

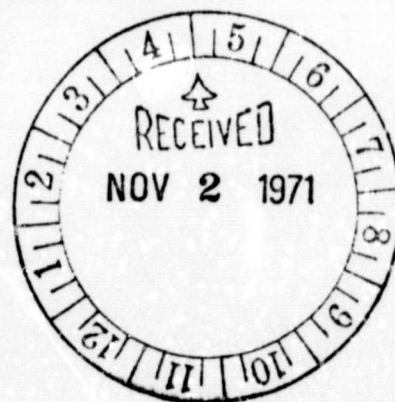
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REVISION D
OCTOBER 1971

PREPARED FOR NASA MANNED
SPACECRAFT CENTER UNDER
CONTRACT NAS9-11528
DRL 26, DRD LS-065T



SPARES AND REPAIR PARTS SUPPORT PLAN

FOR THE

ULTRAVIOLET SPECTROMETER EXPERIMENT S169

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The Johns Hopkins University
Applied Physics Laboratory
8621 Georgia Avenue
Silver Spring, Maryland

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1.0

SCOPE

This plan outlines the spares and repair parts program for the Ultraviolet Spectrometer Experiment S169. The plan includes information on the selection, purchase, acceptance, and storage of spare parts, and on repair procedures. Manufacturing attrition is not included.

2.0

APPLICABLE DOCUMENTS

The following documents are applicable to the extent specified herein:

Discrepancy Report System, RQAM 8.002

Quality Program Plan for the Ultraviolet Spectrometer Experiment S169, SOR-70-031

3.0

SPARES AND REPAIR PARTS PHILOSOPHY

The basic philosophy of this plan is to provide replacement parts for anticipated failures on the minimum level possible. Small quantities of parts are used in this experiment, with each part requiring extensive screening and processing tests. This results in long procurement lead times with a large percentage of the total hardware cost absorbed by vendor line item and lot test charges and associated documentation. The selection of spare parts and determination of quantities are made with the object

of avoiding high replacement costs and preventing schedule delays. These considerations make it mandatory that spare parts be ordered at the same time and from the same vendor as flight and ground support hardware. Due to considerations of economy and traceability, each part type will be purchased or fabricated from one lot.

3.1 RESPONSIBILITY

The Applied Physics Laboratory will establish the need for, supply, and maintain all spare parts required to fulfill the obligations of the contract. The selection of parts will be made to achieve the overall objective of making quick repairs with a minimum of retest and recalibration. All spare flight parts will undergo the same acceptance and screening criteria as flight hardware.

3.2 FIELD REPAIRS

One spectrometer will be built to serve as a backup for the flight spectrometer. The backup unit will be fully qualified for flight. Field repairs will consist solely of replacing the flight spectrometer with its backup unit (or vice versa).

Defective spectrometers will be returned to APL for repair.

3.3 REPAIR PROCEDURE

Defective units from the field sent to APL for repair must be accompanied by a Discrepancy Report (see Discrepancy Report System RQAM 8.002). Upon receipt at APL, the Discrepancy Report will be reviewed to determine disposition or type of repair. Failure Investigation Analysis Reports, Failure Analysis Action, and Material Review Board action will be initiated at that time. All units undergoing repair must be submitted for reinspection and retest as required by the Quality Program Plan SOR-70-031.

4.0 ANTICIPATION OF NEEDS

4.1 SELECTION

The rationale for selection of spare parts is based upon the following criteria:

- a. Criticality to performance of the experiment.
- b. Susceptibility to failure during acceptance tests.
- c. Susceptibility to damage during assembly and test.

d. Ease of replacement.

e. Procurement lead time.

The Spare Parts Plan is based upon providing spares for the following hardware:

Photomultiplier Assembly (includes High Voltage Power Supply and Pulse Amplitude Discriminator)

Thermal Insulation

Fasteners and other Mechanical Components
(cams, cam followers, fiducial mounts, etc.)

