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**The Relation Between Solar Cell Flight Performance Data
and Materials and Manufacturing Data**

Report No. 4

Fourth Quarterly Report

Contract No. NASW-1732

Prepared by

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ABSTRACT

This quarter was spent in acquiring data from the appropriate individuals connected with each flight in this study. Based on these data, the flights to be examined in detail have been identified and the specific data required for these flights have been requested. Some of these data have been received and the remaining data are being forwarded.

A list of the flights covered in this study is presented. Presented as notes to this list are the names and addresses of people who are sources of information for these flights. The reasons for the inclusion or rejection of a flight for detailed analysis in this study are also presented.

Table of Contents

	<u>Page</u>
I. Introduction	1
II. The Selected Flights and Environment	3
III. Information and Data Gathering	17
IV. Summary	23

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List of Tables

		<u>Page</u>
Table I	Specific Flights to be Studied	6
Table II	Specific Flights with Individual Contact	18

I. Introduction

This document is the fourth quarterly report in a program to examine the flight performance data for solar cell power systems in satellites, and to try to relate the differences in performance to the materials and manufacturing factors in the solar cell system.

The general method of approach consists of selecting a group of flights whose space environments are all similar, for which sufficient flight performance data exists, and for which information on the materials and manufacturing factors is available. For the selected group of flights, an attempt will be made to relate the differences in performance to specific materials or manufacturing parameters that may be expected to affect performance.

The work is divided into four general phases defined by the following outline:

Phase I:

- A. Classify all flights from 1957 through 1967 according to their space environment, so that groups of flights with similar environment can be identified.
- B. Ascertain availability of performance data and materials and manufacturing parameters.
- C. Generate a coding procedure to facilitate the recording and use of information gathered relative to performance and materials and manufacturing factors.

Phase II:

Select a group of flights based on the work in Phase I.

Phase III:

Acquire and systematize the actual data needed for the flights selected in Phase II.

Phase IV:

Perform analysis to relate materials and manufacturing factors to flight performance of the selected flights.

Phase I and Phase II have been completed and work has progressed through Phase III. It has been determined that the data required for the performance of this contract are contained in documents which do not receive wide distribution. These documents can only be acquired through personal contacts; the flights to be studied and the people associated with them have been organized so that the required information can be obtained.

The final selection of flights for detailed study was made on the basis of available data that was telemetered back concerning the condition of the solar array. The required data for this study has been requested from the appropriate sources, and some of it has already been received. The remaining data is available and should be received in the near future.

Phase IV of this contract, the analysis of the materials and manufacturing techniques and flight performance is beginning.

II. The Selected Flights and Environment

The initial choice of flights to be studied has been documented in the earlier reports. For completeness, a review of the history of this choice is presented again. An examination of the Space Projects Log from 1957 to 1968 yielded approximately 611 earth satellite flights. By applying the conditions that a suitable flight for study under this contract be (a) in orbit and transmitting data for three months or more, (b) have NASA or DOD as the Project Director, and (c) be unclassified, the number of flights suitable for study were reduced to slightly over 200. These flights were listed in the first quarterly report.

A plot of perigee vs. apogee for these flights showed a number of clusters along the 45° line, suggesting that a rational starting point for selecting flights with similar environments could be chosen by defining four major sets of orbits. I (inside orbit) orbits were defined as having perigee and apogee just inside the first radiation belt. The cutoff point for orbit parameters was arbitrarily chosen to be 760 miles, because above this altitude both electron and proton fluxes increase very rapidly with altitude from negligible to quite significant values. The B (first belt orbit) orbits were defined to be the cluster of flights with perigee and apogee at about 2,000 miles, which is close to the maximum of the first radiation belt. The S (synchronous orbit) orbits, with parameters around 20,000 miles, are the synchronous geostationary flights, and the O (outside orbit) orbits, with orbit parameters between 60,000 and 70,000 miles, are beyond the radiation belts.

The I orbit flights were chosen to be the subject of this study. These flights can be divided into four sub-groupings; thirteen flights with angle of inclination between 28° and 33° ; sixteen flights with angle of inclination between 47° and 60° ; nineteen flights with angle of inclination between 66° and 71° ; and twenty-nine flights with angle of inclination between 79° and 135° . The I orbit flights suffer minimal radiation damage since they are below the maxima in the first radiation belt. However, because of the low orbit, the thermal cycle has appreciable changes in temperature over times measured in minutes. A review of the literature indicated that much more work has been done in examining the radiation effects on solar cells than on any other effect.

