DESIGN, DEVELOPMENT, MANUFACTURE AND QUALIFICATION OF WET-SLUG ALL-TANTALUM CAPACITORS

FINAL REPORT

Period: July 27, 1973 - December 15, 1976

Prepared By

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Prepared For

GEORGE C. MARSHALL SPACE FLIGHT CENTER
Marshall Space Flight Center, Alabama 35812

Contract No. NAS8-29819

SPRAGUE ELECTRIC COMPANY
North Adams, Massachusetts 01247

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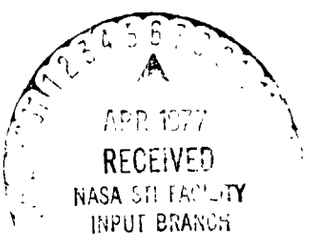

Contract No. NAS8-29819
Sprague Reference: A119-59
Project Engineer: R. H. Maher

Supplemental Report to the Final Report

Attached is Table XXXVIII from the final report, for the 250μF - 10 volt remake group of 20 units, which has been revised to include the electrical parameter results from the 10,000 hour mark achieved on April 1, 1977. It will be noted that all electrical parameters were acceptably stable throughout the test.

The capacitance stability data quite conclusively proves that the extended cathode capacitance has stabilized the total capacitor capacitance throughout the test. Following is a comparison of this parameter between the original group and the remake group with the extended cathode capacitance which makes this fact very apparent.

Capacitance Stability at 10,000 Hours of 125°C Life Test
250μF - 10 Volts

	ΔCapacitance (%)			Standard Deviation	No. Units with % ΔCap > 10%
	Low	Avg.	High	σ	
Original Units	+14.9	+26.2	+37.9	5.8	18/18
Remake Units (Extended Cathode Cap)	+2.81	+4.08	+4.95	0.54	0/20

All requirements of this contract are complete.

TABLE XXXVIII

PARAMETER BEHAVIOR ON EXTENDED 125°C LIFE TEST
RATING 250μF - 10V/7V, TEST TEMP. 125°C, TEST VOLTAGE 6 VOLTS (20 UNITS)
(REMAKE UNITS WITH EXTENDED CATHODE CAPACITANCE)

Parameter	Time on Test	Low	Avg.	High	Standard Deviation
Capacitance (μF)	0 Hours	236.6	254.5	281.1	10.2
	2,000 Hours	241.8	259.7	284.8	9.8
	6,000 Hours	244.9	262.5	286.9	9.6
	10,000 Hours	247.3	264.8	289.1	9.5
ΔCapacitance (%)	2,000 Hours	+1.55	+2.06	+2.82	0.33
	6,000 Hours	+1.21	+3.04	+4.44	0.65
	10,000 Hours	+2.81	+4.08	+4.95	0.54
Dissipation Factor (%)	0 Hours	7.4	8.5	11.1	1.1
	2,000 Hours	7.5	9.2	11.6	1.1
	6,000 Hours	7.9	9.1	11.7	1.3
	10,000 Hours	8.0	9.5	15.9	1.9
DC Leakage Current 25°C (μA), 10V	0 Hours	0.018	0.11	0.44	0.11
	2,000 Hours	0.052	0.13	0.95	0.14
	6,000 Hours	0.39	0.50	0.88	0.12
	10,000 Hours	0.54	0.69	0.99	0.14
DC Leakage Current 125°C (μA)	0 Hours	0.22	0.39	0.86	0.19
	250 Hours	0.12	0.25	0.60	0.21
	1,000 Hours	0.13	0.23	0.40	0.07
	2,000 Hours	0.052	0.13	0.95	0.20
	3,000 Hours	0.40	0.77	2.4	0.54
	4,000 Hours	0.17	0.50	2.5	0.48
	6,000 Hours	0.012	0.21	2.2	0.48
	8,000 Hours	0.059	0.27	1.7	0.41
	10,000 Hours	0.072	0.24	0.76	0.16

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SECTION 1

ABSTRACT

Over eleven hundred T3 case size all-tantalum capacitors encompassing four ratings were developed and tested in accordance with the MIL-C-39006 specification. Approximately one-half of the capacitors were tested as Engineering Evaluation units and one-half tested after the development stage as qualification units. Failure rate level "P" has been granted by DESC primarily on the basis of test data generated from this contract.

The finalized product has all the advantages of the silver cased wet and is capable of withstanding some reverse potential and AC ripple current.

SECTION 2

SCOPE OF WORK

1.0 Purpose

The contractor shall design, develop, manufacture, and qualify a series of wet-slug all-tantalum capacitors capable of meeting the performance requirements of MIL-C-39006 and having the same characteristics as style CLR65 of MIL-C-39006, except as noted below. These devices shall be constructed so as to:

a. Have a hermetic glass-to-metal seal.

b. Withstand nominal reverse voltages and ripple currents and remain functional.

c. Prevent formation of internal conductive whiskers or particles.

2.0 Technical Requirements

2.1 General Description

The contractor shall design and develop a capacitor with the following general features, ~~and in accordance with Table II hereof~~

~~(Development Schedule)~~. Detailed drawings of proposed capacitor construction shall accompany the manufacturer's proposal.

2.1.1 Case

The capacitor case shall be MIL-C-39006 size T_3. The case material shall be tantalum of such structure and purity that it is capable of being formed to withstand reverse bias of up to two volts at 125°C. There shall be no EMF (generated) between the case and anode.

2.1.2 Seal

The capacitors shall have a hermetic seal consisting of a glass-to-tantalum bond and a tantalum-to-tantalum weld capable of maintaining a seal-leak rate of no more than 1×10^{-8} cc/second, at 1 atmosphere pressure differential at 25°C.

2.1.3 Electrolyte

The capacitor electrolyte shall be such that the capacitor characteristics are not affected by placing the capacitor for at least 1000 hours in any position under normal earth gravity.

2.1.4 Reverse Bias

The capacitors shall be capable of withstanding a continuous reverse bias of 2 volts up to 125°C with no permanent degradation of capacitance, DF, or DCL.

2.1.5 Shape and Size

Capacitor size, shape and external dimensions shall conform to the requirements of case sizes specified in MIL-C-39006, Style CLR65.

2.1.6 Voltage Ratings

The capacitors shall be manufactured in 4 ratings: 10, 25, 50 and 100 DC working volts respectively at 85°C.

2.1.8 Capacitance

The capacitance shall be at least the lower values listed in MIL-C-39006, Style CLR65 for 85°C rated voltages of 10, 25, 50 and 100 volts under Case T3. Capacitance tolerance of ±20% acceptable. Capacitance of -55°C and 125°C shall not change more than the values listed in MIL-C-39006.

2.1.9 Surge Voltage

The capacitors shall be capable of withstanding surge voltages as follows at 85°C:

WVDC	Surge Voltage
10	11.5
25	28.8
50	57.5
100	115

2.1.10 DC Leakage

The capacitors shall have DC leakage values less than those listed in MIL-C-39006 at 25° and 125°C and their respective ratings.

2.2 Program Description

2.2.1 Engineering Evaluation

The contractor shall submit test data and reports showing successful completion of all of the following tests. He shall construct sufficient capacitors in case size T_3 and perform the tests presented in MIL-C-39006 for Qualification Groups I thru VI and additional tests as specified, using the sample specified below for 10, 25, 50 and 100 volts capacitors. The contractor shall propose the quantity of each voltage needed. After completion of each test the contractor shall perform failure analysis and submit report to MSFC.

2.2.1.1 Group I and II Tests

Group I and Group II tests prescribed for Qualification in MIL-C-39006 will be performed.

2.2.1.2 Group III Tests

The contractor shal. perform Group III tests (thermal shock, vibration, temperature cycling, but not salt spray) defined in Table I of MIL-C-39006B for each voltage. Leakage of electrolyte after each test shall be determined by litmus paper moistened in deionized water. The test data shall be recorded.

2.2.1.3 Group IV Tests

The contractor shall perform Group IV tests specified MIL-C-39006 for each voltage rating. Results shall be recorded.

2.2.1.4 Group V Tests

The contractor shall perform Group V tests specified in MIL-C-39006 for each voltage. Readings shall be recorded at the various temperatures.

2.2.1.5 Group VI Tests

The contractor shall perform life tests on all capacitors that successfully pass the above tests. The life test shall be in accordance with Group VI requirements. The contractor shall perform failure analysis, report to MSFC, and shall send all good capacitors to MSFC. Capacitors shall be weighed each time measurements are taken.

2.2.1.6 Ripple Current Matrix

The contractor shall perform a matrix study on effects of ripple current on ten properly biased capacitors of each of the four voltages specified above, 240 units total, as follows:

	25°C	85°C	125°C
Condition 1 (120Hz Sinusoidal)	450 mA	450 mA	450 mA
Condition 2 Sawtooth pulses of frequency and amplitude to be determined	Pulse	Pulse	Pulse

The current level should not cause a rise of capacitor temperature more than 5°C at room ambient. If necessary, reduce the 450 mA so as not to exceed this level of I^2R heating.

During electrical tests the contractor shall first measure Cap, DF, and DCL before any forward bias is applied. He shall then apply forward rated voltage for some chosen period, such as five minutes, and again measure Cap, DF, and DCL. Plots for Cap, DF and DCL before and after forward bias shall be made at 0, 120, 500, 1000, 2000 and 4000 hours, and curves drawn.

At least one litmus check shall be made during this testing, and final visual inspection shall be made.

Two capacitors from each rating shall be opened and examined for internal deterioration (whiskers, leaks, cracks, etc.).

Remaining capacitors shall be sent to MSFC.

2.2.1.7 Reverse Bias

The contractor shall perform matrix studies at a reverse voltage of -2 volts using 10 each of each voltage rating made with at least three cathode formation voltages (such as 3 V, 5 V and 7 V) as indicated below.

Nominal Cathode Formation	Temperature		
	25°C	85°C	125°C
Voltage			
3.0	10 each voltage rating	10 each voltage rating	None
5.0	Same	None	10 each voltage rating
7.0	None	5 ea @ 10 V 5 ea @ 100 V	10 each voltage rating

This is a total of 210 capacitors.

These tests shall run for 2000 hours, with electrical tests (Cap, DF, and DCL) taken at 0, 250, 500, 1000 and 2000 hours. See Para. 2.2.1.6 for Electrical Test Method.

2.2.2 Demonstration of Capability to Mass Produce and Qualify

When tests in 2.2.1 indicate to MSFC a capacitor of stable design and of good workmanship and quality, the manufacturer will produce a minimum of 600 size T_3 capacitors and subject them to screening and qualification tests as specified in MIL-C-39006B for Style CLR65. The subgroups should be divided using the full total specified, however only the T_3 case size will be used. That will be a minimum of 594 devices for the voltage classes specified in MIL-C-39006B. All limits and test conditions shall be those specified in MIL-C-39006B.

After the successful completion of the above tests and inspection, the all-tantalum capacitor in the T_3 case size in the voltage ranges specified in MIL-C-39006B will be considered qualified for MSFC use in Critical Space Hardware. These capacitors will be sent to MSFC after completion of tests.

2.3 Reports Requirements

2.3.1 Monthly Progress Reports

The contractor shall have this report prepared for distribution by not later than the 15th day of the month following the reported period. Reports shall be in narrative form, brief and informal in content, and will include, but not be limited to the following:

a. A quantitative description of overall progress;

b. An indication of any current problems which may impede performance, and proposed corrective actions, and:

c. A discussion of the work to be performed during the next monthly reporting period, including the approximate man hours and dollar expenditures.

d. Expenditures to date and forecast of funds required for completion. This should include a detailed discussion of funding deviations or problems.

2.3.2 Final Report

2.3.2.1 The final report shall be narrative in form and include, as applicable, the following:

a. Initial program concepts;

b. Changes in program concepts and factors causing the changes;

c. Problem areas and necessary corrective actions;

d. An overall evaluation of the program and the program results, and;

e. Recommendations.

2.3.2.2 A rough draft of the final report shall be submitted for approval to the Contracting Officer within twenty (20) days after completion of the Scope of Work. Comments will be furnished to the contractor within fifteen (15) days of receipt of the draft copy of the report. Upon receipt of the draft copy in its approved form, the contractor shall reproduce and distribute it as directed in Para. 2.3.5.

2.3.3 Report(s) Preparation Instructions

The above report(s) shall be submitted under a title page showing the following information:

a. Contractor's name and address, including segment generating the report.

b. Title of report, including period covered, when applicable.

c. Author(s)

d. Type of report and contract number

e. Date of publication

f. Prepared for George C. Marshall Space Flight Center, Marshall Space Flight Center, Alabama 35812

g. Include an abstract

h. All technical reports, publications, and visual presentations submitted to MSFC under this contract shall use the International System of Units as the preferred primary system. Expression in SI units alone would obviously impair communications or reduce the usefulness of the report to the primary recipients. When both systems of units are used, SI units are to be stated first and customary units afterwards, in parentheses. In each such case, the publication shall state which system of units was used for the principal measurements and calculations. SI units are specified in National Bureau of Standards Technical News Bulletin, Vol. 48, No. 4, page 61, April 1964; and defined in NASA SP-7012, The International System of Units, Physical Constants, and Conversion Factors, revised 1969. Both of these documents can be obtained from the Superintendent of Documents, U. S. Government Printing Office, Washington, D.C. 20402.

2.3.5 Reports Distribution

Copies of report(s) other than those intended for the Defense Contract Administration Services District, shall be distributed to National Aeronautics and Space Administration, George C. Marshall Space Flight Center, Marshall Space Flight Center, Alabama 35812 to the codes and in the quantities indicated below. A copy of the transmittal letter showing distribution of the reports shall be furnished to A&PS-PR-M.

Codes	Monthly	Quarterly	Final
A&PS-PR-RDMI	1	0	0
A&PS-MS-D	5	5	5
A&PS-TU	0	1	1
S&E-QUAL-QT W. R. Barlow	3	10*	10
S&E-QUAL-OC	1	1	1
S&E-ASTR-RM	1	1	1
S&E-QUAL-E (Davis)	1	1	1
Applicable DCASO	1	1	1
Totals	13	20	20

*Plus reproducible copy.

SECTION 3

DISCUSSION

A. Development Phase

(1) Special Tooling and Equipment

It should be noted that all tooling and equipment are funded solely by the Sprague Electric Company.

An indexing welding fixture was designed in the early part of September, 1973 to be used in the hermetic sealing operation of the can rim and outer seal header. The welding method employed was that of overlapping TIG welds.

Problems with cracked glass plagued this operation and required several modifications in the mechanical and electrical design of the indexing fixture. By the fifth month evaluations revealed that the efficiency and reproducibility of the system was improved to the point where a total of 218 capacitors were welded with

acceptable quality and were scheduled for use in the evaluation of processes in the Engineering Evaluation Phase of the contract.

Several refinements were subsequently made in the system to facilitate the welding operation and this system was not finalized until the eighth month of the contract.

(2) Procurement of Parts

a. Tantalum Cans

Several dozen prototype drawn tantalum cans were obtained from a potential supplier. Results of an evaluation of these tantalum cans indicated that the supplier has the necessary technology to produce tantalum cans having the properties required in this contract. Subsequent to finalization of the appropriate part specifications, procurement was initiated for a sufficient quantity of tantalum cans needed to complete this program.

Two shipments of drawn tantalum cans were received during January 1974. The first of these shipments was used for evaluation including welder set-up and cathode studies. The second shipment was used to

refine processing techniques and to construct parts for the Engineering Evaluation portion of the contract.

The remainder of the tantalum cans to fulfill the requirements of this contract were received by March 1974. However, due to the quantity of cans used in developing a solution to the hermetic seal problem and to alleviate the possibility of a future shortage, 200 additional cans were procured in December, 1974.

b. Tantalum Shells

The tantalum shell portion of the all tantalum capacitor construction is a drawn metal part used in the construction of the tantalum-to-glass-to-tantalum seal. It is that part which forms the periphery of the seal and is welded to the capacitor case. The tantalum can is distinguished from this part in that it comprises the cathode and contains the working electrolyte for the system. Initial attempts to procure the tantalum shell were successful. Subsequent attempts, however, resulted in cracks and excessive metallurgical stresses. These properties precluded

the use of these parts in seal construction. Attempts to alter metallurgical properties were futile. Extensive evaluation finally traced the problem to the surface condition of the tantalum stock. A cooperative program between the Sprague Electric Company, the shell manufacturer and the material supplier was initiated in an attempt to solve the problem. Numerous trips by both Sprague representatives and the material supplier were made. A decision was then made to physically treat the surface of the tantalum stock by established Sprague processes in order to improve drawing properties. Several samples of specially prepared tantalum stock were prepared and submitted to the shell manufacturer.

The treated tantalum was found to perform infinitely better than the untreated stock. Preliminary program scheduling was adhered to and sufficient parts to manufacture the remaining engineering evaluation parts were put through the first stage of shell manufacture. The partially completed shells were then examined by the metallurgy department of the Sprague Electric Company and resubmitted to the shell manufacturer for finishing operation.

Two separate pre-drawing treatments were tried, and the resulting parts evaluated. Both treatments resulted in the satisfactory drawing of shells with one method preferred chemically. Seals were manufactured from the shells using the perferred treatment method and these were used to finish additional capacitors. The shell supply was critical, but the drawing problem was solved.

During the December 1974 report period 1700 shells were received which supplied an adequate number of shells for the contract completion. However, the delay incurred here unavoidably delayed the completion of the contract by a minimum of two months.

c. Glass Insulator (Tantalum Shell)

The extruded glass for use in the glass-to-tantalum-to-glass seal was received in mid-December, 1973. Glass preforms were prepared for use in seal evaluations.

d. Chamber Top Retainer

Initial experiments with the prototype tantalum

cans revealed that it was necessary to modify the top retainer. Hence, redesigned top retainers were ordered and received during December, 1973. These parts, however, along with the bottom retainer required slight modifications for the purpose of a better fit. The modified parts were subsequently procured.