Electronics Housing

Ebert Mirror

Slit Mirrors

Grating

Integrated Motor Gearhead

Connectors and Header Assemblies

Electronic Components (integrated circuits, transistors, etc.)

Circuit Breaker

Electronics Package Assembly

4.2

QUANTITIES

The rationale for determining quantities of spare parts is based upon the following considerations:

a. Susceptibility to damage or failure.

- b. Procurement lead time.
- c. Procurement line item and test lot charges.
- d. Feasibility of using parts from qualification unit.

The additional cost of procuring spare parts at the same time as flight and ground support hardware is very small in relation to total hardware costs. It is thus important that enough spares be ordered at that time to provide for any foreseeable number of repairs. These additional costs are effective expenditures when compared to the cost of a schedule delay due to non-availability of replacement parts and lot replacement costs.

4.2.1 Ultraviolet Spectrometer

4.2.1.1 Electronic Components - The quantity of electronic components (integrated circuits, transistors, diodes, etc.) purchased as spares will be 100% of the quantity required to fabricate one flight spectrometer. These will be used to build one spare Electronic Package Assembly. In no case will the quantity of any spare component purchased be less than two.

4.2.1.2 Major Electronic Assemblies

a. Photomultiplier Assembly - Two Photomultiplier Assemblies will be purchased for spares. One of these will be installed in the spare electronics package.

b. Electronic Circuit Breaker - One circuit breaker will be purchased for a spare. It will be installed in the spare electronics package.

4.2.1.3 Electronics Package - One complete electronics package will be built as a spare. This unit will be inspected and tested as a flight unit and will use flight qualified parts.

4.2.1.4 Purchased Electro-Mechanical Assemblies

Integrated Motor Gearhead - One motor and gearhead will be purchased for a spare.

4.2.1.5 Optics

a. Ebert Mirror - Six Ebert mirrors will be purchased for the experiment. Two will be selected for flight spectrometers, one for the qualification unit, and one for the prototype unit. Of the remainder, two will be available for spares.

b. Slit Mirror - Six pairs of slit mirrors will be purchased for the experiment. Two

pairs will be selected for the flight spectrometers, one for the qualification unit, and one for the prototype unit. Of the remainder, two pairs will be available for spares.

c. Grating - Six gratings will be purchased for the experiment. Two will be selected for flight spectrometers, one for the qualification unit, and one for the prototype unit. Of the remainder, two pairs will be available for spares.

4.2.1.6 Mechanical Assemblies

a. Connectors - One connector of each type used will be purchased for spares. They will be installed in the spare electronics package.

b. Housing Assemblies - One Electronics Housing Assembly will be provided to build a spare electronics package. Spares will not be provided for the baffle and main structure housing.

4.2.2 Bench Test Equipment (BTE)

4.2.2.1 Commercial Test Equipment - No spare commercial test equipment will be purchased. Since three sets of Bench Test Equipment will be built, it will be possible to time-share test equipment between two sets in an emergency.

4.2.2.2 APL-Designed Test Equipment - A quantity of two electronic components of each type used in APL-designed circuits will be purchased for spares. These spares will be limited to parts with long procurement lead times.

4.2.2.3 Miscellaneous - Fuses, leads, lamps, etc. required for the BTE will be provided as required.

4.2.3 Containers and Handling Fixtures

No spare containers or handling fixtures will be provided other than those supplied for the backup and flight spectrometers.

5.0 ACCEPTANCE CRITERIA

Spare spectrometer parts will be subjected to the same testing, screening, and acceptance criteria as flight hardware. Parts common to the spectrometer and ground support equipment will receive flight hardware acceptance tests. Spare parts used only in ground support equipment will be functionally tested at APL. Acceptance criteria are detailed in the Quality Program Plan SOR-70-031.