The final choice of flights has been based on the availability of flight performance data. If flight data concerning the condition of the solar array is unavailable, then no performance examination can be made. For this reason, the flights chosen for detailed study were those with data transmitted back for the solar array output voltage, array current and array temperature. In many cases, the array temperature and some form of voltage such as the battery voltage was telemetered back. Although this data may be satisfactory for determining in go-no go fashion whether the solar array is functioning, it is inadequate for an analysis of performance degradation.

The vehicles that were finally chosen for study are the Pegasus series, numbers 1, 2, and 3; the OSO series, numbers 1, 2, 3 and 4, OGO 4, and Nimbus 2. The OV1 series did not have a direct measurement of the solar array current, but the battery current was monitored. By knowing the load cur-

rent, which was known before launch, and the battery current, the solar array current may be calculated. Therefore, this series has not yet been discarded, although the indirect current determination may not be satisfactory for our analysis.

The I orbit flights (in the near earth environment) that were examined for possible inclusion in this study are shown in Table I. The reasons for inclusion or rejection of each of these flights are presented in the form of notes to Table I.

With the exception of the OV1 series, all of the flights chosen for detailed study have their solar arrays mounted on paddles and separated from the main body of the spacecraft. It would have been desirable to include flights with body mounted solar arrays, since these two basic and different types of configurations may have vastly different effects caused by temperature fluctuations.

Within the final group of flights selected for detailed study are solar cells produced by a variety of manufacturers. Contained in the Pegasus series were cells from Texas Instruments and Centralab. The OSO series were supplied by Heliotek and Spectrolab. OGO 4 cells were manufactured by Centralab and the array was fabricated by TRW. Nimbus 2 had cells and arrays fabricated by R.C.A.

As was pointed out in the last quarterly report, there is a sufficiently large variation in environment even in the near earth orbits, that each flight will have to be examined on an individual basis. It was hoped that this effort might have been reduced by subclassifying the vehicles according to type and looking for correlations. However, the number

Table I.

Specific Flights to be Studied

Flight Name	Int'l. Desig.	Proj. Dir.	Array Voltage	Array Current	Array Temp.	Notes	No Solar Array
1. Pegasus 3	1965 60A	NASA	X	X	X	1	
2. Pegasus 1	1965 9A	NASA	X	X	X	1	
3. Pegasus 2	1965 39A	NASA	X	X	X	1	
4. Transit 4B	1961 AH1	USN				2	
5. TRAAC	1961 AH2	USN				2	
6. OSO 1	1962 Z1	NASA	X	X	X	3	
7. OV4 3	1966 99A	USAF				4	X
8. OV4 1R	1966 99B	USAF				5	X
9. OV4 1T	1966 99D	USAF				5	X
10. OSO 2	1965 7A	NASA	X	X	X	3	
11. OSO 3	1967 20A	NASA	X	X	X	3	
12. TTS 1	1967 123B	NASA	X		X	6	
13. OSO 4	1967 100A	NASA	X	X	X	3	
14. Tiros 3	1961 P1	NASA	X		X	7	
15. Tiros 4	1962 B1	NASA	X		X	7	
16. Tiros 1	1960 B2	NASA	X		X	7	
17. Tiros 2	1960 II-1	NASA	X		X	7	
18. Anna 1B	1962 BM1	USN				2	
19. Explorer 7	1959 I-1	NASA				8	
20. Transit 1B	1960 T2	ARPA				2	
21. Explorer 23	1964 74A	NASA				2	
22. Explorer 16	1962 BX1	NASA				8	
23. Ariel 1	1962 O1	NASA/UK				9	
24. Explorer 17	1963 9A	NASA				10	X
25. Tiros 5	1962 AA1	NASA	X		X	7	

Table I. Cont.