Construction of the Engineering Evaluation parts utilized the original parts which did not alter the capacitor performance or capabilities.

e. Specifications and Drawings

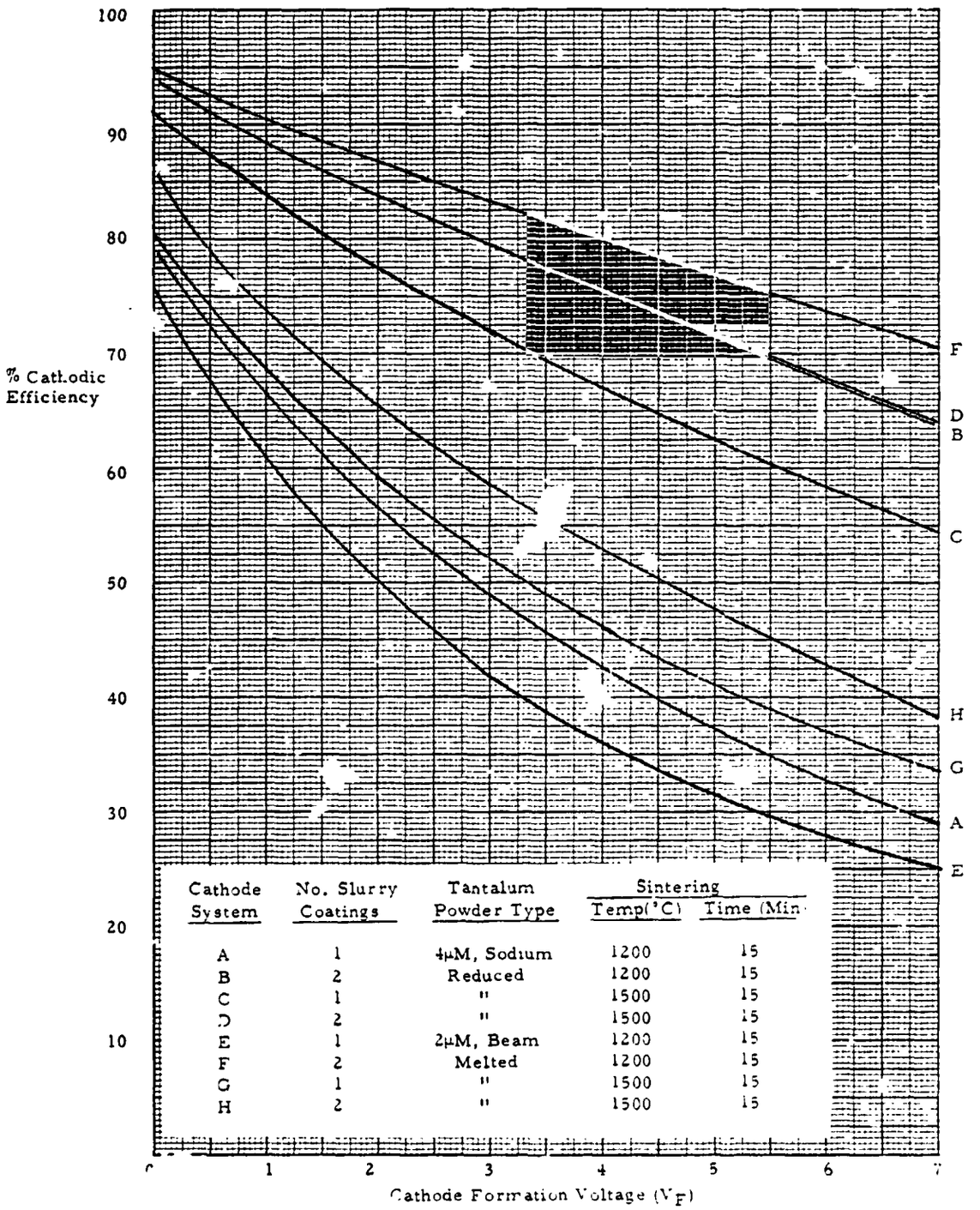
Specifications and drawings pertaining to the component capacitor parts were completed by March, 1974.

(3) Cathode Studies

Several tantalum powders and processing conditions (identified in Figure 1) were evaluated for producing a suitable cathode system. Figure 1 graphically represents the percent cathodic efficiency, plotted against cathode formation voltages for these cathode systems. The percent cathodic efficiency is defined as:

$$C_E = \frac{C_{AE}}{C_{AS}} \times 100$$

Percent Cathodic Efficiency
Vs
Cathode Formation Voltages
For Various Cathode Syste



Cathode System	No. Slurry Coatings	Tantalum Powder Type	Sintering Temp(°C)	Sintering Time (Min)
A	1	4μM, Sodium	1200	15
B	2	Reduced	1200	15
C	1	"	1500	15
D	2	"	1500	15
E	1	2μM, Beam	1200	15
F	2	Melted	1200	15
G	1	"	1500	15
H	2	"	1500	15

Figure 1

Where C_{AE} is the capacitance of a standard 10 volt rated anode measured in series with the experimental cathode system; and C_{AS} is the capacitance of a standard 10 volt rated anode measured in series with a platinized silver cathode. The cathode system F which utilized an ultrahigh CV/gram powder identified in Figure 1 represented the best obtainable cathode performance. Results of these cathode studies indicated that presently available tantalum powders could provide monometallic cathode systems which will permit the contract capacitance objectives to be met at the specified cathode formation voltages of 3, 5 and 7 volts.

Preparation and processing parameters for the monometallic tantalum cathode were finalized and implemented during February 1974. A significant number of tantalum cans were processed with good results using these techniques.

A patent application for this processing technique was filed on August 22, 1974 under number SN 499750, entitled "Method for Preparing the Container of an Electrolytic Capacitor

The above processing technique was obsoleted by a more improved, pressed cathode liner method. The liners are pressed and sintered in the can. In this manner the liner weight and density can be increased and controlled within 5-7% thereby yielding higher and more uniform capacitance values between cans.

Five capacitors rated at 560μF - 6V which were made with pressed cathode liners were vibration tested up to the 80G level, as a means of determining the durability of the cathode system, with satisfactory results. These units were vibrated at 20G's, 40G's and 60G's in each of two directions for 1 hour/direction ahd with the frequency modulated between 10 and 2000 hertz. At the 80G level the same procedure was followed as above but then the capacitors were given 3 hours of additional vibration for a total time of 8 hours. At this point testing of these units ceased.

Listed in Table I are the individual data for each capacitor before test, after shock (100G's) and after vibration at 80G's. The decrease in the dissipation factor (DF) after the 80G vibration test was looked at as a means for lowering the equivalent series resistance (ESR) however these results could not be repeated with other units tested similarly.

TABLE I

CATHODE LINER DURABILITY TESTING
(560μF - 6 V)

	Before Test			Post (100G) Shock			Post Vibration (80G)		
Unit No.	Cap.	DF	DCL	Cap	DF	DCL	Cap	DF	DCL
1	574.1	23.4	.0055	560.1	26.8	.005	592.4	18.2	1.4
2	563.0	23.8	.0075	549.5	26.2	.0130	582.6	16.5	1.4
3	569.6	26.6	.0090	556.7	25.1	.0135	592.6	16.4	1.5
4	571.5	22.4	.0062	557.6	25.6	.0075	593.5	17.3	1.0
5	567.8	24.4	.0048	561.0	28.2	.0084	599.9	18.3	1.3

Cap = Capacitance in μFd
DF = Dissipation Factor in %
DCL = Direct Current Leakage in μA.

(4) Capacitor Design

During the first quarter several prototype 250μF - 10 V rated tantalum capacitors which were constructed (without the hermetic seal) using cathode system F were evaluated for electrical characteristics. After assembly the parts were processed according to standard Sprague Electric Company processing techniques and measured. The typical electrical parameter values for these capacitors were as follows:

a. Capacitance = 263μF

b. Leakage Current @10 V = 2.5μA

c. Equivalent Series Resistance = 1.3 ohms

d. Leakage Current @-2 V = 0.39μA.

Several prototype capacitors were constructed during the second quarter period to evaluate cathode systems and the welding fixture. These evaluations indicated that design modifications were necessary to ensure compatibility with processing parameters. Difficulties encountered in containing the acid electrolyte during welding necessitated modifications to the top retainer portion of the capacitor. Evaluation of the modified design proved to be effective in containing electrolyte during the welding operation and was incorporated into the finalized capacitor design. This design was used in the Engineering Evaluation capacitors.

Ten 60μF - 50 V capacitors were consigned to Marshall Space Flight Center (L. Hamiter) for evaluation.

B. Engineering Evaluation Phase

(1) Test Specification

Test specifications outlining test procedures and sequences to be used during the Engineering Evaluation and Qualification Testing portions of this contract were prepared and issued to appropriate personnel by the Sprague Quality Assurance and Reliability Department during the first quarter of this contract.

Work on the Engineering Evaluation Phase of the contract was initiated in mid-January, 1974.

Processing of parts necessary for use in the Engineering Evaluation began, including the processing of the cathode and anodization of tantalum pellets. The difficulty encountered in procuring tantalum seal shells resulted in a delay in the execution of this portion of the contract. Several Engineering Evaluation test sample capacitors were randomly selected from parts being processed and evaluated. The purpose of this evaluation was to characterize the parts for electrical, temperature and environmental performance. The two ratings evaluated were the 250μF - 10 VDC and the 60 μF - 50 VDC units.

Electrical and temperature characteristics for the 250μF - 10 VDC and 60μF - 50 VDC ratings are shown in Tables II and III respectively. All parameters were within the Specification MIL-C-39006 limits except for two parts which slightly exceeded the -55°C capacitance change requirement. Two parts do not meet initial capacitance specification (i.e. ±20%). All other performance parameters for the 60μF - 50 VDC rating were within specification limits.

Several units of the 60μF - 50 VDC rating were vibration tested per Specification MIL-STD-202 Test Condition "D", without voltage. All parts were found to meet the electrical performance requirement after vibration testing. These data are presented in Table IV. The successful completion of this test demonstrates the capability of the cathode coating to withstand severe vibration without adversely affecting electrical performance.

Temperature cycling performance for the 250μF - 10 VDC¢ rating (-55°C to +125°C after 30 cycles) is presented in Table V. Electrical performance was not affected adversely by cycling tests. This performance indicates the capability of meeting Specification MIL-C-39006 requirements.

TABLE II

TEMPERATURE CHARACTERISTICS PER SPECIFICATION MIL-C-39006
250μF - 10VDC RATING

	25°C				-55°C			85°C				125°C			
			10V	-2V	120Hz			10V				7V			
Unit #	Cap	ESR	DCL	DCL	Cap	%ΔC	Z	Cap	ESR	DCL	%ΔC	Cap	ESR	DCL	%ΔC
1	265	.79	.60	.12	173	-34.7	9.8	278	.49	2.5	+ 4.9	292	.43	5.8	+10.1
2	267	.84	.69	.12	169	-36.7	10.0	283	.53	2.2	+ 5.6	298	.46	4.9	+11.6
3	338	.81	.61	.14	185	-45.2	9.0	357	.72	2.1	+ 5.6	378	.48	4.8	+11.8
4	197	1.27	.56	.10	129	-34.5	12.4	217	.83	2.1	+10.1	227	.70	4.6	+15.2
5	306	.81	.58	.12	186	-39.2	9.5	324	.47	2.0	+ 5.8	342	.40	4.8	+11.7
6	257	1.07	.98	.12	149	-42.0	11.2	277	.64	2.8	+ 7.7	293	.55	5.6	+14.0
7	299	.80	.41	.11	187	-37.4	9.2	315	.51	1.9	+ 5.6	332	.46	4.9	+11.0
8	298	.80	.91	.11	184	-38.2	9.5	310	.50	2.8	+ 4.0	328	.46	6.0	+10.1
9	231	1.0	.61	.10	150	-35.1	11.0	245	.63	1.9	+ 6.0	359	.55	4.8	+12.1
10	250	.70	.63	.10	174	-30.4	9.4	260	.46	2.0	+ 4.0	275	.44	4.2	+10.0
Limit		2.0	2	-		-40	30			10	+14			10	+16

Cap = Capacitance in μFd.
ESR = Equivalent Series Resistance in ohms.
DCL = Direct Current Leakage in μA.
Z = Impedance in ohms.

TABLE III

TEMPERATURE CHARACTERISTICS PER SPECIFICATION MIL-C-39006
60μF - 50VDC RATING

	25°C				-55°C			85°C				125°C			
			50V	-2V			120Hz			50V				30V	
Unit #	Cap	ESR	DCL	DCL	Cap	%ΔC	Z	Cap	ESR	DCL	%ΔC	Cap	ESR	DCL	%ΔC
1	56.9	1.1	.12	.05	50.8	-10.7	30.0	58.8	.68	.40	+ 3.3	59.8	.74	.80	+5.1
2	60.1	1.2	.14	.03	52.6	-12.5	29.0	61.5	.78	.62	+ 2.3	62.9	.74	.99	+4.7
3	59.5	1.1	.11	.02	53.7	- 9.8	27.8	61.0	.75	.43	+ 2.5	62.5	.72	.79	+5.0
4	58.7	1.2	1.1	.02	52.6	-10.4	29.2	60.0	.77	1.6	+ 2.2	61.2	.73	.88	+4.4
5	59.2	1.1	.19	.02	52.7	-11.0	28.7	60.9	.74	.65	+ 2.9	62.4	.72	.98	+5.4
6	60.6	1.1	.14	.02	54.1	-10.7	30.0	62.0	.71	.53	+ 2.3	63.4	.69	.82	+4.6
7	61.8	1.0	.14	.02	56.6	- 8.4	27.2	63.8	.66	.58	+ 3.2	64.6	.70	.79	+4.5
8	61.6	1.5	.13	.02	53.1	-13.8	31.5	63.3	.79	.49	+ 2.8	64.7	.79	.76	+5.0
9	58.4	1.1	.13	.01	51.7	-11.5	29.6	59.8	.72	.48	+ 2.4	61.2	.75	.69	+4.8
10	51.1	1.9	.40	.01	44.7	-12.5	33.0	53.8	.93	1.3	+ 5.3	54.7	.88	.67	+7.0
Limit		3.0	2			-16	45			12	+10.5			12	+12

Cap = Capacitance in μFd.
ESR = Equivalent Series Resistance in ohms.
DCL = Direct Current Leakage in μA.
Z = Impedance in ohms.

TABLE IV

VIBRATION TEST RESULTS
PER MIL-STD-202
60 μF - 50 VDC RATINGS

	Initial Reading			Reading After Vibration Test		
Unit #	Cap	ESR	50V DCL	Cap	ESR	50V DCL
1	60.1	.93	.06	60.2	.90	.13
2	55.3	1.2	.06	55.4	1.1	.13
3	57.1	.91	1.5	57.3	.92	1.2
4	61.9	.95	.05	62.0	.87	.14
5	59.9	1.0	.2	60.0	1.0	1.3
6	60.7	1.0	.05	60.8	.94	.13
7	55.2	1.2	.05	55.3	1.2	.11
8	54.6	1.2	.05	54.4	1.2	.11
9	54.3	1.9	.09	54.7	1.8	.12
10	63.0	.92	.05	63.0	.92	.11

Cap = Capacitance in μFd.
ESR = Equivalent Series Resistance in ohms.
DCL = Direct Current Leakage in μA.

TABLE V

TEMPERATURE CYCLING PERFORMANCE (-55°C to +125°C)
250μF - 10VDC RATING

	Initial			Post 10 Temp. Cycles	Post 20 Temp. Cycles	Post 30 Temperature Cycles			
Unit #	Cap	ESR	10V DCL	10V DCL	10V DCL	Cap	ESR	10V DCL	Test Reage 10V DCL
1	291	.76	.56	.68	.88	274	.63	.86	.52
2	302	.77	2.6	6.1	6.2	279	1.0	6.0	.71
3	363	.86	.54	1.0	1.6	341	.74	1.4	.49
4	217	.77	.43	.70	.54	212	.80	.74	.45
5	334	.68	.42	.75	.58	313	.56	.84	.53
6	314	.76	2.8	.69	.59	301	.66	.71	.43
7	308	.75	.43	.75	.55	298	.63	2.6	.64
8	252	.61	.92	3.1	.81	251	.58	.98	.47

Cap = Capacitance in μFd.
ESR = Equivalent Series Resistance in ohms.
DCL = Direct Current Leakage in μA.

Work continued on this test phase units with the 7 volt cathode groups completed during April 1974. The 48 hour voltage conditioning, (Group I of the MIL-C-39006 Specification) was performed during the May 1974 report period. These test data are reported in Table VI under the 50 unit section.

All initial parameters with the exception of two DCL levels in the 100V rating and one high capacitance part in the 25V rating are within MIL-C-39006, style CLR 65 limits.

Twenty-six units from each of the test ratings, 250μF - 10V, 180μF - 25V, 60μF - 50V and 30μF - 100V, were placed on a Group VI, 2000 hour, 85°C life test. Individual capacitor weights were measured at each readout point. This testing was completed by November 1974 and the test data are reported in Tables VII - X for the 10V - 100V groups respectively.

Additionally capacitors from each of these ratings were subjected to the Qualification Inspection testing for Group III (Shock, Vibration, Salt Spray and temperature cycling), Group IV (Terminal Strength, Moisture Resistance, Surge, Sleeve Test and Cold Temperature Storage) and Group V

TABLE VI

ENGINEERING EVALUATION TESTING
SPECIFICATION MIL-C-39006[illegible]
QUALIFICATION INSPECTION - GROUP I TEST

Rating	Electrical Parameter	(1) 50 Units Voltage Conditioning Low	Avg.	High	Standard Deviation	Visual Inspection	20 Units Voltage Conditioning Low	Avg.	High	Standard Deviation	Visual Inspection	20 Units Voltage Conditioning Low	Avg.	High	Standard Deviation	Visual Inspection
250µF - 10 V	Cap (µF)	200.9	253.0	299.0	27.9	-	231.3	260.4	281.6	13.2	-	201.1	238.4	274.1	22.5	-
T3 Case	DF (%)	8.0	16.3	35.3	6.2	-	8.6	11.3	15.4	1.4	-	9.5	13.0	20.8	3.0	-
	25°C DCL (µA)	0.40	0.56	1.4	0.16	-	0.10	0.12	0.15	0.01	-	0.11	0.14	0.19	0.02	-
	No Mechanical Damage	-	-	-	-	Conforms	-	-	-	-	Conforms	-	-	-	-	Conforms
	No Electrolyte Leakage	-	-	-	-	Conforms	-	-	-	-	Conforms	-	-	-	-	Conforms
180µF - 25 V	Cap (µF)	147.6	176.1	220.8	16.0	-	170.8	199.4	221.7	13.4	-	169.9	201.0	223.3	14.2	-
T3 Case	DF (%)	6.7	10.0	18.1	2.8	-	7.3	13.8	21.8	3.6	-	9.0	12.4	18.4	2 8	-
	25°C DCL (µA)	0.23	0.31	0.44	0.05	-	0.14	0.23	0.45	0.0	-	0.12	0.18	0.22	0.03	-
	No Mechanical Damage	-	-	-	-	Conforms	-	-	-	-	Conforms	-	-	-	-	Conforms
	No Electrolyte Leakage	-	-	-	-	Conforms	-	-	-	-	Conforms	-	-	-	-	Conforms
60µF - 50 V	Cap (µF)	50.13	59.16	64.54	3.03	-	60.96	69.88	71.92	2.58	-	57.31	61.90	69.97	3.23	-
T3 Case	DF (%)	3.0	4.4	7.5	1.0	-	1.6	4.3	5.6	0.6	-	3.0	3.5	4.1	0.3	-
	25°C DCL (µA)	0.11	0.17	1.2	0.18	-	0.037	0.10	0.57	0.13	-	0.041	0.061	0.15	0.030	-
	No Mechanical Damage	-	-	-	-	Conforms	-	-	-	-	Conforms	-	-	-	-	Conforms
	No Electrolyte Leakage	-	-	-	-	Conforms	-	-	-	-	Conforms	-	-	-	-	Conforms
30µF - 100 V	Cap (µF)	29.12	32.56	35.74	2.00	-	30.75	31.58	32.37	0.47	-	28.26	33.98	36.47	1.94	-
T3 Case	DF (%)	2.0	2.5	5.3	0.5	-	1.8	2.3	2.8	0.26	-	2.1	2.5	3.1	0.37	-
	25°C DCL (µA)	0.11	0.29	2.8	0.54	-	0.05	0.12	0.78	0.19	-	0.041	0.080	0.43	0.084	-
	No Mechanical Damage	-	-	-	-	Conforms	-	-	-	-	Conforms	-	-	-	-	Conforms
	No Electrolyte Leakage	-	-	-	-	Conforms	-	-	-	-	Conforms	-	-	-	-	Conforms

(1) 180µF - 25 V Rating - 45 Units.
60µF - 50 V Rating - 45 Units.