6.0 SOURCES OF SUPPLY

Sources of supply for the major selected spare parts are as follows:

Photomultiplier Assembly	-	EMR Division Princeton, N.J.
Ebert Mirror	-	Muffoletto Optical Company Baltimore, Maryland
Slit Mirror	-	Muffoletto Optical Company Baltimore, Maryland
Grating	-	Bausch and Lomb Rochester, N.Y.
Integrated Motor Gearhead	-	Schaeffer Magnetics Corporation Chatsworth, Calif.
Electronics Package Assembly	-	APL
Circuit Breaker	-	Flight Systems, Inc. Mechanicsburg, Pa.

7.0

LEAD TIME FOR PROCUREMENT

Procurement lead times for the selected spare parts (including receiving processing) are as follows:

	<u>Weeks</u>
Photomultiplier Assembly	12
Thermal Insulation	8
Fasteners and Mechanical Components	8
Electronics Housing	8
Ebert Mirror	20
Slit Mirror	20
Grating	23
Integrated Motor Gearhead	18
Connectors and Header Assemblies	10

	<u>Weeks</u>
Electronic Components	12
Electronic Package Assembly	16
Circuit Breaker	14

8.0 STORAGE AND HANDLING

8.1 PROTECTION

The Satellite Reliability Control Group maintains a controlled material area, and will provide procedures to insure protection of spare parts requiring storage. This protection will include protection from improper handling and environmental deterioration. Any part which is subject to damage from careless handling will be provided with a special container to provide protection during movement. The Satellite Reliability Control Group will monitor the storage operation to assure compliance with the specified procedures.

8.2 TEST DATA

All test and inspection data for spares will be stored by the Satellite Reliability Control Group for the duration of the contract. This data will include both vendor and APL data, and will be traceable to the APL purchase order, vendor lot code, and spare part serial number.

8.3 RESUPPLY

The Satellite Reliability Control Group will monitor the rate at which spare parts are being used to insure that an adequate quantity is available at all times. Additional spare parts will be ordered if the rate of usage of any part indicates that the original quantity is insufficient for the duration of the contract.

9.0 CHECKOUT AND CALIBRATION

Retrofits, modifications, and repairs will invalidate acceptance tests and calibration of the spectrometer. Accordingly, after retrofit, modification or repair, the spectrometer will undergo re-inspections and retest as required by the Discrepancy Report (per RQAM 8.002) and concurrence by NASA. Following successful reinspection and retest, the spectrometer will be returned to the OTE facility for recalibration.

10.0 COST

Functional effort included in the Work Breakdown Structure is required to support the spare parts program. This functional effort includes:

- a. Inspecting and testing purchased spare parts.

b. Building, inspecting, and testing spare subassemblies.

c. Repairing, retesting, and recalibrating defective spectrometers.

d. Satellite Reliability Control Group engineering support to insure compliance with this plan.

A rough-order-of-magnitude (ROM) cost estimate for the Spares and Repair Parts Support Plan is \$112,000. Details are submitted on the following pages.

SDD Cost Estimate

UVS SPARES PLAN

*See attached sheet
 Ø = All parts in special

Rate or %

Direct Manpower Costs					
14.2 Man Months	1,015	- 14,413	X .876 =	12,626	(A)
Employee Benefits	31% of (A)		=	3,914	(B)
Routine Direct Costs	23.4* % of (A)		=	2,954	(C)
Routine Procurement	Ø % of (A)	=	(0) *		
Indirect Manpower Costs	68.5 % of (A)		=	8,649	(D)
Man Months	(D) ÷ 1842				
Total Direct & Indirect Costs					
Man Months		(A) + (B) = (C) + (D) =		28,143	
	7094	260			
BCS Machine Hrs. 360	925		X 17% (X83%**)		0
BCS Programming Hrs.	11.60				0
BID Processing Hrs.	29.00				0
BID Reduction Hrs.	6.95				0
CEF Shop Hours 300	8.80				2,640
CME Microelec. Hrs.	11.00				
				Sub-Total	30,783
G & A at 28.0%					8,619
				Sub-Total	39,402
Routine Procurement		*			0
Special M & O		3,538			3,538
Sub-Contracts		62,138***			
IBM Computer Rental		(-)**			
Other		(62,138)			
Procurement Overhead - Sub-Total	65,676	X 7.5%			4,926
				Sub-Total	47,866
Fee at 3.4%					1,627
				Sub-Total	49,493
Sub-Contracts***					62,138
				TOTAL	\$111,631