Specific Flights to be Studied

Flight Name	Int'l Desig.	Proj. Dir.	Array Voltage	Array Current	Array Temp.	Notes	No Solar Array
26. Tiros 6	1962 AV1	NASA	X		X	7	
27. Tiros 7	1963 24A	NASA	X		X	7	
28. Tiros 8	1963 54A	NASA	X		X	7	
29. Explorer 30	1965 93A	USN/NASA			X	11	
30. Transit 2A	1960 H1	USN				2	
31. Solrad 1	1960 H2	USN			X	11	
32. Transit 4A	1961 O1	USN				2	
33. Injun 1/ Solrad 3	1961 O2	USN			X	11	
34. Solrad 7A	1964 1D	USN/USA			X	11	
35. Secor 1	1964 1C	USN/USA			X	12	
36. GGSE 1	1964 1B	USN/USA			X	11	
37. Surcal	1967 53B	USAF/USN			X	11	
38. Surcal	1967 53F	USAF/USN			X	11	
39. GGSE 4	1967 53C	USAF/USN			X	11	
40. GGSE 5	1967 53D	USAF/USN			X	11	
41. Surcal	1967 53J	USAF/USN			X	11	
42. GGSE 2	1965 16B	USN/USA/ USAF			X	11	
43. GGSE 3	1965 16C	USN/USA/ USAF			X	11	
44. Solrad 7B	1965 16D	USN/USA USAF			X	11	
45. Secor 3	1965 16E	USN /USA/ USAF			X	12	

Table I. Cont.

Specific Flights to be Studied

	<u>Flight Name</u>	<u>Int'l. Desig.</u>	<u>Proj. Dir.</u>	<u>Array Voltage</u>	<u>Array Current</u>	<u>Array Temp.</u>	<u>Notes</u>	<u>No Solar Array</u>
46.	Oscar 3	1965 16F	USN/USA/ USAF			X	13	
47.	Surcal	1965 16G	USN/USA/ USAF			X	11	
48.	Surcal	1965 16H	USN/USA/ USAF			X	11	
49.	Explorer 22	1965 64A	NASA				2	
50.	Explorer 20	1964 51A	NASA				8	
51.	Ariel 3	1967 42A	UK				14	
52.	Discoverer 20	1961 E1	USAF				15	X
53.	Discoverer 21	1961 Z1	USAF				15	X
54.	Discoverer 18	1960 Σ1	USAF				15	X
55.	Discoverer 36	1961 AK1	USAF				15	X
56.	None	1962 Σ1	USAF				16	
57.	OGO 4	1967 73A	NASA	X	X	X	17	
58.	None	1963 38C	USN			X	2	
59.	Secor 2	1965 17B	USA			X	12	
60.	None	1964 83C	USAF/USN				2	
61.	None	1964 83D	USAF/USN				2	
62.	Surcal	1965 65B	USN			X	11	
63.	Surcal	1965 65C	USN			X	11	
64.	Surcal	1965 65E	USN			X	11	
65.	Surcal	1965 65F	USN			X	11	
66.	Surcal	1965 65H	USN			X	11	
67.	Surcal	1965 65L	USN			X	11	
68.	None	1963 22A	USAF/USN			X	2	

Table I. Cont.

Specific Flights to be Studied

Flight Name	Int'l Desig.	Proj. Dir.	Array Voltage	Array Current	Array Temp.	Notes	No Solar Array
69. OV1-10	1966 111B	USAF	X		X	18	X
70. Samos 2	1961 A1	USAF				15	X
71. ESSA 1	1966 8A	ESSA	X		X	7	
72. Nimbus 2	1966 40A	NASA	X	X	X	19	
73. OV1-12	1967 72D	USAF	X		X	18	
74. OV1-86	1967 72A	USAF	X		X	18	
75. None	1964 48A	USAF				16	
76. OV1-4	1966 25A	USAF	X		X	18	
77. OV1-5	1966 25B	USAF	X		X	18	

Notes to Table I

1. The Pegasus series, flights 1, 2, and 3, do have sufficient data telemetered back to establish a performance analysis. These vehicles were manufactured by Fairchild-Hiller. Information can be obtained from:

Mr. Richard Julius
S&J Industries
6009 Farrington Avenue
Alexandria, Virginia 22304

Mr. James Mott
Fairchild Hiller Corporation
Fairchild Drive
Germantown, Maryland

2. These are APL flights for which the data cannot be located. Information can be obtained from:

Mr. Wade Radford
Mr. W. E. Allen
Applied Physics Laboratory
The Johns Hopkins University
8621 Georgia Avenue
Silver Spring, Maryland 20910

3. The OSO series of satellites do have sufficient data telemetered back to make a performance analysis of the solar arrays. Information can be obtained from:

Mr. Hal Manzenti
Mr. Bruce Thompson
Ball Brothers Research Corporation
Boulder, Colorado 80302

Mr. John Thole
GSFC
Greenbelt, Maryland

4. OV4 did not have any solar array. Information can be obtained from:

Mr. Robert Demoret
Martin Company
Denver, Colorado

5. OV4 1R and OV4 1T did not have solar arrays. Information can be obtained from:

Mr. J. I. Barker
Avionics Laboratory
Wright-Patterson Air Force Base

6. TTS 1 had data telemetered back, but the scatter was too large to observe performance degradation, therefore, this vehicle is not being studied. Information can be obtained from:

Mr. Frank Kelly
Office M2/1145
TRW Systems Group
One Space Park
Redondo Beach, California 90278

7. The Tiros series of vehicles had no current data telemetered back regarding the condition of the solar array. Information can be obtained from:

Mr. Robert Rados
GSFC
Greenbelt, Maryland

Mr. Abe Schnapf
Astro Electronics Division
R.C.A.
Heightstown, New Jersey

8. Explorer flights numbers 7, 16, and 20 are three flights for which the availability of flight data is not yet known. Information can be obtained from:

Mr. Frank Martin
Mr. Herman Lagow
Mr. E. D. Nelson
GSFC
Greenbelt, Maryland

Mr. Eral Hastings, Jr.
Langley Research Center
Hampton, Virginia

9. There was no flight data telemetered back regarding the solar array on this vehicle. Information can be obtained from:

Mr. Luther Slifer
GSFC
Greenbelt, Maryland

10. Explorer 17 has no solar array. Information can be obtained from:

Mr. Frank Martin
GSFC
Greenbelt, Maryland

11. These vehicles did not have any current data or array voltage telemetered back. They had the array temperature, and battery voltage telemetered back. Information can be obtained from:

Mr. Peter Wilhelm
Mr. Joseph Yuen
NRL
Washington, D. C.

12. Secor 1, 2, and 3 had only the battery voltage and solar array temperature data telemetered back. Information can be obtained from:

Mr. George Sharman
Cubic Corporation
9233 Balboa Avenue
San Diego, California

Mr. E. Cyran
U.S. Army Map Service
6500 Brooks Lane
Washington, D. C. 20315

13. Oscar 3 is a satellite built by the American Radio Relay Link. This vehicle was built by a group of amateur radio operators, and had the battery voltage and temperature, but no solar array current data telemetered back. Information can be obtained from:

Mr. William Dunkerly
American Radio Relay Link
Millington, Connecticut

14. This vehicle has extensive data published on it. But it was built in the United Kingdom, and the degree of difficulty of acquiring data is anticipated to be too great to include it in the study. Information can be obtained through the people listed in Table II.

15. Discoverer flights number 18, 20, 21, and 36 and Samos 2 did not have solar arrays. Information can be obtained from:

Mr. L. Chidester
Box 504
Building 154, Dept. 6225
Lockheed Missile and Spacecraft Company
Sunnyvale, California

16. For vehicles None 1962 Sigma 1 and None 1964 48A, no data could be found at SAMSO. The suggestion was made to search Lockheed for the data required. Information at SAMSO was obtained through:
- Major General L. I. Wilson, Jr.
SAMSO
LO OAR
Air Force Unit Post Office
Los Angeles, California 90045
17. OGO 4 has sufficient flight data available for a performance analysis of the solar arrays. Information can be obtained from:
- Mr. Robert Beltz
Office M2/2170
TRW Systems Group
One Space Park
Redondo Beach, California 90278
18. The OV1 series does not have any direct measurement of solar array current, but the battery current is monitored. By knowing the load current, the solar array current can be calculated. Information can be obtained from:
- Major James McSherry
Lt. Col. Robert S. Slizeski
SAMSO
LO OAR
Air Force Unit Post Office
Los Angeles, California 90045
- Mr. Bruce Zillgitt
Department 506-10
General Dynamics Corporation
Convair Division
P. O. Box 1128
San Diego, California 92112

19. Nimbus 2 has sufficient data telemetered back regarding the solar array for a performance analysis and extensive documentation is available on the vehicle itself. Information can be obtained from:

Mr. C. McKenzie
GSFC
Greenbelt, Maryland

Mr. K. F. Martin
Mr. K. L. Hanson
Millile and Space Division
Valley Forge Space Technology Center
General Electric
P. O. Box 8555
Philadelphia, Pennsylvania 19101

of vehicles is not sufficiently large to allow this approach to be fruitful.

III. Information and Data Gathering

As was reported earlier, an examination of the published literature was made for acquiring the data required for this study. With the exception of the Nimbus 2 flight, the published literature did not have sufficient detail for this study. The data required exists in engineering documents and other reports which did not receive wide circulation. To acquire this information, personal contacts were made with individuals associated with each flight.