TABLE VII

ENGINEERING EVALUATION TEST
SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP VI TESTS
250μF - 10V, T3 CASE (26 UNITS)

		2000 Hour, 85°C Life			
Parameter	Time on Test	Low	Avg.	High	Standard Deviation
Capacitance (μF)	0 Hours	202.2	250.3	299.0	27.7
	2000 Hours	211.0	260.2	302.5	26.4
ΔCapacitance (%)	2000 Hours	+0.3	+4.1	+16.8	+3.87
Dissipation Factor (%)	0 Hours	8.0	16.9	35.3	6.9
	2000 Hours	9.7	20.1	42.1	7.8
DC Leakage Current 25°C (μA)	0 Hours	0.43	0.56	1.4	0.19
	2000 Hours	0.34	0.53	0.84	0.12
DC Leakage Current 85°C (μA)	0 Hours	2.5	3.6	6.0	0.73
	250 Hours	3.0	3.9	5.5	0.58
	1000 Hours	0.66	0.89	1.1	0.13
	2000 Hours	0.55	0.86	1.5	0.27
Weight (g)	0 Hours	10.3600	10.5718	10.9543	0.1256
	250 Hours	10.3679	10.5827	10.9600	0.1251
	1000 Hours	10.3586	10.5734	10.9566	0.1260
	2000 Hours	10.3586	10.5780	10.9620	0.1262

TABLE VIII

ENGINEERING EVALUATION TEST
SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP VI TESTS
180μF - 25 V, T3 CASE (26 UNITS)

	2000 Hour, 85°C Life				
Parameter	Time on Test	Low	Avg.	High	Standard Deviation
Capacitance (μF)	0 Hours	148.7	175.4	204.4	15.6
	2000 Hours	149.6	177.0	206.6	15.4
ΔCapacitance (%)	2000 Hours	+0.17	+0.88	+2.7	0.57
Dissipation Factor (%)	0 Hours	7.0	9.7	16.1	2.5
	2000 Hours	6.9	10.2	17.2	2.7
DC Leakage Current 25°C (μA)	0 Hours	0.26	0.31	0.36	0.023
	2000 Hours	0.16	0.27	1.7	0.29
DC Leakage Current 85°C (μA)	0 Hours	2.0	2.3	3.1	0.24
	250 Hours	0.90	1.0	2.1	0.26
	1000 Hours	0.51	0.68	0.85	0 076
	2000 Hours	0.63	0.86	3.5	0.54
Weight (g)	0 Hours	10.4730	10.6207	10.7414	0.0971
	250 Hours	10.4857	10.6317	10.7536	0.0973
	1000 Hours	10.1875	10.6003	10.3420	0.1279
	2000 Hours	10.4803	10.6263	10.8480	0.0973

TABLE IX

ENGINEERING EVALUATION TESTS
SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP VI TESTS
60μF - 50V, T3 CASE (26 UNITS)

	2000 Hour, 85°C Life				
Parameter	Time on Test	Low	Avg.	High	Standard Deviation
Capacitance (μF)	0 Hours	50.13	58.60	63.95	3.1
	2000 Hours	50.40	58.88	64.28	3.1
ΔCapacitance (%)	2000 Hours	+0.12	+0.54	+1.1	0.21
Dissipation Factor (%)	0 Hours	3.0	4.6	7.5	1.1
	2000 Hours	3.2	4.9	7.9	1.2
DC Leakage Current 25°C (μA)	0 Hours	0.11	0.18	1.2	0.22
	2000 Hours	0.035	0.11	0.40	0.087
DC Leakage Current 85°C (μA)	0 Hours	0.30	0.46	0.88	0.14
	250 Hours	0.12	0.22	0.78	0.15
	1000 Hours	0.13	0.23	0.75	0.14
	2000 Hours	0.13	0.21	1.0	0.17
Weight (g)	0 Hours	10.1636	10.5755	10.8378	0.1360
	250 Hours	10.1777	10.5889	10.8533	0.1359
	1000 Hours	10.1661	10.5776	10.8409	0.1359
	2000 Hours	10.1736	10.5834	10.8482	0.1356

TABLE X

ENGINEERING EVALUATION TESTS
SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP VI TESTS
30μF - 100 V, T3 CASE (26 UNITS)

	2000 Hour, 85°C Life				
Parameter	Time on Test	Low	Avg.	High	Standard Deviation
Capacitance (μF)	0 Hours	29.12	32.94	35.61	1.47
	2000 Hours	29.73	33.03	35.56	1.43
ΔCapacitance (%)	2000 Hours	+0.03	+0.25	+2.09	0.49
Dissipation Factor (%)	0 Hours	2.1	2.6	5.3	0.6
	2000 Hours	2.0	2.7	5.6	0.7
DC Leakage Current 25°C (μA)	0 Hours	0.11	0.13	0.39	0.054
	2000 Hours	0.022	0.081	0.68	0.12
DC Leakage Current 85°C (μA)	0 Hours	0.43	0.70	2.9	0.49
	250 Hours	0.22	0.51	2.4	0.46
	1000 Hours	0.25	0.54	1.5	0.30
	2000 Hours	0.33	0.51	1.0	0.17
Weight (g)	0 Hours	9.9982	10.2336	10.7165	0.1697
	250 Hours	10.0037	10.2442	10.7270	0.1700
	1000 Hours	10.0023	10.2380	10.7209	0.1698
	2000 Hours	10.0000	10.2401	10.7235	0.1703

(Stability at Low and High Temperatures). The summarized test data for these Groups are reported in Tables XI - XVI.

During the August 1974 report period a serious problem relating to the capacitor hermeticity came to light. Leak testing of random samples of capacitors per MIL-STD-202E, Method 112B, Condition C, procedure IIIa revealed fine leaks in 11 of 12 units tested. No gross leaks (Method A) or electrolyte leaks were detected.

This situation prompted an examination of the entire seal situation. As a result all the completed units on hand, with the exception of those at the control lab, were tested for hermeticity. One new development was that gross leak test (MIL-STD-202E, Method 112B, Condition A) failures were noted. Condition A was used as a screen prior to Condition C to minimize contamination of the Mass Spectrometer. The results were 114 gross leaks, 24 fine leaks after gross leak screening, and 111 good seals. This represents a 44.6% yield on seals out of the 249 units tested. Seal problems were narrowed down to sensitivity to welding heat, with the further observation that the condition of the tantalum surface of the shell prior to fusing affected the degree of sensitivity.

TABLE XI

ENGINEERING EVALUATION TESTS
SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP III TEST

Rating	Electrical Parameter	Initial			Shock	Vibration	Salt Spray	Temp. Cycling Initial			Temp. Cycling 30 Cycles		
		Low	Avg.	High				Low	Avg.	High	Low	Avg.	High
250µF - 10V	Cap (µF)	222.3	241.7	258.1	-	-	-	220.4	240.1	259.8	222.1	241.1	257.3
T3 Case	ΔCap (%)	-	-	-	-		-	-	-	-	-0.08	-0.09	-0.96
(3 Units)	DF (%)	8.7	15.2	19.2	-		-	8.6	15.1	19.0	8.3	15.1	19.3
	25°C DCL (µA)	0.70	0.71	0.71	-		-	-	-	-	0.48	0.51	0.54
	Legible Marking	-	-	-	-		Conforms	-	-	-	-	-	-
	No Opens, Shorts	-	-	-	Conforms	Conforms	-	-	-	-	-	-	-
	No Mechanical Damage	-	-	-	Conforms	Conforms	Conforms	-	-	-	Conforms		
	No Electrolyte Leakage	-	-	-	Conforms	Conforms	-	-	-	-	-		
	Thymol	-	-	-	-	-	-	-	-	-	Conforms		
180µF - 25V	Cap (µF)	177.6	188.1	199.4	-	-	-	178.6	190.7	198.5	177.7	189.5	199.2
T3 Case	ΔCap (%)	-	-	-	-	-	-	-	-	-	+0.35	-0.60	-1.64
(3 Units)	DF (%)	12.7	15.0	18.1	-	-	-	12.0	13.4	14.8	11.4	13.5	14.8
	25°C DCL (µA)	0.38	0.39	0.40	-	-	-	0.26	0.36	0.42	0.31	0.34	0.38
	No Opens, Shorts	-	-	-	Conforms	Conforms	-	-	-	-	Conforms		
	No Mechanical Damage	-	-	-	Conforms	Conforms	Conforms	-	-	-	-		
	No Electrolyte Leakage	-	-	-	Conforms	Conforms	-	-	-	-	Conforms		
	Legible Marking	-	-	-	-	-	Conforms	-	-	-	-		
	Thymol	-	-	-	-	-	-	-	-	-	Conforms		
60µF - 50V	Cap (µF)	55.14	58.61	60.81	-	-	-	55.09	58.73	61.09	55.33	58.76	60.94
T3 Case	ΔCap (%)	-	-	-	-	-	-	-	-	-	0.0	+0.10	+0.44
(3 Units)	DF (%)	3.5	4.1	4.5	-	-	-	3.5	3.6	3.8	3.3	3.8	4.1
	25°C DCL (µA)	0.13	0.19	0.24	-	-	-	0.11	0.26	0.44	0.14	0.35	0.49
	Legible Marking	-	-	-	-	-	Conforms	-	-	-	-	-	-
	No Opens, Shorts	-	-	-	Conforms	Conforms	-	-	-	-	Conforms		
	No Mechanical Damage	-	-	-	Conforms	Conforms	Conforms	-	-	-	-		
	No Electrolyte Leakage	-	-	-	Conforms	Conforms	-	-	-	-	Conforms		
	Thymol	-	-	-	-	-	-	-	-	-	Conforms		
30µF - 100V	Cap (µF)	29.27	30.53	32.44	-	-	-	29.21	30.51	32.42	29.13	30.39	32.27
T3 Case	ΔCap (%)	-	-	-	-	-	-	-	-	-	-0.27	-0.39	-0.46
(3 Units)	DF (%)	2.0	2.5	2.9	-	-	-	2.0	2.4	2.6	2.1	2.4	2.6
	25°C DCL (µA)	0.11	0.54	1.4	-	-	-	0.11	0.79	1.9	0.2	1.5	2.1
	No Opens, Shorts	-	-	-	Conforms	Conforms	-	-	-	-	-	-	-
	No Mechanical Damage	-	-	-	Conforms	Conforms	Conforms	-	-	-	-	-	-
	No Electrolyte Leakage	-	-	-	Conforms	Conforms	-	-	-	-	Conforms		
	Legible Marking	-	-	-	-	-	Conforms	-	-	-	-		
	Thymol	-	-	-	-	-	-	-	-	-	Conforms		

ENGINEERING EVALUATION TESTS
SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP IV TESTS

Rating	Electrical Parameter	Initial			Terminal Strength			Surge			Moisture Resistance			Sleeve Test		Low Temperature Storage		
		Low	Avg.	High	Solderability	Pull Test	Bend Test	Low	Avg.	High	Low	Avg.	High	Dielectric	Insulation	Low	Avg.	High
250µF - 10 V	Cap (µF)	239.8	261.5	298.1	-	-	-	219.2	246.0	287.3	226.8	251.8	291.1	-	-	222.4	248.7	289.5
T3 Case	DF (%)	13.1	19.0	22.8	-	-	-	11.6	18.0	21.8	12.6	18.7	22.8	-	-	11.0	17.1	20.8
(3 Units)	25°C DCL (µA)	0.61	0.64	0.68	-	-	-	0.30	0.32	0.37	0.61	0.92	1.5	-	-	0.32	0.39	0.43
	ΔCap (%)	-	-	-	-	-	-	-	-	-	+1.3	+2.5	+3.5	-	-	-0.6	-1.3	-1.9
	Tinning (95%)	-	-	-	Conforms	-	-	-	-	-	-	-	-	-	-	-	-	-
	Legible Marking	-	-	-	-	-	-	-	-	-		Conforms		-	-	-	-	-
	No Mechanical Damage	-	-	-	-	Conforms	Conforms		Conforms			Conforms		-	-		Conforms	
	No Opens, Shorts	-	-	-	-	-	-		Conforms			-		-	-		-	
	No Electrolyte Leakage	-	-	-	-	-	-		Conforms			Conforms		-	-		Conforms	
	No Breakdown	-	-	-	-	-	-		-			-		Conforms	-		-	
	Insulation Resistance ≥100 Megohm	-	-	-	-	-	-		-			-		-	Conforms		-	
180µF - 25 V	Cap (µF)	169.7	177.6	184.1	-	-	-	134.6	156.2	185.3	143.4	150.9	185.5	-	-	137.0	156.5	183.6
T3 Case	DF (%)	6.7	8.5	10.9	-	-	-	5.9	7.8	11.7	6.6	9.2	11.8	-	-	-1.02	-2.25	-4.46
(3 Units)	25°C DCL (µA)	0.36	0.39	0.44	-	-	-	0.22	0.25	0.31	2.0	2.7	3.4	-	-	6.1	7.5	10.2
	ΔCap (%)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.20	0.37	0.58
	Tinning (95%)	-	-	-	Conforms	-	-	-	-	-		Conforms		-	-	-	-	-
	Legible Marking	-	-	-	-	-	-	-	-	-		Conforms		-	-	-	-	-
	No Mechanical Damage	-	-	-	-	Conforms	Conforms		Conforms			-		-	-		Conforms	
	No Opens, Shorts	-	-	-	-	-	-		Conforms			-		-	-		-	
	No Electrolyte Leakage	-	-	-	-	-	-		Conforms			Conforms		-	-		Conforms	
	No Breakdown	-	-	-	-	-	-		-			-		Conforms	-		-	
	Insulation Resistance ≥100 Megohm	-	-	-	-	-	-		-			-		-	Conforms		-	
60µF - 50 V	Cap (µF)	60.13	60.52	60.89	-	-	-	59.75	59.97	60.20	59.95	60.34	60.61	-	-	59.88	60.07	60.34
T3 Case	DF (%)	3.7	3.9	4.2	-	-	-	3.6	3.7	3.9	3.7	3.8	3.8	-	-	3.5	3.6	3.7
(3 Units)	25°C DCL (µA)	0.12	0.12	0.13	-	-	-	0.12	0.12	0.13	0.55	1.0	1.2	-	-	0.11	0.17	0.29
	ΔCap (%)	-	-	-	-	-	-	-	-	-	+0.33	+0.62	+0.85	-	-	-0.12	0.44	-0.76
	Tinning (95%)	-	-	-	Conforms	-	-	-	-	-	-	-	-	-	-	-	-	-
	Legible Marking	-	-	-	-	-	-	-	-	-		Conforms		-	-	-	-	-
	No Mechanical Damage	-	-	-	-	Conforms	Conforms		Conforms			Conforms		-	-		Conforms	
	No Opens, Shorts	-	-	-	-	-	-		Conforms			-		-	-		-	
	No Electrolyte Leakage	-	-	-	-	-	-		Conforms			Conforms		-	-		Conforms	
	No Breakdown	-	-	-	-	-	-		-			-		Conforms	-		-	
	Insulation Resistance ≥100 Megohm	-	-	-	-	-	-		-			-		-	Conforms		-	
30µF - 100 V	Cap (µF)	29.15	31.93	35.07	-	-	-	24.60	29.73	34.68	25.14	30.09	34.77	-	-	24.58	29.73	34.68
T3 Case	DF (%)	2.1	2.5	3.1	-	-	-	1.8	2.0	2.3	2.5	3.0	3.9	-	-	1.8	2.1	2.3
(3 Units)	25°C DCL (µA)	0.12	0.51	0.82	-	-	-	0.12	0.33	0.45	5.1	10.9	18.0	-	-	3.1	7.3	11.0
	ΔCap (%)	-	-	-	-	-	-	-	-	-	+0.26	+1.3	+2.2	-	-	-0.26	-1.3	-2.2
	Tinning (95%)	-	-	-	Conforms	-	-	-	-	-	-	-	-	-	-	-	-	-
	Legible Marking	-	-	-	-	-	-	-	-	-		Conforms		-	-	-	-	-
	No Mechanical Damage	-	-	-	-	Conforms	Conforms		Conforms			Conforms		-	-		Conforms	
	No Opens, Shorts	-	-	-	-	-	-		Conforms			-		-	-		-	
	No Electrolyte Leakage	-	-	-	-	-	-		Conforms			Conforms		-	-		Conforms	
	No Breakdown	-	-	-	-	-	-		-			-		Conforms	-		-	
	Insulation Resistance ≥100 Megohm	-	-	-	-	-	-		-			-		-	Conforms		-	

TABLE XIII

ENGINEERING EVALUATION TESTS
SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP V TESTS
250μF - 10V/7V, T3 CASE (3 UNITS)

Electrical Parameter	25°C			-55°C			25°C			85°C		
	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High
Cap (μF)	200.9	224.9	248.9	144.9	154.1	158.9	201.0	225.5	251.3	207.0	233.3	261.0
DF (%)	8.1	10.8	13.6	-	-	-	8.80	11.2	13.8	12.1	14.2	16.0
DCL (μA)	0.68	0.71	0.75	-	-	-	0.35	0.43	0.55	5.3	5.8	6.3
Z (Ω)	-	-	-	11	11	11	-	-	-	-	-	-
ΔCap (%)	-	-	-	-27.9	-31.2	-36.3	+0.05	+0.25	+0.96	+3.0	+3.7	+4.9

	125°C			25°C		
	Low	Avg.	High	Low	Avg.	High
Cap (μF)	216.0	242.8	271.3	200.4	224.9	250.2
DF (%)	12.8	14.5	15.8	8.5	10.6	13.1
DCL (μA)	9.6	9.8	9.9	0.37	0.41	0.46
ΔCap (%)	+7.2	+7.9	+9.0	-0.25	0.0	+0.52

TABLE XIV

ENGINEERING EVALUATION TESTS
SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP V TESTS
180μF - 25 V/15 V, T3 Case (3 UNITS)

Electrical Parameter	25°C			-55°C			25°C			85°C		
	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High
Cap (μF)	169.3	180.2	186.5	109.0	123.2	132.9	166.9	177.9	185.2	178.5	186.1	192.0
DF (%)	7.8	11.0	15.9	-	-	-	7.5	10.5	15.0	10.4	11.6	12.4
DCL (μA)	0.35	0.37	0.40	-	-	-	0.29	0.33	0.40	2.3	2.5	2.6
Z (Ω)	-	-	-	12	14	17	-	-	-	-	-	-
ΔCap (%)	-	-	-	-28.7	-31.7	-35.6	-0.70	-1.25	-1.62	-1.7	+0.25	+5.4

	125°C			25°C		
	Low	Avg.	High	Low	Avg.	High
Cap (μF)	183.8	191.0	196.5	167.7	177.9	184.1
DF (%)	10.9	11.6	12.2	7.4	10.5	15.1
DCL (μA)	3.8	3.9	4.0	0.24	0.25	0.26
ΔCap (%)	+4.4	+6.1	+8.6	-0.95	-1.23	-1.46

TABLE XV

ENGINEERING EVALUATION TESTS
SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP V TESTS
60μF - 50V/30V, T3 CASE (3 UNITS)

Electrical	25°C			-55°C			25°C			85°C		
Parameter	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High
Cap (μF)	54.31	56.89	61.22	46.50	49.36	53.66	53.93	56.64	61.13	55.60	58.13	62.49
DF (%)	3.9	3.9	4.1	-	-	-	4.1	4.4	4.8	3.4	3.5	3.7
DCL (μA)	0.12	0.25	0.50	-	-	-	0.12	0.42	1.0	0.28	0.37	0.50
Z (Ω)	-	-	-	27	29	30	-	-	-	-	-	-
ΔCap (%)	-	-	-	-12.4	-13.3	-14.3	-0.15	-0.46	-0.70	+2.1	+2.2	+2.4

	125°C			25°C		
	Low	Avg.	High	Low	Avg.	High
Cap (μF)	56.85	59.34	63.70	54.13	56.75	61.21
DF (%)	3.5	3.6	3.7	4.0	4.1	4.4
DCL (μA)	0.55	0.65	0.78	0.12	0.20	0.36
ΔCap (%)	+4.0	+4.3	+4.7	-0.016	-0.26	-0.44

TABLE XVI

ENGINEERING EVALUATION TESTS
SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP V TESTS
100μF - 100V/65V, T3 CASE (3 UNITS)

Electrical	25°C			-55°C			25°C			85°C		
Parameter	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High
Cap (μF)	29.77	31.57	32.66	27.17	29.46	30.68	29.59	31.39	32.39	30.28	32.08	33.12
DF (%)	2.1	2.2	2.4	-	-	-	2.0	2.2	2.4	2.6	2.6	2.7
DCL (μA)	0.12	0.12	0.13	-	-	-	0.12	1.1	2.8	0.87	1.3	2.2
Z (Ω)	-	-	-	34	37	40	-	-	-	-	-	-
ΔCap (%)	-	-	-	-5.2	-6.?	-8.7	-0.28	-0.57	-0.83	+1.4	+1.6	+1.7

	125°C			25°C		
	Low	Avg.	High	Low	Avg.	High
Cap (μF)	31.15	33.05	34.02	29.44	31.27	31.27
DF (%)	3.9	4.2	4.5	1.8	1.9	2.0
DCL (μA)	1.6	2.1	2.9	0.13	0.19	0.30
ΔCap (%)	+4.2	+4.6	+4.6	-0.8	-1.0	-1.1

Changes in the seal fusing and welding processes, in order to minimize the heat sensitivity, resulted in a decrease in units failing the seal tests from 54% to only 7%. Since shells were in short supply only 130 seals were available for welding with the new processing methods. These 130 seals resulted in 121 units successfully completing the seal tests. The 7% loss represents nearly an eight fold decrease in the loss rate from faulty seals.