CLF (Machine Shop) Costs

<u>Requirement</u>	<u>Est. Shop Hrs.</u>	<u>Cost</u>
Housing, Elec. Mod.	200 hrs.	\$1,760.00
P.C. Boards & Headers	100 hrs.	\$ 880.00

UVS Electronic and Mechanical Components

Spare Parts List

Part Name	Part Number	Value/ Type	Quantity	Unit Cost	Total Cost
Resistor	CD3016-2	422K Ω	2	1.00	2.00
"	"	316K Ω	2	1.00	2.00
"	"	10K Ω	2	0.79	1.58
"	CD3016-3	21.5 Ω	2	1.00	2.00
"	"	42.2 Ω	2	1.87	3.74
"	"	10 Ω	2	1.67	3.34
"	CD3016-4	200 Ω	2	1.37	2.74
"	"	100 Ω	2	1.00	2.00
"	"	511 Ω	4	1.37	5.48
"	"	16.9K Ω	2	1.67	3.34
"	"	7.5K Ω	2	1.87	3.74
"	"	2.37K Ω	2	1.37	2.74
"	"	750K Ω	2	1.67	3.34
"	"	511K Ω	2	1.67	3.34
"	"	499K Ω	2	1.67	3.34
"	"	100K Ω	2	1.37	2.74
"	"	316 Ω	2	1.37	2.74
"	CD3020-N05	2.5K Ω	2	2.53	5.06
"	"	3.0K Ω	2	2.53	5.06
"	CD3020-05	1.5K Ω	2	1.68	3.36
"	"	0.25 Ω	2	2.43	4.86
"	CD3038-2	2K Ω	5	1.71	8.55
"	"	5.11K Ω	3	1.41	4.23
"	"	4.02K Ω	6	0.79	4.74
"	"	2.5K Ω	3	1.41	4.23
"	"	10K Ω	11	0.62	6.82
"	"	1K Ω	4	1.41	5.64
"	"	15K Ω	5	1.71	8.55
"	"	20K Ω	2	1.41	2.82
"	"	12K Ω	2	1.41	2.82
"	"	6.8K Ω	2	1.41	2.82
"	"	5.6K Ω	2	1.41	2.82
"	"	51.1K Ω	4	1.71	6.84
"	"	100 Ω	5	0.79	3.95
"	"	8.25K Ω	2	1.41	2.82
"	"	42.2K Ω	2	1.41	2.82
"	"	6.19K Ω	2	1.41	2.82
"	"	3.83 Ω	2	1.71	3.42
"	"	6.49K Ω	2	1.71	3.42
"	"	110K Ω	2	1.71	3.42
"	"	49.9K Ω	2	1.80	3.60
"	"	12.1K Ω	2	1.41	2.82
"	CD3055-2	5.11K Ω	2	1.41	2.82
"	"	10K Ω	2	1.41	2.82
"	MH661	6.8M Ω	2	5.83	11.66
"	"	10M Ω	4	5.83	23.32
"	GB32P82	2K Ω	2	19.37	38.74