In addition to letter and telephone contacts with these people, personal visits were made to personnel at Centralab, Fairchild-Hiller, G.E., GSFC, Heliotek, Lockheed, NRL, OCLI and TRW. In addition to acquiring detailed data for the specific flights of interest, a thorough understanding was obtained for the entire manufacturing process of solar cells and solar arrays through these visits.

The notes to Table I contain the list of names of people who were sources of information for each of the flights in this study. Table II is a more inclusive list of names of people who were connected in some way with each of these flights. This list should provide a reasonable starting point for anyone trying to seek information about these flights.

The data that are required for a detailed analysis of the selected flights have either been obtained, or are being sent and should be available within the next couple of weeks. These data are being analyzed and organized for the correlation analysis.

All of the performance data have not yet been obtained. These data generally exist on computer tapes, and can be ob-

Table II

Specific Flights with Individual Contact

<u>Flight Name</u>	<u>International Designation</u>	<u>Sponsoring Agency</u>	<u>Individual Contact</u>	<u>Contact Affiliation</u>
Anna 1B	1962 BM1	USN	R.E. Fischell J.H. Martin W.E. Radford W.E. Allen J.H. Martin J.S. Teener E.L. Ralph	APL Heliotek
Ariel 1	1962 01	NASA/UK	L. Slifer	GSFC
Ariel 3	1967 42A	UK	R.B. Bent F.C. Trebel R.C. Cook P.G. Garratt	S.R.C. Radio & Space Research Station Slough, England Royal Aircraft Establishment
Discoverer 18	1960 Σ1	USAF	L. Chidester	Lockheed
Discoverer 20	1961 E1	USAF	L. Chidester	Lockheed
Discoverer 21	1961 Z1	USAF	L. Chidester	Lockheed
Discoverer 36	1961 AK1	USAF	L. Chidester	Lockheed
ESSA	1966 8A	ESSA	A. Schnapf R. Rados	RCA GSFC
Explorer 7	1959 I-1	NASA	J. Boehm	MSFC
Explorer 16	1962 BX1	NASA	F. Martin	GSFC
Explorer 17	1963 9A	NASA	F. Martin	GSFC
Explorer 20	1964 51A	NASA	E.D. Nelson	GSFC
Explorer 22	1965 64A	NASA	W. Allen	APL
Explorer 23	1964 74A	NASA	F. Martin	GSFC
Explorer 30	1965 93A	USN/NASA	F. Martin	GSFC

Table II (Cont.)

Specific Flights with Individual Contact

<u>Flight Name</u>	<u>International Designation</u>	<u>Sponsoring Agency</u>	<u>Individual Contact</u>	<u>Contact Affiliation</u>
GGSE 1	1964 1B	USN/USA	P. Wilhelm	NRL
GGSE 2	1965 16B	USN/USA/USAF	J. Yuen	NRL
GGSE 3	1965 16C	USN/USA/USAF	"	"
GGSE 4	1967 53C	USAF/USN	"	"
GGSE 5	1967 53D	USAF/USN	"	"
Nimbus 2	1966 40A	NASA	K.F. Merten K.L. Hanson W.J. Schlotter H. Press C. McKenzie	G.E. GSFC
None	1963 38C	USN	R.F. Fischell	APL
None	1964 83C	USAF/USN	J.H. Martin W.E. Radford W.E. Allen	
None	1962 Σ1	USAF		
None	1963 22A	USAF/USN	R.F. Fischell	APL
None	1964 48A	USAF		
None	1964 83D	USAF/USN	R.F. Fischell	APL
OGO 4	1967 73A	NASA	H. Montgomery F.B. Shaffer J. Callaghan G.J. Gleghorn A. Krausy R.L. Robinson R.B. Beltz H.G. Mesch A.C. Lee	GSFC TRW
Oscar 3	1965 16F	USN/USA/ USAF	W. Dunkerly	ARRL

Table II (Cont.)