However, due to further problems in the welding of the hermetic seal a comprehensive program, including the investigation of laser welding, was started. Fortunately there were sufficient shells and cans on hand at this time to allow a thorough and methodical investigation of the problem. Significant progress on this problem was made during the seventeenth report period and by the eighteenth report period it was concluded that laser welding was the solution to the hermeticity problem. Over 500 units were laser welded with a greater than 97% hermetic yield.

Due to losses encountered during the welding and hermetic seal difficulties it was necessary that a few additional units be assembled to complete the ripple matrix units. These units along with the units for completion of the reverse voltage test matrix were completed by May, 1975. The

voltage conditioning data for these groups are reported in Table VI under the two 20 unit headings. The ripple test units were sent to NASA on May 13, 1975 for testing.

The 7 volt cathode formation group began the 2 volt reverse testing at 85°C and 125°C during October, 1974. Ten capacitors from each of the four ratings were subjected to the 125°C temperature and 5 units from the 10V and 100V groups were placed on the 85°C test. This testing was completed by January, 1975. The summarized test data are reported in Tables XVII and XVIII for the 85°C and 125°C temperature testing respectively. These data indicate that a 7 volt formed cathode is capable of withstanding intermittent voltage reversals in the order of 2 volts. It should be noted that a stability reage at the 85°C rated voltage and temperature for 16 hours was performed at the end of each readout interval.

The 3 volt and 5 volt cathode formation groups were completed by May, 1975 and commenced the 2 volt reverse bias matrix testing. This testing was completed by August 1975 and the summarized test data are reported

TABLE XVII

ENGINEERING EVALUATION TEST
2 VOLT REVERSE BIAS AT 85°C
7 VOLT CATHODE FORMATION

Rating	Time on Test	Post Test Readouts: Cap (µF) Low	Avg.	High	σ	DF (%) Low	Avg.	High	σ	25°C DCL (µA) Low	Avg.	High	σ	Post 16 Hours Stability Reads at 85°C Rated Voltage: Cap (µF) Low	Avg.	High	σ	DF (%) Low	Avg.	High	σ	25°C DCL (µA) Low	Avg.	High	σ	% ΔCap Low	Avg.	High	σ
250µF - 10V	0 Hours	212.5	254.9	295.7	30.8	9.9	14.2	24.1	5.8	0.40	0.43	0.49	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	213.3	254.2	292.3	29.5	10.4	14.7	24.8	5.9	0.86	1.6	4.2	1.5	213.3	255.0	293.8	29.9	10.0	14.2	23.4	5.5	0.40	0.45	0.50	0.05	-	-	-	-
(5 Units)	500 Hours	212.9	262.6	294.4	35.0	10.2	16.9	26.3	7.8	0.84	1.7	4.8	1.8	214.9	255.8	294.3	29.8	10.2	14.5	24.2	5.8	0.33	0.39	0.46	0.06	-	-	-	-
	1000 Hours	242.0	266.2	310.4	39.2	10.0	16.8	25.9	7.8	1.1	1.9	4.9	1.7	213.4	256.0	293.5	29.7	10.2	14.8	24.3	5.7	0.29	0.35	0.41	0.05	-	-	-	-
	2000 Hours	215.2	273.6	342.6	48.7	10.7	17.9	24.8	9.1	0.63	1.4	4.2	1.6	213.8	254.6	292.8	29.6	10.3	14.8	25.2	6.0	0.031	0.050	0.090	0.024	-0.1	-0.5	1.0	0.4
30µF - 100V	0 Hours	32.27	33.31	34.25	0.89	2.0	2.3	2.7	0.3	0.11	0.68	2.6	1.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	31.96	33.05	34.02	0.91	2.1	2.3	2.6	0.2	0.25	0.71	2.3	0.89	32.16	33.28	34.33	0.93	2.0	2.3	2.6	0.2	0.11	0.20	0.49	0.15	-	-	-	-
(5 Units)	500 Hours	31.87	32.94	33.93	0.89	2.0	2.1	2.3	0.1	0.24	0.46	1.3	0.47	32.35	33.37	34.40	0.90	2.1	2.4	2.6	0.2	0.10	0.11	0.12	0.01	-	-	-	-
	1000 Hours	31.83	32.73	33.92	3.8	1.8	2.2	2.7	0.35	0.21	0.44	1.2	0.42	32.20	33.30	34.36	0.93	2.0	2.3	2.5	0.2	0.055	0.064	0.092	0.016	-	-	-	-
	2000 Hours	31.87	32.96	33.95	0.89	1.8	2.4	3.7	0.7	0.20	0.27	0.41	0.088	32.10	33.21	34.23	0.92	2.0	2.2	2.4	0.2	0.018	0.027	0.043	0.010	-0.06	-0.3	0.5	0.29

σ = Standard Deviation.

TABLE XVIII

ENGINEERING EVALUATION TEST
2 VOLT REVERSE BIAS AT 125°C
7 VOLT CATHODE FORMATION

Rating	Time on Test	Post Test Readouts: Cap (µF) Low	Avg.	High	σ	DF (%) Low	Avg.	High	σ	25°C DCL (µA) Low	Avg.	High	σ	Post 16 Hours Stability Reage at 85°C Rated Voltage: Cap (µF) Low	Avg.	High	σ	DF (%) Low	Avg.	High	σ	25°C DCL (µA) Low	Avg.	High	σ	% ΔCap Low	Avg.	High	σ
250µF - 10V/7V	0 Hours	227.6	268.3	297.1	25.3	11.0	16.7	26.1	5.7	0.42	0.49	0.66	0.07	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	233.6	274.6	301.7	25.2	12.1	18.6	30.4	6.3	1.6	2.5	6.8	1.5	234.5	275.1	302.0	25.2	11.5	17.8	29.1	6.0	0.49	0.88	1.2	0.22	-	-	-	-
(10 Units)	500 Hours	217.4	280.3	306.8	26.3	11.9	19.2	29.8	6.5	1.9	2.5	6.2	1.3	236.7	282.1	319.6	28.1	11.6	18.8	29.3	6.1	0.65	0.87	1.1	0.16	-	-	-	-
	1000 Hours	216.6	282.4	308.9	27.0	12.9	20.3	31.2	6.5	2.2	2.8	4.8	0.74	235.1	280.3	307.3	26.7	12.5	19.8	31.3	6.9	0.32	0.59	0.82	0.18	-	-	-	-
	2000 Hours	233.9	280.6	306.8	27.7	15.0	23.5	34.7	6.8	2.1	3.2	6.1	1.3	231.7	277.0	304.2	27.2	14.2	22.4	33.7	7.0	0.07	0.13	0.28	0.06	+0.9	+3.2	+6.9	1.6
180µF - 25V/15V	0 Hours	147.6	172.6	220.8	21.2	7.2	9.4	14.1	2.2	0.23	0.26	0.30	0.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	151.4	177.5	223.2	21.2	8.2	10.8	15.1	2.1	0.79	0.91	1.00	0.07	151.8	176.2	223.4	21.2	7.9	10.3	14.7	2.2	0.40	0.46	0.63	0.07	-	-	-	-
(10 Units)	500 Hours	153.6	178.9	223.4	19.9	7.8	10.5	14.8	2.6	1.2	1.3	1.5	0.10	157.9	179.0	224.8	20.7	7.8	10.4	14.9	2.3	0.69	0.74	0.77	0.02	-	-	-	-
	1000 Hours	153.7	179.1	223.6	20.2	8.0	10.9	15.7	2.5	2.0	2.2	2.4	0.10	156.7	179.6	224.3	20.0	8.3	11.1	15.9	2.4	0.50	0.55	0.61	0.05	-	-	-	-
	2000 Hours	158.5	179.8	223.9	20.3	9.3	14.5	22.7	4.0	1.4	1.6	2.2	0.3	150.7	177.8	223.4	21.0	9.5	14.6	27.9	6.0	0.12	0.15	0.21	0.03	+0.6	+3.0	+5.0	1.4
60µF - 50V/30V	0 Hours	56.33	61.03	64.54	2.4	3.1	4.1	5.3	0.6	0.11	0.15	0.48	0.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	56.95	61.32	64.67	2.28	3.3	4.7	6.9	1.1	1.0	2.0	4.9	1.1	57.06	61.62	64.97	2.31	3.3	4.3	5.8	0.7	0.10	0.19	0.46	0.13	-	-	-	-
(10 Units)	500 Hours	57.06	61.47	64.78	2.26	3.1	4.4	6.1	0.8	0.36	0.54	0.95	0.18	57.40	61.83	65.18	2.27	3.4	4.9	7.7	1.3	0.24	0.26	0.29	0.018	-	-	-	-
	1000 Hours	57.23	61.66	64.96	2.22	3.3	5.0	8.1	1.4	0.34	0.48	0.79	0.14	57.53	62.01	65.35	2.24	3.6	5.1	7.2	1.2	0.11	0.27	1.7	0.50	-	-	-	-
	2000 Hours	57.25	61.86	65.16	2.24	4.0	6.4	8.4	1.4	0.47	0.82	1.3	0.25	57.37	62.16	65.52	2.28	4.2	6.5	8.8	1.6	0.024	0.16	1.2	0.36	+0.2	+1.8	+3.1	0.9
30µF - 100V/65V	0 Hours	32.31	33.80	35.74	1.0	2.0	2.4	2.9	0.24	0.11	0.41	2.6	0.84	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	32.31	33.63	35.63	1.0	2.0	2.5	3.0	0.24	0.52	0.83	1.2	0.19	32.53	33.91	36.04	1.05	2.3	2.5	3.0	0.2	0.10	0.17	0.36	0.09	-	-	-	-
(10 Units)	500 Hours	32.27	33.60	35.65	1.0	2.1	2.5	3.9	0.5	0.42	0.66	1.3	0.25	32.71	34.01	36.02	1.00	2.3	2.7	3.5	0.4	0.10	0.10	0.11	0.01	-	-	-	-
	1000 Hours	32.36	33.66	35.64	1.0	2.1	2.4	2.7	0.2	0.47	0.64	0.87	0.14	32.74	34.01	36.02	1.00	2.4	2.6	3.0	0.2	0.066	0.22	1.4	0.41	-	-	-	-
	2000 Hours	32.51	34.54	39.36	2.0	2.5	4.5	12.7	3.2	0.53	0.98	3.4	0.86	32.76	34.01	35.95	0.97	2.6	3.6	11.2	2.7	0.022	0.054	0.093	0.024	-0.1	+0.6	+1.4	0.4

σ = Standard Deviation.

in Tables XIX - XXII. In general the 5 volt cathode formations proved to be satisfactory and the 3 volt cathode formations to be marginal for the required 2 volt reverse capability.

A summary of all the Engineering Evaluation Testing is given in Table XXIII.

During August 1975 reports were received from NASA that several capacitors were showing excessive capacitance loss during ripple voltage testing. Evaluation of the data indicated that this behavior was probably dependent upon initial cathode capacitance. A higher cathode capacitance appears to be required than is necessary only to support the anode capacitance to obtain the desired total initial capacitance. Hence, 60μF - 50 volt capacitors with extended cathode capacitances adequate to cope with the ripple current encountered in the testing were constructed for retesting to confirm that low cathode capacitance was the problem. Ten of these 60μF - 50 volt units to replace the ten units showing excessive capacitor change on ripple test were shipped to NASA for the retest during November 1975.

Analysis of two capacitors of each rating (250μF - 10 V, 180μF - 25 V, 60μF - 50 V and 30μF - 100 V) failing the

TABLE XIX

ENGINEERING EVALUATION TEST
2 VOLT REVERSE BIAS AT 25°C
3 VOLT CATHODE FORMATION

Rating	Time on Test	Post Test Readouts: Cap (µF) Low	Cap (µF) Avg.	Cap (µF) High	Cap (µF) σ	DF (%) Low	DF (%) Avg.	DF (%) High	DF (%) σ	25°C DCL (µA) Low	25°C DCL (µA) Avg.	25°C DCL (µA) High	25°C DCL (µA) σ	Post 16 Hours Stability Reage at 85°C Rated Voltage: Cap (µF) Low	Cap (µF) Avg.	Cap (µF) High	Cap (µF) σ	DF (%) Low	DF (%) Avg.	DF (%) High	DF (%) σ	25°C DCL (µA) Low	25°C DCL (µA) Avg.	25°C DCL (µA) High	25°C DCL (µA) σ	% ΔCap Low	% ΔCap Avg.	% ΔCap High	% ΔCap σ
250µF - 10V	0 Hours	231.3	259.6	281.6	15.0	9.4	10.9	12.5	0.9	0.10	0.12	0.15	0.016	-	-	-	-	-	-	-	-	-	-	-	-				
T3 Case	250 Hours	231.5	260.3	282.3	15.2	8.8	10.3	12.2	0.9	0.21	0.25	0.31	0.033	231.7	259.7	281.3	14.1	9.0	10.6	12.5	1.0	0.24	0.28	0.33	0.030	-	-	-	-
(10 Units)	500 Hours	231.1	259.8	280.4	14.9	9.4	10.7	11.6	0.7	0.15	0.22	0.34	0.063	231.5	259.9	281.4	15.1	9.3	10.9	12.8	1.0	0.040	0.050	0.072	0.011	-	-	-	-
	1000 Hours	231.0	259.2	281.1	15.2	9.1	10.8	12.7	1.0	0.19	0.20	0.22	0.008	231.8	260.3	281.7	14.9	9.3	10.7	12.7	0.9	0.047	0.011	0.21	0.062	-	-	-	-
	2000 Hours	230.8	259.3	280.5	15.1	9.2	10.5	12.4	0.9	0.11	0.16	0.21	0.037	231.1	259.1	280.9	15.1	9.6	10.9	12.6	0.9	0.12	0.14	0.18	0.021	+0.04	-0.14	-0.36	0.21
180µF - 25V	0 Hours	170.8	198.7	217.8	14.1	7.3	13.8	20.5	3.8	0.14	0.24	0.45	0.09	-	-	-	-	-	-	-	-	-	-	-	-				
T3 Case	250 Hours	159.8	192.9	207.9	18.3	6.7	11.0	15.5	2.6	0.34	0.42	0.52	0.06	156.6	191.8	206.7	19.3	7.0	11.3	14.2	2.5	0.19	0.32	0.52	0.13	-	-	-	-
(10 Units)	500 Hours	158.6	192.0	206.3	18.0	7.1	12.0	18.3	3.1	0.15	0.37	0.56	0.10	156.7	191.7	207.2	19.4	7.4	11.7	14.5	2.4	0.029	0.10	0.35	0.10	-	-	-	-
	1000 Hours	155.3	190.6	206.1	19.5	7.3	11.8	14.6	2.4	0.25	0.36	0.50	0.08	155.7	191.4	207.2	19.5	7.6	11.7	14.4	2.4	0.11	0.23	0.65	0.16	-	-	-	-
	2000 Hours	158.8	194.2	207.7	15.4	7.2	13.3	33.1	7.3	0.32	0.55	1.5	0.36	154.5	189.5	204.9	19.4	7.6	11.7	14.8	2.3	0.19	0.26	0.51	0.09	-0.5	-4.8	-12.0	4.6
60µF - 50V	0 Hours	66.60	69.74	71.92	1.81	3.7	4.4	5.6	0.6	0.055	0.096	0.36	0.093	-	-	-	-	-	-	-	-	-	-	-	-				
T3 Case	250 Hours	66.58	69.84	72.43	1.89	3.4	4.0	5.2	0.6	0.11	0.15	0.19	0.03	66.55	69.81	72.37	1.89	3.6	4.2	5.4	0.6	0.052	0.060	0.066	0.005	-	-	-	-
(10 Units)	500 Hours	66.42	69.68	72.26	1.89	3.6	4.3	5.6	0.6	0.11	0.15	0.20	0.03	66.66	69.89	72.50	1.89	3.7	4.3	5.6	0.6	0.026	0.034	0.059	0.009	-	-	-	-
	1000 Hours	66.43	69.69	72.26	1.90	3.7	4.3	5.6	0.6	0.16	0.32	0.65	0.17	66.56	69.87	72.50	1.92	3.7	4.3	5.6	0.6	0.012	0.035	0.082	0.027	-	-	-	-
	2000 Hours	66.05	69.72	72.25	1.96	3.6	4.2	5.4	0.6	0.082	0.20	0.65	0.19	66.33	69.67	72.20	1.92	3.6	4.3	5.6	0.6	0.058	0.077	0.098	0.013	-0.07	-0.10	-0.41	0.22
30µF - 100V	0 Hours	30.75	31.42	32.03	0.51	1.8	2.2	2.7	0.26	0.052	0.066	0.085	0.010	-	-	-	-	-	-	-	-	-	-	-	-				
T3 Case	250 Hours	30.74	31.44	32.06	0.50	1.6	2.0	2.4	0.20	0.14	0.20	0.25	0.035	30.78	31.42	32.02	0.49	1.7	2.1	2.6	0.26	0.060	0.079	0.15	0.026	-	-	-	-
(10 Units)	500 Hours	30.75	31.32	31.91	0.50	1.7	2.2	2.6	0.25	0.15	0.21	0.31	0.045	30.89	31.52	32.12	0.50	1.8	2.2	2.7	0.26	0.026	0.061	0.22	0.058	-	-	-	-
	1000 Hours	30.74	31.27	31.88	0.48	1.6	2.2	2.8	0.30	0.23	0.34	0.45	0.070	30.86	31.49	32.14	0.49	1.8	2.2	2.8	0.27	0.02	0.060	0.17	0.052	-	-	-	-
	2000 Hours	30.69	31.34	31.93	0.50	1.7	2.1	2.6	0.27	0.15	0.22	0.40	0.073	30.69	31.36	31.97	0.51	1.7	2.1	2.6	0.24	0.11	0.16	0.30	0.056	-0.06	-0.18	-0.28	0.07

σ = Standard Deviation.