UVS Electronic and Mechanical Components

Spare Parts List

cont'd

Part Name	Part Number	Value/ Type	Quantity	Unit Cost	Total Cost
Capacitor	CD3000-06	1uf	2	2.35	4.70
"	CD3000-20	1uf	2	2.75	5.50
"	CD3000-35	1uf	2	1.45	2.90
"	CD3000-50	1uf	2	1.65	3.30
"	"	4.7uf	2	1.81	3.62
"	CD3003-1	0.5uf	2	19.25	38.50
"	CD3004	1000pf	14	4.75	66.50
"	"	.01uf	2	12.77	25.54
"	"	3300pf	2	9.00	18.00
"	CD3005-1	1000pf	4	25.85	103.40
"	"	330pf	2	19.75	39.50
"	"	33pf	6	12.25	73.50
"	"	3900pf	2	31.20	62.40
"	CD3005-5	47pf	2	14.80	29.60
"	CD3049-15	0.56mf	2	3.45	6.90
"	CD3072-15	120uf	2	7.11	14.22
"	CD3072-25	22uf	2	4.98	9.96
"	CD3072-30	68uf	2	5.98	11.96
"	"	150uf	2	7.03	14.06
"	CD3072-50	10uf	2	4.98	9.96
"	"	47uf	2	5.98	11.96
"	CD3072-75	110uf	2	14.49	28.98
"	F68C394-10	0.39uf	2	3.75	7.50
"	X5S-327	2000pf	2	28.75	57.50
Diode	JAN TX-5419	N/A	2	6.70	13.40
"	CD5001	IN3730	4	4.50	18.00
"	CD5003	IN3070	5	14.20	71.00
"	CD5004-42B	IN3042B	2	8.50	17.00
"	CD5030-03	IN4611C	2	65.00	130.00
"	CD5045	IN4935	11	12.00	132.00
Diode, Light Emitting	TIL 24	N/A	2	16.60	33.20
Light Sensor	TIL 604	N/A	2	13.75	27.50
Transistor	CD5222-1	2N2907A	2	5.00	10.00
"	CD5222-2	2N2905A	4	7.90	31.60
"	CD5223-3	2N2222A	6	5.25	31.50
"	CD5223-4	2N2219A	2	9.75	19.50
"	CD5264	2N4864	2	28.90	57.80
Transformer	7232-2098	N/A	2	100.00	200.00
"	7232-2099	N/A	2	100.00	200.00
Choke	7232-2108	N/A	2	50.00	100.00

Electronic Circuit Breaker PI10,159	144-101	1	660.80	660.80
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UVS Mechanical Assemblies

Part Name	Part Number	Value/ Type	Quantity	Unit Cost	Total Cost
Shock Mounts	PI10,167	N/A	1 set	360.00	360.00
Connector	WSW0038M20BNF00	N/A	1	54.92	54.92
"	WSE0038F28BNH01	N/A	1	48.70	48.70
"	ME414-0104-0001	N/A	1	36.19	36.19
"	ME414-0121-0029	N/A	1	45.06	45.06
"	ME414-0125-0031	N/A	1	48.65	48.65
Thermal Insulation			1	100.00	100.00

BTE Electronic Components

Crystal					
Oscillator	NOH100013087	N/A	2	88.92	177.84
Capacitor	150D106x9010B2	10uf	6	0.36	2.16
"	150D106x9020B2	10uf	3	0.36	1.08
"	150D156x9035B2	15uf	2	0.70	1.40
Resistor	RH-5	1 Ω	2	1.50	3.00
"	RH-50	24 Ω	2	1.84	3.68
"	RH-50	25 Ω	2	1.84	3.68
"	RH-50	26 Ω	2	1.84	3.68
"	RH-50	27 Ω	2	1.84	3.68
"	RH-50	28 Ω	2	1.84	3.68

Total \$3,538.52

UVS SUBCONTRACT HARDWARE

SPARE PARTS LIST

Part Name	Part Number	Value/ Type	Quantity	Unit Cost	Total Cost
Photo-multiplier	7232-005	607L	2	9,426	18,852.00
Integrated Motor Gearhead	7232-004	N/A	1	4,208	4,208.00
<u>UVS Optics</u>					
Ebert Mirror w/coating	PI10,157	N/A	2	2,729	5,458.00
Slit Mirror	PI10,158	N/A	2 pair	792pr.	1,584.00
Gratings	PI10,156	N/A	2	8,268	16,536.00
Mechanical hardware (cams, followers, etc.)			A/R		500.00
				Total	\$47,138.00