	SAT101, SAT107, SAT114, SAT118	5	20	0.2500	0.2290	0.4560	0.1150	2.00
Saturn	S	System	Propulsion	Total	Delayed cutoff; Premature cutoff	SAT101, SAT107, SAT114, SAT118	8	20	0.4000	0.3850	0.6060	0.2440	2.00
Saturn	S	System	Structural	Incipient	Oscillations	SAT101	1	20	0.0500	0.0129	0.1930	0.0009	15.00
Saturn	S	System	Structural	Total	Oscillations	SAT101	1	20	0.0500	0.0129	0.1930	0.0009	15.00

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Space Shuttle	STS	Component	O-Ring	Catastrophic	Leak	STS75	1	45	0.0222	0.0057	0.0860	0.0004	14.96
Space Shuttle	STS	Component	O-Ring	Total	Leak	STS75	1	45	0.0222	0.0057	0.0860	0.0004	14.96
Space Shuttle	STS	Component	Unknown	Total		STS70, STS99	2	45	0.0444	0.0288	0.1330	0.0062	4.63
Space Shuttle	STS	Launch Vehicle	Rocket	Catastrophic	Explosion	STS75	1	45	0.0222	0.0057	0.0860	0.0004	14.96
Space Shuttle	STS	Launch Vehicle	Rocket	Degraded		STS70	1	45	0.0222	0.0057	0.0860	0.0004	14.96
Space Shuttle	STS	Launch Vehicle	Rocket	Incipient	Low velocity	STS99	1	45	0.0222	0.0057	0.0860	0.0004	14.96
Space Shuttle	STS	Launch Vehicle	Rocket	Total	Explosion; Low velocity	STS70, STS75, STS99	3	45	0.0667	0.0526	0.1630	0.0169	3.11
Space Shuttle	STS	Stage	First	Degraded		STS70	1	45	0.0222	0.0057	0.0860	0.0004	14.96
Space Shuttle	STS	Stage	First	Incipient		STS99	1	45	0.0222	0.0057	0.0860	0.0004	14.96
Space Shuttle	STS	Stage	First	Total		STS70, STS99	2	45	0.0444	0.0288	0.1330	0.0062	4.63
Space Shuttle	STS	Stage	Other	Catastrophic		STS75	1	45	0.0222	0.0057	0.0860	0.0004	14.96
Space Shuttle	STS	Stage	Other	Total		STS75	1	45	0.0222	0.0057	0.0860	0.0004	14.96
Space Shuttle	STS	Subsystem	Solid Rocket Booster	Catastrophic	Burn through	STS75	1	45	0.0222	0.0057	0.0860	0.0004	14.96
Space Shuttle	STS	Subsystem	Solid Rocket Booster	Total	Burn through	STS75	1	45	0.0222	0.0057	0.0860	0.0004	14.96
Space Shuttle	STS	Subsystem	Unknown	Total		STS70, STS99	2	45	0.0444	0.0288	0.1330	0.0062	4.63
Space Shuttle	STS	System	Flight Control	Degraded		STS99	1	45	0.0222	0.0057	0.0860	0.0004	14.96
Space Shuttle	STS	System	Flight Control	Total		STS99	1	45	0.0222	0.0057	0.0860	0.0004	14.96
Space Shuttle	STS	System	Propulsion	Catastrophic		STS70, STS75	2	45	0.0444	0.0288	0.1330	0.0062	4.63
Space Shuttle	STS	System	Propulsion	Total		STS70, STS75	2	45	0.0444	0.0288	0.1330	0.0062	4.63
TMD Countermeasure Mitiga	T	Launch Vehicle	Rocket	Catastrophic		OTR2	1	2	0.5000	0.4470	0.9750	0.2050	2.18
TMD Countermeasure Mitiga	T	Launch Vehicle	Rocket	Total		OTR2	1	2	0.5000	0.4470	0.9750	0.2050	2.18