TABLE XX

ENGINEERING EVALUATION TEST
2 VOLT REVERSE BIAS AT 85°C
3 VOLT CATHODE FORMATION

Rating	Time on Test	Post Test Readouts: Cap (µF) Low	Avg.	High	σ	DF (%) Low	Avg.	High	σ	25°C DCL (µA) Low	Avg.	High	σ	Post 16 Hour Stability Reage at 85°C Rated Voltage: Cap (µF) Low	Avg.	High	σ	DF (%) Low	Avg.	High	σ	25°C DCL (µA) Low	Avg.	High	σ	% ΔCap Low	Avg.	High	σ
250µF - 10V	0 Hours	241.0	261.2	277.6	11.8	8.6	11.8	15.4	1.7	0.11	0.12	0.14	0.01	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	247.1	284.1	321.8	27.3	11.4	14.3	16.5	1.9	1.1	3.0	4.8	1.4	238.2	258.1	275.5	13.0	8.2	11.3	14.9	1.7	0.20	0.22	0.24	0.01	-	-	-	-
(10 Units)	500 Hours	236.1	270.3	316.4	30.9	8.9	13.1	16.2	2.7	0.4	1.4	3.5	1.3	234.7	255.9	274.8	13.7	8.3	11.4	15.1	1.8	0.02	0.035	0.051	0.011	-	-	-	-
	1000 Hours	228.3	253.9	276.6	16.5	8.2	12.4	15.5	2.3	0.2	3.6	9.2	2.6	228.2	251.6	270.9	15.0	8.0	11.8	15.5	2.2	0.013	0.51	1.8	0.71	-	-	-	-
	2000 Hours	226.3	263.8	343.7	41.2	8.5	14.2	24.5	5.3	0.19	1.1	3.9	1.5	222.2	246.8	266.4	15.1	8.3	11.6	16.0	2.0	0.10	0.12	0.15	0.017	-1.8	-5.5	-7.6	1.9
180µF - 25V	0 Hours	176.5	200.2	221.7	13.3	10.3	13.7	21.8	3.4	0.16	0.22	0.32	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	161.3	214.5	244.6	30.2	8.2	15.2	19.1	3.3	0.55	1.6	2.4	0.72	161.1	193.2	220.2	17.7	8.2	11.5	15.8	2.3	0.12	0.22	0.40	0.10	-	-	-	-
(10 Units)	500 Hours	159.1	223.0	252.3	34.9	8.3	16.1	24.8	4.6	0.41	1.4	2.2	0.65	159.3	192.6	219.5	18.4	8.6	11.4	16.1	2.6	0.013	0.040	0.091	0.025	-	-	-	-
	1000 Hours	158.9	190.6	216.5	17.2	8.4	11.6	16.5	2.7	0.48	1.9	3.2	0.94	160.2	191.4	217.0	17.3	8.6	11.2	15.4	2.4	0.10	0.15	0.22	0.047	-	-	-	-
	2000 Hours	160.9	224.4	276.5	41.0	8.4	16.2	22.5	4.6	0.51	2.0	3.6	1.3	158.3	188.4	212.9	16.2	8.6	11.4	15.7	2.5	0.15	0.20	0.25	0.028	-2.2	-8.9	-11.7	3.6
60µF - 50V	0 Hours	60.96	70.63	71.89	3.3	3.6	4.3	5.2	0.6	0.037	0.11	0.57	0.16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	61.60	70.57	73.06	3.3	4.3	5.0	5.9	0.6	2.5	3.5	6.8	1.2	61.67	70.31	76.28	3.69	3.4	4.1	4.9	0.6	0.049	0.11	0.32	0.10	-	-	-	-
(10 Units)	500 Hours	61.23	70.34	73.36	3.4	4.3	5.0	5.9	0.6	2.0	3.0	5.2	0.8	61.61	69.90	73.06	3.14	3.5	4.2	5.0	0.6	0.021	0.047	0.21	0.058	-	-	-	-
	1000 Hours	61.09	69.44	73.57	3.3	3.5	4.2	5.2	0.7	3.2	3.9	6.0	0.8	61.31	69.80	73.58	3.26	3.5	4.1	4.8	0.6	0.014	0.037	0.093	0.024	-	-	-	-
	2000 Hours	62.07	70.95	74.29	3.4	4.7	5.6	6.6	0.7	3.5	4.6	7.3	1.2	59.83	69.02	72.11	3.44	3.5	4.1	4.9	0.6	0.038	0.11	0.31	0.094	-0.5	-1.5	-2.4	0.6
30µF - 100V	0 Hours	30.93	31.74	32.37	0.38	2.0	2.3	2.8	0.25	0.050	0.18	0.78	0.26	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	31.30	32.11	32.66	0.39	2.6	3.0	3.8	0.37	0.80	1.5	5.0	1.3	30.88	31.61	31.88	0.31	1.8	2.2	2.7	0.25	0.042	0.23	1.0	0.32	-	-	-	-
(10 Units)	500 Hours	30.88	31.90	32.97	0.59	2.7	3.6	9.7	2.1	0.65	2.9	15.0	4.5	30.96	31.74	32.40	0.39	2.0	2.3	2.9	0.28	0.015	0.17	1.1	0.34	-	-	-	-
	1000 Hours	30.60	31.36	31.98	0.37	1.8	2.2	2.7	0.26	0.80	1.5	2.4	0.58	30.40	30.54	32.33	1.89	1.8	2.3	2.9	0.32	0.012	0.21	1.3	0.39	-	-	-	-
	2000 Hours	31.14	32.04	33.31	0.77	1.8	3.0	4.0	0.68	0.35	2.0	8.3	2.4	30.68	31.45	32.17	0.39	1.9	2.2	2.6	0.24	0.065	0.83	4.2	1.29	-0.62	-1.24	-4.03	1.0

σ = Standard Deviation.

TABLE XXI

ENGINEERING EVALUATION TEST
2 VOLT REVERSE BIAS AT 25°C
5 VOLT CATHODE FORMATION

Rating	Time on Test	Post Test Readouts: Cap (µF) Low	Avg.	High	σ	DF (%) Low	Avg.	High	σ	25°C DCL (µA) Low	Avg.	High	σ	Post 16 Hour Stability Reage at 85°C Rated Voltage: Cap (µF) Low	Avg.	High	σ	DF (%) Low	Avg.	High	σ	25°C DCL (µA) Low	Avg.	High	σ	% ΔCap Low	Avg.	High	σ
250µF - 10V	0 Hours	211.6	244.5	274.1	22.0	9.5	12.5	20.8	3.1	0.11	0.14	0.19	0.024	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	215.2	246.7	275.7	21.6	9.2	11.9	19.9	3.0	0.21	0.27	0.45	0.066	212.1	244.6	274.5	22.2	9.1	12.1	20.2	3.1	0.26	0.30	0.37	0.035	-	-	-	-
(10 Units)	500 Hours	213.1	245.9	274.4	21.8	9.6	12.5	20.7	3.1	0.20	0.33	1.2	0.31	213.3	245.6	275.5	22.3	9.4	12.5	20.7	3.1	0.040	0.059	0.11	0.02	-	-	-	-
	1000 Hours	211.1	239.8	263.8	20.0	9.3	12.4	20.3	3.1	0.18	0.23	0.31	0.035	212.6	244.8	274.6	21.9	9.5	12.5	20.3	3.0	0.016	0.10	0.25	0.081	-	-	-	-
	2000 Hours	213.7	246.4	274.7	21.7	9.2	12.1	20.1	3.0	0.15	0.18	0.25	0.039	210.3	243.9	273.8	22.5	9.5	12.4	20.5	3.1	0.12	0.16	0.21	0.032	+0.04	-0.26	+0.64	0.27
180µF - 25V	0 Hours	169.9	196.3	214.7	17.3	9.6	11.9	18.4	3.0	0.13	0.19	0.22	0.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	168.7	190.7	209.7	19.7	7.0	8.9	11.6	1.5	0.33	0.40	0.48	0.04	154.3	189.0	209.3	21.1	7.2	9.5	12.8	1.8	0.21	0.27	0.32	0.03	-	-	-	-
(10 Units)	500 Hours	156.5	189.9	209.6	20.4	7.7	9.9	13.4	1.9	0.30	0.39	0.47	0.04	154.7	189.2	209.3	21.0	7.6	9.9	12.8	1.8	0.032	0.066	0.12	0.03	-	-	-	-
	1000 Hours	153.9	188.2	208.9	21.2	7.6	9.8	13.0	1.7	0.22	0.42	1.6	0.42	154.5	188.1	209.0	20.9	7.5	9.8	13.0	1.8	0.039	0.12	0.16	0.038	-	-	-	-
	2000 Hours	124.3	181.8	207.7	28.4	7.1	9.4	12.9	1.9	0.28	0.16	0.42	0.038	153.0	186.9	207.6	21.3	7.8	9.7	12.8	1.7	0.18	0.20	0.28	0.020	-1.1	-6.9	-9.9	3.3
60µF - 50V	0 Hours	57.31	61.04	66.95	2.60	3.4	3.7	4.1	0.2	0.041	0.070	0.15	0.04	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	57.27	61.05	66.93	2.60	3.1	3.5	3.9	0.3	0.10	0.16	0.26	0.05	57.30	61.02	66.96	2.62	3.2	3.7	4.0	0.2	0.042	0.21	1.6	0.49	-	-	-	-
(10 Units)	500 Hours	57.23	60.97	66.93	2.63	3.3	3.7	4.1	0.3	0.072	0.21	0.83	0.21	57.45	60.56	63.09	1.60	3.4	3.8	4.1	0.2	0.019	0.057	0.34	0.10	-	-	-	-
	1000 Hours	57.27	60.99	66.92	2.62	3.4	3.8	4.1	0.2	0.10	0.52	3.1	0.93	57.41	61.10	67.10	2.63	3.4	3.8	4.1	0.3	0.015	0.051	0.19	0.051	-	-	-	-
	2000 Hours	57.38	61.04	67.04	2.63	3.2	3.6	4.0	0.3	0.051	0.23	0.80	0.22	57.09	60.93	66.87	2.65	3.3	3.7	4.0	0.3	0.018	0.090	0.21	0.061	0.0	-0.18	-0.49	0.16
30µF - 100V	0 Hours	31.54	34.12	35.55	1.26	2.1	2.4	3.1	0.3	0.023	0.097	0.43	0.12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	31.52	34.01	35.43	1.24	1.9	2.2	2.8	0.25	0.12	0.29	0.95	0.26	31.54	34.07	35.54	1.24	2.1	2.3	2.9	0.25	0.048	0.13	0.61	0.17	-	-	-	-
(10 Units)	500 Hours	31.47	34.00	35.41	1.26	2.0	2.3	2.9	0.27	0.11	0.61	3.8	1.14	31.57	34.18	35.62	1.28	2.1	2.4	3.0	0.26	0.018	0.042	0.12	0.033	-	-	-	-
	1000 Hours	31.44	34.02	35.49	1.27	2.0	2.4	2.9	0.27	0.14	0.36	0.73	0.21	31.65	34.20	35.65	1.26	2.0	2.4	3.0	0.29	0.015	0.033	0.063	0.016	-	-	-	-
	2000 Hours	31.50	33.98	35.44	1.25	2.0	2.2	2.9	0.29	0.15	0.22	0.30	0.052	31.41	33.99	35.46	1.28	2.0	2.3	2.9	0.28	0.11	0.14	0.21	0.021	-0.25	-0.37	-0.76	0.16

σ = Standard Deviation.

TABLE XXII

ENGINEERING EVALUATION TEST
2 VOLT REVERSE BIAS AT 125°C
5 VOLT CATHODE FORMATION

Rating	Time on Test	Post Test Readouts: Cap (µF) Low	Avg.	High	σ	DF (%) Low	Avg.	High	σ	25°C DCL (µA) Low	Avg.	High	σ	Post 16 Hour Stability Reage at 85°C Rated Voltage: Cap (µF) Low	Avg.	High	σ	DF (%) Low	Avg.	High	σ	25°C DCL (µA) Low	Avg.	High	σ	% ΔCap Low	Avg.	High	σ
250µF - 10V/7V	0 Hours	201.7	232.5	273.8	22.3	9.8	13.6	20.0	3.0	0.11	0.14	0.19	0.027	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	235.6	305.6	387.9	56.6	14.4	25.6	31.5	6.2	3.8	6.1	8.5	1.4	211.0	240.2	280.2	22.6	9.9	13.4	20.3	3.0	0.29	0.41	0.48	0.062	-	-	-	-
(10 Units)	500 Hours	223.1	277.8	364.9	48.4	11.2	21.6	29.2	6.9	0.68	2.0	3.8	0.94	208.7	238.0	276.5	22.1	10.2	14.0	21.2	3.2	0.015	0.042	0.21	0.059	-	-	-	-
	1000 Hours	198.9	233.8	270.5	35.9	10.2	15.2	22.6	3.8	0.58	1.5	3.8	0.97	200.6	233.6	270.1	23.8	9.8	14.7	22.7	3.7	0.10	0.59	1.5	0.38	-	-	-	-
	2000 Hours	195.2	233.9	286.4	30.4	10.7	20.2	35.1	7.8	0.50	0.88	3.0	0.76	192.6	223.6	263.7	24.3	10.1	15.5	27.9	5.1	0.25	0.28	0.35	0.031	+1.0	-2.0	-6.9	3.7
180µF - 25V/15V	0 Hours	190.7	205.8	222.3	8.9	9.0	12.9	16.6	2.8	0.12	0.18	0.22	0.03	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	207.4	335.6	377.6	59.9	13.7	33.9	40.1	8.1	3.0	7.0	8.3	1.7	186.1	202.5	216.9	8.1	7.7	10.7	14.2	2.5	0.15	0.30	0.84	0.20	-	-	-	-
(10 Units)	500 Hours	200.9	281.0	360.7	54.9	10.6	31.8	42.7	12.5	1.2	3.8	5.2	1.4	188.0	200.7	210.3	6.6	8.0	11.3	15.0	2.5	0.014	0.074	0.16	0.54	-	-	-	-
	1000 Hours	193.6	220.4	256.3	19.8	10.1	15.8	21.2	4.5	1.4	3.9	5.9	1.9	185.6	200.6	213.8	8.0	7.8	11.3	15.1	2.5	0.12	0.18	0.39	0.083	-	-	-	-
	2000 Hours	194.5	249.8	335.6	62.1	9.2	20.6	36.9	11.9	1.1	3.0	5.8	2.0	182.3	196.0	208.7	7.8	7.6	11.2	15.6	2.5	0.33	0.40	0.45	0.040	-0.9	-4.8	-6.7	1.7
60µF - 50V/30V	0 Hours	57.82	62.78	69.97	3.84	3.1	3.4	3.8	0.3	0.042	0.054	0.083	0.011	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	60.84	66.27	73.14	4.19	6.0	8.4	9.6	1.4	6.8	8.2	9.6	0.9	58.26	63.38	70.42	3.84	2.9	3.5	6.0	0.9	0.031	0.089	0.48	0.14	-	-	-	-
(10 Units)	500 Hours	59.33	68.49	88.18	8.13	4.0	7.9	10.8	2.1	2.6	4.2	5.3	1.0	58.48	63.73	70.42	3.85	3.0	3.9	8.2	1.5	0.021	0.034	0.050	0.009	-	-	-	-
	1000 Hours	58.60	64.16	70.53	4.04	3.1	5.3	13.0	2.8	2.0	5.6	9.2	2.2	58.18	63.87	70.68	4.16	3.1	4.3	11.7	2.6	0.012	0.093	0.63	0.19	-	-	-	-
	2000 Hours	58.18	67.62	78.99	6.38	3.5	11.7	18.4	5.5	3.1	7.5	15.0	4.2	57.54	62.84	70.14	4.01	2.9	3.3	3.7	0.3	0.11	0.42	2.1	0.61	-0.06	+0.02	-0.83	0.46
30µF - 100V/65V	0 Hours	28.26	33.85	36.47	2.52	2.1	2.6	3.1	0.42	0.041	0.059	0.089	0.015	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T3 Case	250 Hours	28.81	35.31	39.50	3.20	2.3	5.8	9.0	2.7	0.45	1.8	2.8	0.70	28.93	33.94	36.54	2.42	2.0	2.4	3.2	0.46	0.038	0.071	0.21	0.054	-	-	-	-
(10 Units)	500 Hours	28.94	34.29	37.68	2.51	2.1	4.5	9.6	2.7	0.28	1.0	2.0	0.55	29.10	34.09	36.70	2.42	2.1	2.6	3.5	0.50	0.032	0.059	0.16	0.041	-	-	-	-
	1000 Hours	29.48	33.76	36.77	2.35	2.3	3.3	5.1	0.90	0.41	1.6	2.9	0.85	29.85	34.13	36.58	2.26	2.1	2.6	3.6	0.51	0.014	0.19	1.3	0.39	-	-	-	-
	2000 Hours	29.89	33.83	36.32	2.12	2.2	3.0	4.6	0.82	0.45	2.2	7.5	2.4	29.75	33.91	36.43	2.21	2.1	2.6	3.5	0.55	0.11	0.81	3.8	1.24	-0.03	+0.27	+5.3	2.0

σ = Standard Deviation.

TABLE XXIII

ENGINEERING EVALUATION TEST
TEST/SAMPLE PLAN
(UNITS/TEST)

Test Routine	250μF - 10V Test Report No. (R804)	180μF - 25V Test Report No. (R805)	60μF - 50V Test Report No. (R803)	30μF - 100V Test Report No. (R802)
1. Group I				
Voltage Conditioning	90	85	85	90
DC Leakage	90	85	85	90
Capacitance	90	85	85	90
Dissipation Factor	90	85	85	90
2. Group II				
Visual & Mech. (Internal)	2	2	2	2
Visual & Mech. (External)	75	75	75	75
3. Group III				
Shock	3	3	3	3
Vibration	3	3	3	3
Temperature Cycle	3	3	3	3
4. Group IV				
Solderability	3	3	3	3
Terminal Strength	3	3	3	3
Surge	3	3	3	3
Moisture	3	3	3	3
Dielectric Sleeve Test	3	3	3	3
Insulation Sleeve Test	3	3	3	3
Low Temp. Storage	3	3	3	3
Seal	3	3	3	3
5. Group V				
Stab. Low & High Temp.	3	3	3	3
6. Group VI				
Life Test	26	26	26	26
7. 2 Volt Reverse Bias Matrix				
Cathode Formation Voltage				
3.0 Volts (25°C)	10	10	10	10
3.0 Volts (85°C)	10	10	10	10
5.0 Volts (25°C	10	10	10	10
5.0 Volts (125°C)	10	10	10	10
7.0 Volts (85°C)	5	-	-	5
7.0 Volts (125°C)	10	10	10	10

NASA ripple current test for capacitance loss was undertaken and completed in December, 1975. In general it was shown that the capacitance loss was due to an increased thickness in the cathode dielectric oxide layer as is evident by a color change in the cathode lining. A detailed report including colored photographs showing the cathode colors were sent to NASA.