Specific Flights with Individual Contact

<u>Flight Name</u>	<u>International Designation</u>	<u>Sponsoring Agency</u>	<u>Individual Contact</u>	<u>Contact Affiliation</u>
OSO 1	1962 Z1	NASA	J. Thole	GSFC
OSO 2	1965 7A	NASA	W. Gallagher	"
OSO 3	1967 20A	NASA	W. Downs	Ball Bros. Corp.
OSO 4	1967 100A	NASA	H. Manzenti	"
			B. Thompson	"
OV4 3	1966 99A	USAF	R. Dermoret	Martin Company
OV4 1R	1966 99B	USAF	J.I. Barker	WPAFB
OV4 1T	1966 99D	USAF	J.I. Barker	WPAFB
OV1 4	1966 25A	USAF	L. Otten	General Dynamics
OV1 5	1966 25B	USAF	B. Zillgitt	"
OV1 10	1966 111B	USAF	J. McSherry	SAMSO
OV1 12	1967 72D	USAF	R. Slizeski	"
OV1 86	1967 72A	USAF	"	"
Pegasus 1	1965 9A	NASA	J. Mott	Fairchild-Hiller
			G. Graff	Fairchild-Hiller
Pegasus 2	1965 39A	NASA	R. Julius	S&J Industries
Pegasus 3	1965 60A	NASA	"	"
Samos 2	1961 A1	USAF	F. Ackerman	Lockheed
			L. Chidester	Lockheed
Secor 1	1964 1C	USN/USA	G. Sharman	Cubic Corp.
Secor 2	1965 17B	USA	E. Cyran	U.S.A. Map
		USAF/		Service
Secor 3	1965 16E	USN/USA	"	"
Solrad 1	1960 H2	USN	P. Wilhelm	NRL
Injun 1/				
Solrad 3	1961 02	USN	G. Peiper	NASA
Solrad 7A	1964 1D	USN/USA	P. Wilhelm	NRL
		USAF/	J. Yuen	NRL
Solrad 7B	1965 16D	USN/USA	"	"

Table II (Cont.)

Specific Flights with Individual Contact

<u>Flight Name</u>	<u>International Designation</u>	<u>Sponsoring Agency</u>	<u>Individual Contact</u>	<u>Contact Affiliation</u>
Surcal	1965 16G	USAF/ USN/USA	"	"
Surcal	1965 16H	USAF/ USN/USA	J. Yuen	NRL
Surcal	1965 65B	USN	P. Wilhelm	NRL
Surcal	1965 65C	USN	"	"
Surcal	1965 65E	USN	"	"
Surcal	1965 65F	USN	"	"
Surcal	1965 65H	USN	"	"
Surcal	1965 65L	USN	"	"
Surcal	1967 53B	USAF/USN	"	"
Surcal	1967 53F	USAF/USN	"	"
Surcal	1967 53J	USAF/USN	"	"
Tiros 1	1960 B2	NASA	R. Rados	GSFC
Tiros 2	1960 II-1	NASA	W.G. Stroud	
Tiros 3	1961 P1	NASA	E. Cortright	
Tiros 4	1962 B1	NASA	J. Maskasky	
Tiros 5	1962 AA1	NASA	A. Schnapf	RCA
Tiros 6	1962 A#1	NASA	R. Scott	RCA
Tiros 7	1963 24A	NASA	"	"
Tiros 8	1963 54A	NASA	"	"
Tiros 10	1965 51A	NASA	"	"
TRAAC	1961 AH2	USN	R.E. Fischell	APL
			W. Allen	"
Transit 1B	1960 T2	ARPA	R.E. Fischell	APL
Transit 2B	1960 H1	USN	W.C. Scott	APL
Transit 4A	1961 O1	USN	W. Allen	"
Transit 4B	1961 AH1	USN	"	"
TTS 1	1967 123B	NASA	P. Burr	GSFC
			R. Kelly	TRW

tained in printout format by direct request.

With the performance data that are available for these flights it is not possible to reconstruct the total I-V curve and analyze the degradation with time. If these I-V curves were available, then not only could the amount of degradation be determined, but a strong indication of its causes would also be available. From the data that are available, generally only a small region or single point on the I-V curve can be reconstructed over time.

There should be some degradation for each flight due to its radiation environment. This degradation should be predictable, and therefore, the change in I-V characteristics and hence the change in telemetered data should be predictable. If the observed degradation differs vastly from the predicted degradation, then this would be a good starting point for a materials and manufacturing analysis. Variations from expected performance have been observed for the vehicles selected for detailed analysis.

The initial calculations predicting the performance degradations for these flights are about to be made, and the appropriate data to analyze the actual degradation for each vehicle will be obtained, if it has not already been obtained.

IV. Summary

The vehicles chosen for detailed study are listed. The reasons why they were selected and the others were rejected are given.

A list of all the flights chosen for possible detailed study is given. This list has a number of footnotes containing information about the flights, and the names and addresses of people who are knowledgeable about these flights.

The data that are required for the detailed analysis required by this study have been either obtained, or is being shipped and should be available within the next two weeks.

Phase IV, the analysis and correlation phase, is beginning with the next quarter.