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
TMD Countermeasure Mitiga	T	Stage	Second	Catastrophic	Premature separation	OTR2	1	2	0.5000	0.4470	0.9750	0.2050	2.18
TMD Countermeasure Mitiga	T	Stage	Second	Total	Premature separation	OTR2	1	2	0.5000	0.4470	0.9750	0.2050	2.18
TMD Countermeasure Mitiga	T	System	Separation	Catastrophic		OTR2	1	2	0.5000	0.4470	0.9750	0.2050	2.18
TMD Countermeasure Mitiga	T	System	Separation	Total		OTR2	1	2	0.5000	0.4470	0.9750	0.2050	2.18
Vanguard	V	Component	Fuel Injector	Degraded	Clogged	V13	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Component	Fuel Injector	Total	Clogged	V13	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Component	Low Pressure Head	Degraded	Delayed intake	V19	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Component	Low Pressure Head	Total	Delayed intake	V19	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Component	Relay	Catastrophic	No latching	V16	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Component	Relay	Total	No latching	V16	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Component	Separation Spring	Degraded	Binding	V12	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Component	Separation Spring	Total	Binding	V12	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Component	Unknown	Total		V10, V11, V14, V15, V18, V22	6	14	0.4286	0.4090	0.6749	0.2481	1.65
Vanguard	V	Component	Valve	Catastrophic	Failed to close	V17	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Component	Valve	Total	Failed to close	V17	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Launch Vehicle	Rocket	Catastrophic	Explosion; Fire	V10, V11, V13, V14, V15, V16, V18, V19	8	14	0.5710	0.5590	0.7940	0.3930	1.42
Vanguard	V	Launch Vehicle	Rocket	Degraded	Erratic flight	V17	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Launch Vehicle	Rocket	Incipient		V12, V22	2	14	0.1430	0.1040	0.3850	0.0281	3.70
Vanguard	V	Launch Vehicle	Rocket	Total	Explosion; Fire; Erratic flight	V10, V11, V12, V13, V14, V15, V16, V17, V18, V19, V22	11	14	0.7860	0.7810	0.9390	0.6490	1.20
Vanguard	V	Stage	First	Catastrophic	Propulsion failure; Flight control failure	V18, V19	2	14	0.1430	0.1040	0.3850	0.0281	3.70
Vanguard	V	Stage	First	Incipient		V22	1	14	0.0714	0.0185	0.2760	0.0012	14.96

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Vanguard	V	Stage	First	Total	Propulsion failure; Flight control failure	V18, V19, V22	3	14	0.2140	0.1820	0.4660	0.0712	2.56
Vanguard	V	Stage	Second	Catastrophic	Propulsion failure; Failed to shutdown	V10, V11, V13, V14, V16, V17	6	14	0.4290	0.4090	0.6750	0.2480	1.65
Vanguard	V	Stage	Second	Degraded		V15	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Stage	Second	Total	Propulsion failure; Failed to shutdown	V10, V11, V13, V14, V15, V16, V17	7	14	0.5000	0.4840	0.7360	0.3180	1.52
Vanguard	V	Stage	Third	Incipient	Separation partial failure	V12	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Stage	Third	Total	Separation partial failure	V12	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Subsystem	Auxilary Peroxide Jet	Catastrophic		V22	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Subsystem	Auxilary Peroxide Jet	Total		V22	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Subsystem	Fuel	Catastrophic	Low fuel flow rate; Low chamber pressure; Contamination; Uneven fuel flow rate	V10, V13, V14, V15, V19	5	14	0.3570	0.3340	0.6100	0.1830	1.82
Vanguard	V	Subsystem	Fuel	Total	Low fuel flow rate; Low chamber pressure; Contamination; Uneven fuel flow rate	V10, V13, V14, V15, V19	5	14	0.3570	0.3340	0.6100	0.1830	1.82
Vanguard	V	Subsystem	Pitch Jet	Degraded		V17	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Subsystem	Pitch Jet	Total		V17	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Subsystem	Satellite Ejection	Degraded	Excess payload tumble rate	V12	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Subsystem	Satellite Ejection	Total	Excess payload tumble rate	V12	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	Subsystem	Unknown	Total		V11, V16, V18	3	14	0.2140	0.1820	0.4660	0.0712	2.56
Vanguard	V	System	Electrical	Catastrophic	Relay failure	V16	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	System	Electrical	Total	Relay failure	V16	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	System	Flight Control	Catastrophic	Spurious flight control; Loss of attitude control	V18	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	System	Flight Control	Degraded		V22	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	System	Flight Control	Total	Spurious flight control; Loss of attitude control	V18, V22	2	14	0.1430	0.1040	0.3850	0.0281	3.70

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Vehicle	Vehicle Code	Vehicle Element	Description	Failure Severity	Failure Mode(s)	Related Data Pages	No. of Failures	No. of Records	Mean Reliability	Median Reliability	UCL	LCL	Error Factor
Vanguard	V	System	Propulsion	Catastrophic	Combustion instability; Premature shutdown; Fuel system failure	V10, V11, V13, V14, V15, V19	6	14	0.4290	0.4090	0.6750	0.2480	1.65
Vanguard	V	System	Propulsion	Degraded		V17	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	System	Propulsion	Total	Combustion instability; Premature shutdown; Fuel system failure	V10, V11, V13, V14, V15, V17, V19	7	14	0.5000	0.4840	0.7360	0.3180	1.52
Vanguard	V	System	Separation	Incipient	Delayed separation; Premature separation	V12	1	14	0.0714	0.0185	0.2760	0.0012	14.96
Vanguard	V	System	Separation	Total	Delayed separation; Premature separation	V12	1	14	0.0714	0.0185	0.2760	0.0012	14.96