The ten 60μF - 50 V remake capacitors completed 2000 hours of ripple current testing at NASA by April 1976. The test data are reported in Table XXIV for the electrical parameters of capacitance, dissipation factor and room temperature DC leakage as well as capacitance stability. The test conditions are stated in the parameter data summary table.

It will be noted that all capacitors experienced some capacitance loss over the test interval, however, with the maximum loss being -6.6%. With the original units the maximum capacitance loss was -42%. The failure mode here was apparently eliminated via the extended cathode surface area.

TABLE XXIV

[1]RIPPLE CURRENT TEST ON REMAKE UNITS
60μF - 50 V, "T" CASE SIZE
EXTENDED CATHODE AREA

	0 Hour			1000 Hours			2000 Hours		
	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High
Cap (MFD)	56.8	61.3	64.2	54.6	58.2	61.4	54.7	58.5	61.6
ΔCap (%)	-	-	-	-3.5	-5.0	-7.1	-3.1	-4.5	-6.6
DF (%)	[2]0.2	1.7	9.7	2.0	3.0	4.0	3.5	4.2	7.2
25°C DCL (μA)	0.7	1.0	2.0	[3]-	-	-	0.8	1.1	1.7

[1]Test Conditions: 1st 1000 Hours at 1/2 AMP RMS Each Unit
2nd 1000 Hours at 1/3 AMP RMS Each Unit

[2]DF Values Measured at Sprague Prior to Shipping Units:
Low = 3.1%, Avg. = 3.4%, High = 4.4%

[3]DC Leakage Values for this Readout were not Obtained from NASA.

The initial DF values reported at NASA seem to be out-of-line with the values measured at Sprague prior to shipping the units. The 2000 hour DF values are much more reasonable when one compares them with the Sprague initial values.

C. Qualification Test Phase

Initial processing of the Qualification Test Phase capacitor parts began in June 1974. During the next 3 - 4 months the development of the hermeticity problem and the unavailability of materials resulted in a prolonged period of inactivity in this phase.

By December 1974 approximately 75% of the qualification test units had been processed to the point preceding the hermetic seal closure. Once again the hermeticity problem delayed further progress on these units for a couple of months. However, by April 1975, 594 test capacitors had been delivered to the Sprague test facility for commencement of this test phase.

During May 1975 the qualification testing had proceeded as follows:

Group I testing was complete. One unit (60μF - 50 V) was replaced as a result of high DC leakage. 1.

remained within the required 2.0μA range but deviated greatly from the remainder of the units (see Table XXV).

Group II and Group III tests were completed without failure (see Tables XXVI and XXVII respectively).

Group IV had been completed without failure (see Table XXVIII).

Group V had been completed without failure (see Tables XXIX - XXXII for the 10V, 25V, 50V and 100V groups, respectively).

Group VI was scheduled for the 1000 hour readout on 9 June 1975. The 250 hour readout was successfully passed.

Group VII was scheduled for completion about 4 June 1975.

Group VIII was scheduled for the 1000 hour readout on 9 June 1975. The 250 hour readout was successfully passed.

Group IX had been completed without failure (see Table XXXIII).

The Group VII testing was completed during the first week of June 1975. The tests were completed successfully, and in

TABLE XXV

SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP I TEST

Rating	Electrical Parameter	Voltage Conditioning Low	Avg.	High	Visual Inspection
250μF - 10V	Cap (μF)	217.8	267.8	298.0	-
T3 Case	DF (%)	7.0	9.4	13.2	-
(99 Units)	25°C DCL(μA)	0.12	0.24	0.33	-
	No Mechanical Damage	-	-	-	Conforms
	No Electrolyte Leakage	-	-	-	Conforms
180μF - 25V	Cap (μF)	151.3	186.2	212.5	-
T3 Case	DF (%)	6.1	7.3	10.3	-
(99 Units)	25°C DCL (μA)	0.10	0.14	0.20	-
	No Mechanical Damage	-	-	-	Conforms
	No Electrolyte Leakage	-	-	-	Conforms
60μF - 50V	Cap (μF)	51.88	64.62	71.59	-
T3 Case	DF (%)	2.4	3.1	6.1	-
(198 Units)	25°C DCL (μA)	0.010	0.023	0.19	-
	No Mechanical Damage	-	-	-	Conforms
	No Electrolyte Leakage	-	-	-	Conforms
30μF - 100V	Cap (μF)	27.76	30.93	35.39	-
T3 Case	DF (%)	1.9	2.7	5.1	-
(198 Units)	25°C DCL (μA)	0.010	0.022	0.52	-
	No Mechanical Damage	-	-	-	Conforms
	No Electrolyte Leakage	-	-	-	Conforms

TABLE XXVI

SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP II EXAMINATION

Rating	Area of Exam	Visual and Mechanical Examination	
		Internal (1 Unit)	External (98 Units)
250μF - 10V T3 Case	Internal Degradation	Conforms	-
	Dimensions	-	Conforms
	Workmanship	-	Conforms
	Markings	-	Conforms
180μF - 25V T3 Case	Internal Degradation	Conforms	-
	Dimensions	-	Conforms
	Workmanship	-	Conforms
	Markings	-	Conforms
		(2 Units)	(196 Units)
60μF - 50V T3 Case	Internal Degradation	Conforms	-
	Dimensions	-	Conforms
	Workmanship	-	Conforms
	Markings	-	Conforms
30μF - 100V T3 Case	Internal Degradation	Conforms	-
	Dimensions	-	Conforms
	Workmanship	-	Conforms
	Markings	-	Conforms

TABLE XXVII

SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP III TESTS

Rating	Electrical Parameter	Initial			Shock	Vibration	Salt Spray	Temp. Cycling Initial			Temp. Cycling 30 Cycles		
		Low	Avg.	High				Low	Avg.	High	Low	Avg.	High
250µF - 10V	Cap (µF)	248.8	273.6	296.3	-	-	-	247.3	275.4	296.0	247.0	274.6	294.9
T3 Case	ΔCap (%)	-	-	-	-	-	-	-	-	-	0.31	-0.21	1.22
(6 Units)	DF (%)	7.4	9.0	10.4		-	-	7.9	9.1	10.6	7.2	8.9	9.7
	25°C DCL (µA)	0.24	0.30	0.33		-	-	0.30	0.35	0.39	0.38	0.44	0.56
	Legible Marking	-	-	-	-	-	Conforms	-	-	-		-	
	No Opens, Shorts	-	-	-	Conforms	Conforms	-	-	-	-		Conforms	
	No Mechanical Damage	-	-	-	Conforms	Conforms	Conforms	-	-	-		-	
	No Electrolyte Leakage	-	-	-	Conforms	Conforms	-	-	-	-		Conforms	
	Thymol	-	-	-	-	-	-	-	-	-		Conforms	
180µF - 25V	Cap (µF)	162.3	185.1	205.8	-	-	-	161.3	184.2	204.3	160.4	183.8	204.2
T3 Case	ΔCap (%)	-	-	-	-	-	-	-	-	-	-0.05	-0.24	-0.77
(6 Units)	DF (%)	6.2	7.0	7.8	-	-	-	5.8	6.8	7.9	5.3	6.3	6.9
	25°C DCL (µA)	0.16	0.18	0.20	-	-	-	0.20	0.22	0.24	0.21	0.27	0.35
	No Opens, Shorts	-	-	-	Conforms	Conforms	-	-	-	-		Conforms	
	No Mechanical Damage	-	-	-	Conforms	Conforms	Conforms	-	-	-		-	
	No Electrolyte Leakage	-	-	-	Conforms	Conforms	-	-	-	-		Conforms	
	Legible Marking	-	-	-	-	-	Conforms	-	-	-		-	
	Thymol	-	-	-	-	-	-	-	-	-		Conforms	
60µF - 50V	Cap (µF)	61.08	64.47	67.54	-	-	-	60.08	64.34	67.33	60.77	64.28	67.38
T3 Case	ΔCap (%)	-	-	-	-	-	-	-	-	-	0.0	-0.10	-0.24
(12 Units)	DF (%)	2.8	3.3	4.0	-	-	-	2.8	3.2	3.8	2.7	3.0	3.6
	25°C DCL (µA)	0.021	0.033	0.058	-	-	-	0.064	0.084	0.18	0.068	0.099	0.20
	Legible Marking	-	-	-	-	-	Conforms	-	-	-		-	
	No Opens, Shorts	-	-	-	Conforms	Conforms	-	-	-	-		Conforms	
	No Mechanical Damage	-	-	-	Conforms	Conforms	Conforms	-	-	-		-	
	No Electrolyte Leakage	-	-	-	Conforms	Conforms	-	-	-	-		Conforms	
	Thymol	-	-	-	-	-	-	-	-	-		Conforms	
30µF - 100V	Cap (µF)	27.76	30.70	32.11	-	-	-	27.59	30.47	31.83	27.54	30.37	32.79
T3 Case	ΔCap (%)	-	-	-	-	-	-	-	-	-	-0.17	-0.32	-0.50
(12 Units)	DF (%)	2.2	2.8	4.0	-	-	-	2.0	2.4	2.7	1.8	2.2	2.5
	25°C DCL (µA)	0.012	0.018	0.039	-	-	-	0.11	0.14	0.23	0.12	0.20	0.45
	No Opens, Shorts	-	-	-	Conforms	Conforms	-	-	-	-		Conforms	
	No Mechanical Damage	-	-	-	Conforms	Conforms	Conforms	-	-	-		-	
	No Electrolyte Leakage	-	-	-	Conforms	Conforms	-	-	-	-		Conforms	
	Legible Marking	-	-	-	-	-	Conforms	-	-	-		-	
	Thymol	-	-	-	-	-	-	-	-	-		Conforms	

TABLE XXVIII

SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP IV TESTS

Rating	Electrical Parameter	Initial			Terminal Strength			Surge			Moisture Resistance			Sleeve Test		Low Temperature Storage		
		Low	Avg.	High	Solderability	Pull Test	Bend Test	Low	Avg.	High	Low	Avg.	High	Dielectric	Insulation	Low	Avg.	High
250μF - 10V	Cap (μF)	243.1	277.0	295.0	-	-	-	220.8	262.0	287.6	224.4	265.1	290.2	-	-	225.0	265.4	290.6
T3 Case	DF (%)	8.0	8.7	9.5	-	-	-	6.4	7.6	8.3	6.5	7.6	8.3	-	-	6.9	7.9	8.4
(6 Units)	25°C DCL (μA)	0.19	0.24	0.33	-	-	-	0.20	0.24	0.28	0.23	0.29	0.40	-	-	0.14	0.21	0.31
	ΔCap (%)	-	-	-	-	-	-		-		+0.67	+1.23	+1.81	-	-	+0.08	+0.14	+0.46
	Tinning (95%)	-	-	-	Conforms	-	-		-			-		-	-		-	
	Legible Marking	-	-	-	-	-	-		-			Conforms		-	-		-	
	No Mechanical Damage	-	-	-	-	Conforms	Conforms		Conforms			Conforms		-	-		Conforms	
	No Opens, Shorts	-	-	-	-	-	-		Conforms			-		-	-		-	
	No Electrolyte Leakage	-	-	-	-	-	-		Conforms			Conforms		-	-		Conforms	
	No Breakdown	-	-	-	-	-	-		-			-		Conforms	-		-	
	Insulation Resistance ≥100 Megohm	-	-	-	-	-	-		-			-		-	Conforms		-	
180μF - 25V	Cap (μF)	165.7	181.7	192.7	-	-	-	171.8	182.1	192.2	164.6	172.4	183.3	-	-	164.1	171.5	182.6
T3 Case	DF (%)	6.2	7.0	7.8	-	-	-	10.7	12.7	19.3	5.0	6.4	8.2	-	-	4.8	5.9	7.0
(6 Units)	25°C DCL (μA)	0.16	0.18	0.21	-	-	-	0.42	0.48	0.55	0.24	0.32	0.40	-	-	0.13	0.20	0.30
	ΔCap (%)	-		-	-	-	-		-		-0.07	-4.10	-7.54	-	-	-0.23	-0.56	-1.44
	Tinning (95%)	-		-	Conforms	-	-		-			Conforms		-	-		-	
	Legible Marking	-		-	-	-	-		-			Conforms		-	-		-	
	No Mechanical Damage	-	-	-	-	Conforms	Conforms		Conforms			-		-	-		Conforms	
	No Opens, Shorts	-	-	-	-	-	-		Conforms			-		-	-		-	
	No Electrolyte Leakage	-	-	-	-	-	-		Conforms			Conforms		-	-		Conforms	
	No Breakdown	-	-	-	-	-	-		-			-		Conforms	-		-	
	Insulation Resistance ≥100 Megohm	-	-	-	-	-	-		-			-		-	Conforms		-	
60μF - 50V	Cap (μF)	56.51	63.35	68.13	-	-	-	54.33	61.28	65.05	54.64	61.71	65.84	-	-	54.76	61.54	65.66
T3 Case	DF (%)	2.5	3.0	3.6	-	-	-	2.2	2.7	3.3	2.2	2.8	3.8	-	-	2.2	2.8	3.2
(12 Units)	25°C DCL (μA)	0.017	0.023	0.031	-	-	-	0.043	0.063	0.090	0.018	0.077	0.15	-	-	0.052	0.090	0.20
	ΔCap (%)	-	-	-	-	-	-		-		+0.20	+0.69	+1.15	-	-	-0.07	-0.25	-0.90
	Tinning (95%)	-	-	-	Conforms	-	-		-			-		-	-		-	
	Legible Marking	-	-	-	-	-	-		-			Conforms		-	-		-	
	No Mechanical Damage	-	-	-	-	Conforms	Conforms		Conforms			Conforms		-	-		Conforms	
	No Opens, Shorts	-	-	-	-	-	-		Conforms			-		-	-		-	
	No Electrolyte Leakage	-	-	-	-	-	-		Conforms			Conforms		-	-		Conforms	
	No Breakdown	-	-	-	-	-	-		-			-		Conforms	-		-	
	Insulation Resistance ≥100 Megohm	-	-	-	-	-	-		-			-		-	Conforms		-	
30μF - 100V	Cap (μF)	29.61	31.15	33.16	-	-	-	27.94	30.24	32.31	28.15	30.34	32.52	-	-	28.03	30.24	32.46
T3 Case	DF (%)	1.8	2.4	2.8	-	-	-	1.5	1.8	2.1	1.8	2.0	2.8	-	-	1.7	1.9	2.2
(12 Units)	25°C DCL (μA)	0.011	0.056	0.52	-	-	-	0.062	0.10	0.36	0.13	0.18	0.28	-	-	0.11	0.21	0.28
	ΔCap (%)		-	-	-	-	-		-		0.0	+0.31	+1.22	-	-	-0.03	-0.32	-0.79
	Tinning (95%)	-	-	-	Conforms	-	-		-			-		-	-		-	
	Legible Marking	-	-	-	-	-	-		-			Conforms		-	-		-	
	No Mechanical Damage	-	-	-	-	Conforms	Conforms		Conforms			Conforms		-	-		Conforms	
	No Opens, Shorts	-	-	-	-	-	-		Conforms			-		-	-		-	
	No Electrolyte Leakage	-	-	-	-	-	-		Conforms			Conforms		-	-		Conforms	
	No Breakdown	-	-	-	-	-	-		-			-		Conforms	-		-	
	Insulation Resistance ≥100 Megohm	-	-	-	-	-	-		-			-		-	Conforms		-	

TABLE XXIX

SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP V TESTS
250μF - 10V/7V, T3 CASE (6 UNITS)

Electrical Parameter	25°C			-55°C			25°C			85°C		
	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High
Cap (μF)	229.2	252.6	289.4	169.0	191.9	218.6	222.0	250.4	288.5	231.0	261.2	300.0
DF (%)	8.2	8.8	9.6	-	-	-	7.8	8.8	9.5	9.2	9.4	9.6
DCL (μA)	0.19	0.25	0.30	-	-	-	0.15	0.19	0.22	0.64	1.1	1.3
Z (Ω)	-	-	-	5.1	6.4	7.8	-	-	-	-	-	-
ΔCap (%)	-	-	-	-22.7	-24.1	-25.0	-0.31	-0.90	-1.39	+2.97	+3.39	+3.76

	125°C			25°C		
	Low	Avg.	High	Low	Avg.	High
Cap (μF)	241.6	273.5	315.6	221.5	251.9	290.3
DF (%)	7.0	7.4	7.8	7.7	8.3	9.2
DCL (μA)	1.2	2.4	2.9	0.30	0.35	0.39
ΔCap (%)	+7.67	+8.23	+9.05	+0.04	-0.32	-1.25

TABLE XXX

SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP V TESTS
180μF - 25 V/15 V, T3 CASE (6 UNITS)

Electrical Parameter	25°C			-55°C			25°C			85°C		
	Low	Avg.	High	Low	Avg	High	Low	Avg.	High	Low	Avg.	High
Cap (μF)	166.0	180.3	199.3	111.5	135.2	156.0	164.0	178.8	198.1	171.5	185.3	205.0
DF (%)	6.2	7.5	10.3	-	-	-	6.5	7.7	9.4	6.3	6.6	7.5
DCL (μA)	0.14	0.16	0.18	-	-	-	0.15	0.13	0.22	1.1	1.2	1.4
Z (Ω)	-	-	-	10.5	12.3	19.4	-	-	-	-	-	-
ΔCap (%)	-	-	-	-17.9	-24.7	-44.1	-0.34	-0.85	-1.27	+2.11	+2.78	+3.31

	125°C			25°C		
	Low	Avg.	High	Low	Avg.	High
Cap (μF)	177.0	190.2	209.2	164.5	178.5	197.0
DF (%)	6.5	6.8	7.2	5.9	6.9	7.1
DCL (μA)	1.2	1.4	1.6	0.25	0.30	0.38
ΔCap (%)	+4.97	+5.48	+6.63	-0.80	-1.01	-1.16

TABLE XXXI

SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP V TESTS
60μF - 50V/30V, T3 CASE (12 UNITS)

Electrical Parameter	25°C			-55°C			25°C			85°C		
	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High
Cap (μF)	57.57	63.77	69.95	52.55	59.31	64.40	57.45	63.37	69.60	58.84	65.03	71.45
DF (%)	2.6	3.1	3.2	-	-	-	3.4	4.0	4.2	2.6	3.0	3.3
DCL (μA)	0.016	0.038	0.16	-	-	-	0.063	0.12	0.28	0.22	0.32	0.54
Z (Ω)	-	-	-	19	21	25	-	-	-	-	-	-
ΔCap (%)	-	-	-	-5.08	-7.00	-9.20	-0.13	-0.64	-1.98	+1.01	+1.99	+2.86

	125°C			25°C		
	Low	Avg.	High	Low	Avg.	High
Cap (μF)	59.65	66.10	72.65	57.37	63.36	69.61
DF (%)	2.9	3.3	3.6	2.4	2.9	3.0
DCL (μA)	0.32	0.49	0.94	0.061	0.12	0.40
ΔCap (%)	+2.92	+3.65	+4.67	-0.09	-0.66	-2.14

TABLE XXXII

SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP V TESTS
30μF - 100 V/65 V, T3 CASE (12 UNITS)

Electrical Parameter	25°C			-55°C			25°C			85°C		
	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High
Cap (μF)	28.78	30.81	33.28	26.45	28.61	31.25	28.53	30.64	33.10	29.30	31.37	33.90
DF (%)	1.9	2.5	3.1	-	-	-	2.3	2.8	3.2	2.3	2.5	2.7
DCL (μA)	0.010	0.013	0.021	-	-	-	0.082	0.10	0.12	0.61	0.79	0.88
Z (Ω)	-	-	-	42	47	51	-	-	-	-	-	-
ΔCap (%)	-	-	-	-4.35	-7.14	-9.11	-0.20	-0.54	-0.87	+1.51	+1.87	+2.02

	125°C			25°C		
	Low	Avg.	High	Low	Avg.	High
Cap (μF)	29.90	32.04	34.68	28.38	30.50	32.96
DF (%)	3.6	4.1	4.5	1.7	2.1	2.4
DCL (μA)	1.1	1.2	1.4	0.12	0.16	0.29
ΔCap (%)	+3.68	+4.01	+4.30	-0.81	-1.02	-1.39

TABLE XXXIII

SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP IX TESTS

Rating	Electrical Parameter	Initial			Resistance To Solvents			Resistance To Solder Heat			Visual Inspection (2 Units)
		Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	
250µF - 10V	Cap (µF)	217.8	256.3	287.4	215.7	254.9	288.4	215.2	253.3	284.2	-
T3 Case	DF (%)	7.8	9.8	13.2	7.7	8.8	10.8	7.4	9.5	13.4	-
(3 Units)	25°C DCL (µA)	0.20	0.22	0.24	0.30	0.38	0.44	0.21	0.29	0.35	-
	ΔCap (%)	-	-	-		-		-0.12	-0.60	-1.46	-
	No Mechanical Damage	-	-	-		Conforms		-	-	-	-
	Legible Marking	-	-	-		Conforms		-	-	-	-
	Internal Examination	-	-	-		-		-	-	-	Conforms
180µF - 25V	Cap (µF)	151.3	179.9	209.2	149.4	177.7	207.3	149.2	177.8	207.6	-
T3 Case	DF (%)	6.4	6.5	6.6	5.5	5.8	6.0	5.5	5.8	5.9	-
(3 Units)	25°C DCL (µA)	0.11	0.12	0.12	0.35	0.38	0.39	0.32	0.34	0.36	-
	ΔCap (%)	-	-	-		-		+0.11	+0.04	+0.14	-
	No Mechanical Damage	-	-	-		onforms		-	-	-	-
	Legible Marking	-	-	-		Conforms		-	-	-	-
	Internal Examination	-	-	-		-		-	-	-	Conforms
60µF - 50V	Cap (µF)	55.75	62.52	70.89	55.70	62.30	70.75	55.75	62.33	70.77	-
T3 Case	DF (%)	2.6	4.2	2.9	2.4	2.7	3.8	2.4	2.7	3.8	-
(6 Units)	25°C DCL (µA)	0.019	0.024	0.028	0.060	0.068	0.082	0.075	0.094	0.11	-
	ΔCap (%)	-	-	-		-		+0.02	+0.05	+0.15	-
	No Mechanical Damage	-	-	-		Conforms		-	-	-	-
	Legible Marking	-	-	-		Conforms		-	-	-	-
	Internal Examination	-	-	-		-		-	-	-	Conforms
30µF - 100V	Cap (µF)	29.79	31.68	34.52	29.64	31.43	34.30	29.61	31.42	34.29	-
T3 Case	DF (%)	1.3	2.7	3.7	2.0	2.2	2.6	2.0	2.2	2.5	-
(6 Units)	25°C DCL (µA)	0.010	0.013	0.016	0.067	0.090	0.12	0.073	0.11	0.14	-
	ΔCap (%)	-	-	-		-		0.0	-0.03	-0.10	-
	No Mechanical Damage	-	-	-		Conforms		-	-	-	-
	Legible Marking	-	-	-		Conforms		-	-	-	-
	Internal Examination	-	-	-		-		-	-	-	Conforms

addition all 18 Group VII units successfully passed the "for information only" fine leak tests requested by Dr. Holladay of NASA (see Table XXXIV).

By the end of July 1975 the Group VI and Group VIII 2000 hour life tests at 85°C and 125°C, respectively, had completed testing with the final readouts made during August.

The Group VI life tests were completed without failure (see Table XXXV). In the Group VIII life tests conducted at 125°C several capacitance change (increase) failures were encountered in the lower voltage groups (10 and 25 volt units). The 50 and 100 volt units passed satisfactorily (see Table XXXVI). As in the case of the capacitance change problems encountered in the ripple test portion of the Engineering Evaluation Phase, the problem appeared to be due to insufficient initial cathode capacitance. A sufficient number of 250μF - 10V rated capacitors with extended cathode capacitance adequate enough to eliminate the capacitance drift failure mode began construction.

Meanwhile, the life test units which completed the 2000 hour life tests were returned to the Sprague Control Laboratory where the 85°C and 125°C life tests were carried on until a total of 10,000 hours had been reached.

TABLE XXXIV

SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP VII TESTS

Rating	Electrical Parameter	Initial			Vacuum Life Test		
		Low	Avg.	High	Low	Avg.	High
250μF - 10 V	Cap (μF)	230.2	238.4	253.0	232.3	238.7	251.5
T3 Case	DF (%)	8.0	9.4	10.7	7.6	9.5	11.7
(3 Units)	25°C DCL (μA)	0.26	0.28	0.30	0.26	0.68	1.4
	Weight (g)	9.3161	9.4068	9.4625	9.3200	9.4106	9.4661
	ΔCap (%)	-	-	-	+0.42	+0.27	+0.96
	ΔWeight (mg)	-	-	-	0.0036	0.0037	0.0039
180μF - 25 V	Cap (μF)	176.0	189.2	206.3	176.3	190.4	208.3
T3 Case	DF (%)	6.7	6.8	6.9	6.6	6.7	6.8
(3 Units)	25°C DCL (μA)	0.11	0.12	0.12	0.29	0.31	0.33
	Weight (g)	9.1266	9.4776	9.6650	9.1313	9.4820	9.6690
	ΔCap (%)	-	-	-	+0.17	+0.56	+0.97
	ΔWeight (mg)	-	-	-	+0.0040	+0.0044	+0.0047
60μF - 50 V	Cap (μF)	61.60	65.42	70.31	61.96	65.69	70.40
T3 Case	DF (%)	2.8	3.4	4.3	2.8	3.4	4.4
(6 Units)	25°C DCL (μA)	0.016	0.018	0.024	0.11	0.12	0.15
	Weight (g)	9.5576	9.7219	9.8613	9.5608	9.7255	9.8648
	ΔCap (%)	-	-	-	+0.13	+0.43	+1.07
	ΔWeight (mg)	-	-	-	+0.0031	+0.0036	+0.0042
30μF - 100 V	Cap (μF)	29.31	30.81	32.17	29.49	30.94	32.20
T3 Case	DF (%)	2.6	2.9	3.4	2.2	2.5	3.0
(6 Units)	25°C DCL (μA)	0.015	0.018	0.021	0.11	0.14	0.20
	Weight (g)	9.6064	9.8432	10.3840	9.6103	9.8466	10.3864
	ΔCap (%)	-	-	-	+0.09	+0.45	+0.61
	ΔWeight (mg)	-	-	-	+0.0034	+0.0034	+0.0040

TABLE XXXV

SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP VI TESTS

Rating	Electrical Parameter	Initial			85°C Life Test 250 Hours			85°C Life Test 1000 Hours			85°C Life Test 2000 Hours			Visual Inspection
		Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	
250μF - 10V T3 Case (51 Units)	Cap (μF)	218.0	267.3	292.6	-	-	-	-	-	-	220.8	262.6	295.6	-
	DF (%)	7.0	9.5	12.3	-	-	-	-	-	-	6.8	9.2	18.1	-
	25°C DCL (μA)	0.10	0.24	0.32	-	-	-	-	-	-	0.29	0.66	1.0	-
	85°C DCL (μA)	0.22	0.90	1.2	0.22	0.56	4.9	0.28	0.56	0.91	0.35	1.4	2.1	-
	ΔCap (%)	-	-	-	-	-	-	-	-	-	0.0	+0.39	+5.02	-
	No Mechanical Damage	-	-	-	-	-	-	-	-	-	-	-	-	Conforms
	No Electrolyte Leakage	-	-	-	-	-	-	-	-	-	-	-	-	Conforms
	Legible Marking	-	-	-	-	-	-	-	-	-	-	-	-	Conforms
180μF - 25V T3 Case (51 Units)	Cap (μF)	151.4	188.0	212.5	-	-	-	-	-	-	157.1	188.5	212.2	-
	DF (%)	6.4	7.3	8.8	-	-	-	-	-	-	5.7	6.8	8.5	-
	25°C DCL (μA)	0.10	0.14	0.20	-	-	-	-	-	-	0.035	0.085	0.21	-
	85°C DCL (μA)	1.0	1.3	2.0	0.15	0.26	1.9	0.14	0.23	0.84	0.28	0.38	0.80	-
	ΔCap (%)	-	-	-	-	-	-	-	-	-	0.0	+0.32	+1.68	-
	No Mechanical Damage	-	-	-	-	-	-	-	-	-	-	-	-	Conforms
	No Electrolyte Leakage	-	-	-	-	-	-	-	-	-	-	-	-	Conforms
	Legible Marking	-	-	-	-	-	-	-	-	-	-	-	-	Conforms
60μF - 50V T3 Case (102 Units)	Cap (μF)	53.71	65.07	71.59	-	-	-	-	-	-	53.73	65.08	71.29	-
	DF (%)	2.4	3.2	6.1	-	-	-	-	-	-	2.4	3.0	5.9	-
	25°C DCL (μA)	0.010	0.019	0.062	-	-	-	-	-	-	0.011	0.022	0.19	-
	85°C DCL (μA)	0.14	0.24	0.78	0.031	0.097	1.9	0.019	0.039	0.43	0.069	0.12	0.68	-
	ΔCap (%)	-	-	-	-	-	-	-	-	-	0.0	-0.02	+1.51	-
	No Mechanical Damage	-	-	-	-	-	-	-	-	-	-	-	-	Conforms
	No Electrolyte Leakage	-	-	-	-	-	-	-	-	-	-	-	-	Conforms
	Legible Marking	-	-	-	-	-	-	-	-	-	-	-	-	Conforms
30μF - 100V T3 Case (102 Units)	Cap (μF)	27.59	31.11	35.39	-	-	-	-	-	-	27.34	31.00	34.68	-
	DF (%)	2.0	2.7	5.1	-	-	-	-	-	-	1.7	2.2	2.8	-
	25°C DCL (μA)	0.010	0.022	0.20	-	-	-	-	-	-	0.011	0.039	0.91	-
	85°C DCL (μA)	0.32	0.47	1.4	0.12	0.27	3.1	0.10	0.17	0.58	0.19	0.31	2.5	-
	ΔCap (%)	-	-	-	-	-	-	-	-	-	0.0	-0.35	-1.02	-
	No Mechanical Damage	-	-	-	-	-	-	-	-	-	-	-	-	Conforms
	No Electrolyte Leakage	-	-	-	-	-	-	-	-	-	-	-	-	Conforms
	Legible Marking	-	-	-	-	-	-	-	-	-	-	-	-	Conforms

TABLE XXXVI

SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP VIII TESTS

Rating	Electrical Parameter	Initial			125°C Life Test: 250 Hours			1000 Hours			2000 Hours			Sleeve Test		Barometric Pressure
		Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Dielectric	Insulation	
250µF - 10V/7V	Cap (µF)	213.1	272.4	298.0	-	-	-	-	-	-	245.1	286.0	326.0	-	-	-
T3 Case	DF (%)	8.2	9.5	11.3	-	-	-	-	-	-	8.9	10.2	12.0	-	-	-
(20 Units)	25°C DCL (µA)	0.16	0.28	0.21	-	-	-	-	-	-	0.15	0.24	0.69	-	-	-
	125°C DCL (µA)	0.56	3.2	4.8	0.46	1.0	2.2	0.35	0.78	1.2	0.32	0.82	1.5	-	-	-
	ΔCap (%)	-	-	-	-	-	-	-	-	-	+6.15	+9.6	+15.0	-	-	-
	No Mechanical Damage	-	-	-	-	-	-	-	-	-		Conforms		Conforms	Conforms	Conforms
	No Breakdown	-	-	-	-	-	-	-	-	-		-		Conforms	-	Conforms
	Insulation Resistance ≥100 Megohm	-	-	-	-	-	-	-	-	-		-		-	Conforms	-
	No Electrolyte Leakage	-	-	-	-	-	-	-	-	-		Conforms		-	-	Conforms
	Legible Marking	-	-	-	-	-	-	-	-	-		Conforms		-	-	Conforms
250µF - 10V/7V	Cap (µF)	240.5	254.5	281.1	-	-	-	241.3	259.2	284.9	241.8	259.7	284.8	-	-	-
Remake Units	DF (%)	7.4	8.5	11.1	-	-	-	7.7	8.5	10.8	7.5	9.2	11.6	-	-	-
(20 Units)	25°C DCL (µA)	0.018	0.11	0.41	-	-	-	0.15	0.20	0.29	0.19	0.29	0.75	-	-	-
	125°C DCL (µA)	0.22	0.39	1.86	0.12	0.25	0.60	0.13	0.23	0.40	0.052	0.13	0.95	-	-	-
	ΔCap (%)	-	-	-	-	-	-	+1.34	+1.84	+2.42	+1.55	+2.06	+2.82	-	-	-
	No Mechanical Damage	-	-	-	-	-	-	-	-	-		Conforms		-	-	Conforms
	No Breakdown	-	-	-	-	-	-	-	-	-		-		Conforms	-	Conforms
	Insulation Resistance ≥100 Megohm	-	-	-	-	-	-	-	-	-		-		-	Conforms	-
	No Electrolyte Leakage	-	-	-	-	-	-	-	-	-		Conforms		-	-	Conforms
	Legible Marking	-	-	-	-	-	-	-	-	-		Conforms		-	-	Conforms
180µF - 25V/15V	Cap (µF)	149.3	186.2	211.6	-	-	-	-	-	-	165.5	199.4	221.4	-	-	-
T3 Case	DF (%)	6.0	7.2	10.3	-	-	-	-	-	-	6.7	7.5	10.7	-	-	-
(20 Units)	25°C DCL (µA)	0.10	0.12	0.18	-	-	-	-	-	-	0.15	0.31	1.2	-	-	-
	125°C DCL (µA)	1.2	1.7	2.3	0.25	0.40	1.4	0.21	0.32	0.70	0.38	0.48	0.69	-	-	-
	ΔCap (%)	-	-	-	-	-	-	-	-	-	+3.96	+7.22	+10.9	-	-	-
	No Mechanical Damage	-	-	-	-	-	-	-	-	-		Conforms		Conforms	Conforms	Conforms
	No Breakdown or Flashover	-	-	-	-	-	-	-	-	-		-		Conforms	-	Conforms
	Insulation Resistance ≥100 Megohm	-	-	-		-	-	-	-	-		-		-	Conforms	-
	No Electrolyte Leakage					-	-	-				Conforms		-	-	Conforms
	Legible Marking					-	-	-				Conforms		-	-	Conforms

TABLE XXXVI (CONTINUED)

SPECIFICATION MIL-C-39006B, QUALIFICATION INSPECTION - GROUP VIII TESTS

Rating	Electrical Parameter	Initial			125°C Life Test 250 Hours			1000 Hours			2000 Hours			Sleeve Test		Barometric Pressure
		Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Dielectric	Insulation	
60pF - 50V/30V	Cap (pF)	58.09	64.46	69.66	-	-	-	-	-	-	54.95	65.69	71.10	-	-	-
T3 Case	DF (%)	2.5	2.8	4.5	-	-	-	-	-	-	2.4	2.8	4.2	-	-	-
(40 Units)	25°C DCL (μA)	0.011	0.029	0.048	-	-	-	-	-	-	0.028	0.090	0.52	-	-	-
	125°C DCL (μA)	0.28	0.43	0.61	0.041	0.10	0.72	0.038	0.25	0.85	0.10	0.20	1.5	-	-	-
	ΔCap (%)	-	-	-	-	-	-	-	-	-	+0.90	+1.96	+5.92	-	-	-
	No Mechanical Damage	-	-	-	-	-	-	-	-	-	Conforms			-	-	Conforms
	No Breakdown or Flashover	-	-	-	-	-	-	-	-	-	-			Conforms	-	Conforms
	Insulation Resistance ≥100 Megohm		-	-	-	-	-	-	-	-	-			-	Conforms	-
	No Electrolyte Leakage	-	-	-	-	-	-	-	-	-	Conforms			-	-	Conforms
	Legible Marking	-	-	-	-	-	-	-	-	-	Conforms			-	-	Conforms
80pF - 100V/65V	Cap (pF)	27.87	30.51	32.09	-	-	-	-	-	-	29.02	30.82	32.17	-	-	-
T3 Case	DF (%)	2.0	2.8	3.7	-	-	-	-	-	-	1.9	2.4	3.0	-	-	-
(40 Units)	25°C DCL (μA)	0.011	0.018	0.031	-	-	-	-	-	-	0.019	0.20	0.94	-	-	-
	125°C DCL (μA)	0.72	1.1	1.6	0.19	1.1	2.1	1.5	2.7	5.0	0.18	0.80	7.8	-	-	-
	ΔCap (%)	-	-	-	-	-	-	-	-	-	+0.10	+1.05	+4.13	-	-	-
	No Mechanical Damage	-	-	-	-	-	-	-	-	-	Conforms			Conforms	Conforms	Conforms
	No Breakdown or Flashover	-	-	-	-	-	-	-	-	-	-			Conforms	-	Conforms
	Insulation Resistance ≥100 Megohm	-			-	-	-	-	-	-	-			-	Conforms	-
	No Electrolyte Leakage	-					-	-	-	-	Conforms			-	-	Conforms
	Legible Marking	-					-				Conforms			-	-	Conforms

By November 1975 the 250μF - 10 V/7 V, remake units with the extended cathode capacitance were completed and had begun 125°C life testing. The 2000 hour test mark was achieved during April 1976. A comparison of the test data between this group and the original test group of this rating is given in Table XXXVII. It is unequivocally clear that the extended cathode capacitance had stabilized the capacitance parameter during this test. These units were placed back on test to continue to 10,000 hours. By the completion date of this contract these units had achieved 6000 hours of test and exhibited excellent parameter stability. A complete electrical parameter readout was taken at this point and is reported in Table XXXVIII.

A follow-up report to this contract with the summarized 10,000 hour data will be made around March 1977.

The 10,000 hour, 85°C extended life test mark was achieved during September 1976. Complete parameter readouts of capacitance, dissipation factor, 25°C DC leakage and 85°C DC leakage were obtained on each unit. These data are reported in summarized form in Tables XXXIX - XLII along with the calculated values for capacitance change and the standard deviation.

TABLE XXXVII

SPECIFICATION MIL-C-39006B
QUALIFICATION INSPECTION - GROUP VIII TESTS

Rating	Electrical Parameter	Initial			125°C Life Test: 250 Hours			125°C Life Test: 1000 Hours			125°C Life Test: 2000 Hours			Sleeve Test		Barometric Pressure
		Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Low	Avg.	High	Dielectric	Insulation	
250µF - 10V/7V T3 Case (20 Units)	Cap (µF)	213.1	272.4	298.0	-	-	-	-	-	-	245.1	286.0	326.0	-	-	-
	DF (%)	8.2	9.5	11.3	-	-	-	-	-	-	8.9	10.2	12.0	-	-	-
	25°C DCL (µA)	0.16	0.28	0.21	-	-	-	-	-	-	0.15	0.24	0.69	-	-	-
	125°C DCL (µA)	0.56	3.2	4.8	0.46	1.0	2.2	0.35	0.78	1.2	0.32	0.82	1.5	-	-	-
	ΔCap (%)	-	-	-	-	-	-	-	-	-	+6.15	+9.6	+15.0	-	-	-
	No Mechanical Damage	-	-	-	-	-	-	-	-	-	Conforms			Conforms	Conforms	Conforms
	No Breakdown	-	-	-	-	-	-	-	-	-		-		Conforms	-	Conforms
	Insulation Resistance ≥ 100 Megohm	-	-	-	-	-	-	-	-	-		-		-	Conforms	-
	No Electrolyte Leakage	-	-	-	-	-	-	-	-	-	Conforms			-	-	Conforms
	Legible Marking	-	-	-	-	-	-	-	-	-	Conforms			-	-	Conforms
250µF - 10V/7V Remake Units (20 Units)	Cap (µF)	240.5	254.5	281.1	-	-	-	241.3	259.2	284.9	248.8	259.7	284.8	-	-	-
	DF (%)	7.4	8.5	11.1	-	-	-	7.7	8.5	10.8	7.5	9.2	11.6	-	-	-
	25°C DCL (µA)	0.018	0.11	0.44	-	-	-	0.15	0.20	0.29	0.19	0.29	0.75	-	-	-
	125°C DCL (µA)	0.22	0.39	0.86	0.12	0.25	0.60	0.13	0.23	0.40	0.052	0.13	0.95	-	-	-
	ΔCap (%)	-	-	-	-	-	-	+1.34	+1.84	+2.42	+1.55	+2.06	+2.82	-	-	-
	No Mechanical Damage	-	-	-	-	-	-	-	-	-	Conforms			-	-	Conforms
	No Breakdown	-	-	-	-	-	-	-	-	-		-		Conforms	-	Conforms
	Insulation Resistance ≥ 100 Megohm	-	-	-	-	-	-	-	-	-		-		-	Conforms	-
	No Electrolyte Leakage	-	-	-	-	-	-	-	-	-	Conforms			-	-	Conforms
	Legible Marking	-	-	-	-	-	-	-	-	-	Conforms			-	-	Conforms

TABLE XXXVIII

PARAMETER BEHAVIOR ON EXTENDED 125°C LIFE TEST
RATING 250μF - 10V/7V, TEST TEMP. 125°C, TEST VOLTAGE 6 VOLTS (20 UNITS)
(REMAKE UNITS WITH EXTENDED CATHODE CAPACITANCE)

Parameter	Time on Test	Low	Avg.	High	Standard Deviation
Capacitance (μF)	0 Hours	236.6	254.5	281.1	10.2
	2,000 Hours	241.8	259.7	284.8	9.8
	6,000 Hours	244.9	262.5	286.9	9.6
	10,000 Hours				
ΔCapacitance (%)	2,000 Hours	+1.55	+2.06	+2.82	0.33
	6,000 Hours	+1.21	+3.04	+4.44	0.65
	10,000 Hours				
Dissipation Factor (%)	0 Hours	7.4	8.5	11.1	1.1
	2,000 Hours	7.5	9.2	11.6	1.1
	6,000 Hours	7.9	9.1	11.7	1.3
	10,000 Hours				
DC Leakage Current 25°C (μA), 10V	0 Hours	0.018	0.11	0.44	0.11
	2,000 Hours	0.052	0.13	0.95	0.14
	6,000 Hours	0.39	0.50	0.88	0.12
	10,000 Hours				
DC Leakage Current 125°C (μA)	0 Hours	0.22	0.39	0.86	0.19
	250 Hours	0.12	0.25	0.60	0.21
	1,000 Hours	0.13	0.23	0.40	0.07
	2,000 Hours	0.052	0.13	0.95	0.20
	3,000 Hours	0.40	0.77	2.4	0.54
	4,000 Hours	0.17	0.50	2.5	0.48
	6,000 Hours	0.012	0.21	2.2	0.48
	8,000 Hours	0.059	0.27	1.7	0.41
	10,000 Hours				

TABLE XXXIX

PARAMETER BEHAVIOR ON EXTENDED 85°C LIFE TEST
RATING 250μF - 10V, TEST TEMP. 85°C, TEST VOLTAGE 10 VOLTS (51 UNITS)

Parameter	Time on Test	Low	Avg.	High	Standard Deviation
Capacitance (μF)	0 Hours	218.0	267.3	292.6	-
	2,000 Hours	220.8	262.6	295.6	-
	6,000 Hours	224.3	271.8	299.5	-
	10,000 Hours	224.6	275.0	304.1	22.3
ΔCapacitance (%)	2,000 Hours	0.0	+0.39	+5.02	-
	6,000 Hours	0.0	+1.72	+2.82	-
	10,000 Hours	+0.64	+2.91	+4.30	0.71
Dissipation Factor (%)	0 Hours	7.0	9.5	12.3	-
	2,000 Hours	6.8	9.2	18.1	-
	6,000 Hours	5.8	8.6	14.6	-
	10,000 Hours	6.7	9.7	21.1	2.2
DC Leakage Current 25°C (μA)	0 Hours	0.10	0.24	0.32	-
	2,000 Hours	0.29	0.66	1.0	-
	6,000 Hours	0.13	0.24	0.42	-
	10,000 Hours	0.083	0.20	0.88	0.13
DC Leakage Current 85°C (μA)	0 Hours	0.22	0.90	1.2	-
	250 Hours	0.22	0.56	4.9	-
	1,000 Hours	0.28	0.56	0.91	-
	2,000 Hours	0.35	1.4	2.1	-
	3,000 Hours	0.16	0.34	0.60	-
	4,000 Hours	0.16	0.27	0.27	-
	6,000 Hours	0.16	0.50	0.55	-
	8,000 Hours	0.20	0.34	0.58	-
	10,000 Hours	0.035	0.33	1.05	0.14

TABLE XL

PARAMETER BEHAVIOR ON EXTENDED 85°C LIFE TEST
RATING 180μF - 25 V, TEST TEMP. 85°C, TEST VOLTAGE 25 VOLTS (51 UNITS)

Parameter	Time on Test	Low	Avg.	High	Standard Deviation
Capacitance (μF)	0 Hours	151.4	188.0	212.5	-
	2,000 Hours	157.1	188.5	212.2	-
	6,000 Hours	154.2	191.3	215.8	-
	10,000 Hours	159.3	191.4	215.6	14.9
ΔCapacitance (%)	2,000 Hours	0.0	+0.32	+1.68	-
	6,000 Hours	+0.15	+1.81	+4.07	-
	10,000 Hours	+0.84	+1.82	+3.38	0.51
Dissipation Factor (%)	0 Hours	6.4	7.3	8.8	-
	2,000 Hours	5.7	6.8	8.5	-
	6,000 Hours	4.8	6.6	13.0	-
	10,000 Hours	5.3	6.9	8.7	1.1
DC Leakage Current 25°C (μA)	0 Hours	0.10	0.14	0.20	-
	2,000 Hours	0.035	0.085	0.21	-
	6,000 Hours	0.18	0.26	0.40	-
	10,000 Hours	[illegible]	0.12	0.95	0.14
DC Leakage Current 85°C (μA)	0 Hours	1.0	1.3	2.0	-
	250 Hours	0.15	0.26	1.9	-
	1,000 Hours	0.14	0.23	0.84	-
	2,000 Hours	0.28	0.38	0.80	-
	3,000 Hours	0.21	0.30	0.49	-
	4,000 Hours	0.15	0.31	0.60	-
	6,000 Hours	0.18	0.25	0.46	-
	8,000 Hours	0.22	0.29	0.49	-
	10,000 Hours	0.10	0.30	2.4	0.33

TABL XLI

PARAMETER BEHAVIOR ON EXTENDED 85°C LIFE TEST
RATING 60μF - 50V, TEST TEMP. 85°C, TEST VOLTAGE 50 VOLTS (102 UNITS)

Parameter	Time on Test	Low	Avg.	High	Standard Deviation
Capacitance (μF)	0 Hours	53.71	65.07	71.[illegible]9	-
	2,000 Hours	53.73	65.08	71.29	-
	6,000 Hours	54.24	65.46	71.49	-
	10,000 Hours	54.44	65.56	71.35	3.86
ΔCapacitance (%)	2,000 Hours	0.0	±0.21	+1.51	-
	6,000 Hours	+0.1[illegible]	+1.26	+2.56	-
	10,000 Hours	+0.2[illegible]	+0.89	+6.0	0.73
Dissipation Factor (%)	0 Hours	2.4	3.[illegible]	6.1	-
	2,000 Hours	2.4	3.0	5.9	-
	6,000 Hours	2.1	3.0	5.8	-
	10,000 Hours	2.5	3.2	6.2	0.71
DC Leakage Current .5°C (μA)	0 Hours	0.010	0.19	0.062	-
	2,000 Hours	0.011	0.022	0.19	-
	6,000 Hours	0.032	0.060	0.14	-
	10,000 Hours	0.0[illegible]3	0.053	0.45	0.043
DC Leakage Current 85°C (μA)	0 Hours	0.14	0.24	0.78	-
	250 Hours	0.31	0.097	1.9	-
	1,000 Hours	0.019	0.039	0.43	-
	2,000 Hours	0.069	0.12	0.68	-
	3,000 Hours	0.059	0.12	0.60	-
	4,000 Hours	0.024	0.11	0.57	-
	6,000 Hours	0.082	0.082	0.50	-
	8,000 Hours	0.10	0.17	0.61	-
	10,000 Hours	0.053	0.097	0.47	0.056

TABLE XLII

PARAMETER BEHAVIOR ON EXTENDED 85°C LIFE TEST
RATING 30μF - 100V, TEST TEMP. 85°C, TEST VOLTAGE 100 VOLTS (102 UNITS)

Parameter	Time on Test	Low	Avg.	High	Standard Deviation
Capacitance (μF)	0 Hours	27.59	31.11	35.39	-
	2,000 Hours	27.34	31.00	34.68	-
	6,000 Hours	27.62	31.28	35.53	-
	10,000 Hours	27.59	31.32	35.58	1.34
ΔCapacitance (%)	2,000 Hours	0.0	-0.35	-1.02	-
	6,000 Hours	0.0	+0.57	+1.46	-
	10,000 Hours	0.0	+0.63	+1.32	0.40
Dissipation Factor (%)	0 Hours	2.0	2.7	5.1	-
	2,000 Hours	1.7	2.2	2.8	-
	6,000 Hours	1.6	2.3	3.3	-
	10,000 Hours	1.9	2.4	3.1	0.23
DC Leakage Current 25°C (μA)	0 Hours	0.010	0.022	0.20	-
	2,000 Hours	0.011	0.039	0.91	-
	6,000 Hours	0.028	0.052	0.078	-
	10,000 Hours	0.022	0.063	0.20	0.088
DC Leakage Current 85°C (μA)	0 Hours	0.32	0.47	1.4	-
	250 Hours	0.12	0.27	3.1	-
	1,000 Hours	0.10	0.17	0.58	-
	2,000 Hours	0.19	0.31	2.5	-
	3,000 Hours	0.11	0.19	0.50	-
	4,000 Hours	0.17	0.25	0.81	-
	6,000 Hours	0.12	0.17	0.34	-
	8,000 Hours	0.13	0.21	0.88	-
	10,000 Hours	0.15	0.35	9.3	0.91

All capacitors successfully completed this test. However, one unit in the 100 volt group exhibited a hot DC leakage value an order of magnitude higher than the maximum 8,000 hour value. This value was still within the MIL-C-39006/22 specification allowed maximum value.

The 10,000 hour readout for all four ratings on the 125°C extended life test occurred during October 1976. The low, average and high data for the electrical parameters of capacitance, dissipation factor, 25°C DC leakage and 125°C DC leakage for each group has been reported in Tables XLIII - XLVI. Additionally the standard deviation statistic for each parameter has been included.

The three lower voltage groups exhibited failures for excessive capacitance increase at the end of 6,000 hours of test and that every group had a failure for excessive capacitance increase at the end of 10,000 hours of test. The number of capacitors failing decreased with increasing rated potential as indicated below:

Rating	Number of Units with $\%\ \Delta C > 10\%$	
	6,000 Hours	10,000 Hours
250µF - 10 V	18/18	18/18
180µF - 25 V	17/20	20/20
50µF - 50 V	1/40	2/40
30µF - 100 V	0/40	1/40

TABLE LIII

PARAMETER BEHAVIOR ON EXTENDED 125°C LIFE TEST
RATING 250μF - 10V/7V, TEST TEMP. 125°C, TEST VOLTAGE 6 VOLTS (20 UNITS)

Parameter	Time on Test	Low	Avg.	High	Standard Deviation
Capacitance (μF)	0 Hours	213.1	272.4	298.0	-
	2,000 Hours	245.1	286.0	326.0	-
	6,000 Hours	295.0	325.0	352.3	-
	10,000 Hours	268.7	346.4	377.1	24.4
ΔCapacitance (%)	2,000 Hours	+6.15	+9.60	+15.0	-
	6,000 Hours	+11.1	+17.3	+25.7	-
	10,000 Hours	+14.9	+26.2	+37.9	5.8
Dissipation Factor (%)	0 Hours	8.2	9.5	11.3	-
	2,000 Hours	8.9	10.2	12.0	-
	6,000 Hours	9.4	11.0	13.1	-
	10,000 Hours	9.7	12.6	30.1	4.6
DC Leakage Current 25°C (μA), 10V	0 Hours	0.16	0.28	0.21	-
	2,000 Hours	0.15	0.24	0.69	-
	6,000 Hours	0.42	0.58	1.1	-
	10,000 Hours	0.37	0.57	1.1	0.20
DC Leakage Current 25°C (μA)	0 Hours	0.56	3.2	4.8	-
	250 Hours	0.46	1.0	2.2	-
	1,000 Hours	0.35	0.78	1.2	-
	2,000 Hours	0.32	0.82	1.5	-
	3,000 Hours	0.50	0.93	1.5	-
	4,000 Hours	0.19	0.34	0.93	-
	6,000 Hours	0.12	0.50	1.4	-
	8,000 Hours	0.69	1.7	2.1	-
	10,000 Hours	0.35	0.80	1.1	0.18

TABLE XLIV

PARAMETER BEHAVIOR ON EXTENDED 125°C LIFE TEST
RATING 180μF - 25 V/15 V, TEST TEMP. 125°C, TEST VOLTAGE 15 VOLTS (20 UNITS)

Parameter	Time on Test	Low	Avg.	High	Standard Deviation
Capacitance (μF)	0 Hours	149.3	186.2	211.6	-
	2,000 Hours	165.5	199.4	221.4	-
	6,000 Hours	183.4	212.2	234.2	-
	10,000 Hours	194.5	225.9	245.9	14.4
ΔCapacitance (%)	2,000 Hours	+3.96	+7.22	+10.9	-
	6,000 Hours	+6.1	+14.2	+22.8	-
	10,000 Hours	+11.8	+21.4	+31.9	9.0
Dissipation Factor (%)	0 Hours	6.0	7.2	10.3	-
	2,000 Hours	6.7	7.5	10.7	-
	6,000 Hours	6.4	7.9	10.8	-
	10,000 Hours	7.0	8.0	10.8	0.86
DC Leakage Current 25°C (μA), 25 V	0 Hours	0.10	0.12	0.18	-
	2,000 Hours	0.15	0.31	1.2	-
	6,000 Hours	0.35	0.39	0.46	-
	10,000 Hours	0.38	0.48	0.92	0.13
DC Leakage Current 125°C (μA)	0 Hours	1.2	1.7	2.3	-
	250 Hours	0.25	0.40	1.4	-
	1,000 Hours	0.21	0.32	0.70	-
	2,000 Hours	0.38	0.48	0.69	-
	3,000 Hours	0.28	0.48	1.2	-
	4,000 Hours	0.20	0.30	0.69	-
	6,000 Hours	0.20	0.29	0.45	-
	8,000 Hours	0.21	0.25	0.47	-
	10,000 Hours	0.42	0.53	0.69	0.08

TABLE XLV

PARAMETER BEHAVIOR ON EXTENDED 125°C LIFE TEST
RATING 60μF - 50V/30V, TEST TEMP. 125°C, TEST VOLTAGE 50 VOLTS (40 UNITS)

Parameter	Time on Test	Low	Avg.	High	Standard Deviation
Capacitance (μF)	0 Hours	58.09	64.46	69.66	-
	2,000 Hours	54.95	65 69	71.10	-
	6,000 Hours	57.86	67.13	72.63	-
	10,000 Hours	60.03	68.15	73.99	2.92
ΔCapacitance (%)	2,000 Hours	+0.90	+1.96	+5.92	-
	6,000 Hours	-1.21	+4.22	+11.5	-
	10,000 Hours	-1.01	+5.83	+15.7	2.44
Dissipation Factor (%)	0 Hours	2.5	2.8	4.5	-
	2,000 Hours	2.4	2.8	4.2	-
	6,000 Hours	2.5	2.9	4.2	-
	10,000 Hours	2.5	3.0	5.3	0.5
DC Leakage Current 25°C (μA), 50V	0 Hours	0.011	0.029	0.048	-
	2,000 Hours	0.028	0.080	0.52	-
	6,000 Hours	0.11	0.16	0.32	-
	10,000 Hours	0.11	0.19	0.93	0.13
DC Leakage Current 125°C (μA)	0 Hours	0.28	0.43	0.61	-
	250 Hours	0.041	0.10	0.72	-
	1,000 Hours	0.038	0.25	0.85	-
	2,000 Hours	0.10	0.20	1.5	-
	3,000 Hours	0.021	0.19	2.5	-
	4,000 Hours	0.069	0.18	1.9	-
	6,000 Hours	0.034	0.058	0.25	-
	8,000 Hours	0.038	0.13	0.48	-
	10,000 Hours	0.058	0.13	2.0	0.30

TAF E XLVI

PARAMETER BEHAVIOR ON EXTENDED 125°C LIFE TEST
RATING 30μF - 100V/65V, TEST TEMP. 125°C, TEST VOLTAGE 65 VOLTS (40 UNITS)

Parameter	Time on Test	Low	Avg.	High	Standard Deviation
Capacitance (μF)	0 Hours	27.87	30.51	32.09	-
	2,000 Hours	29.02	30.82	32.17	-
	6,000 Hours	29.80	31.41	33.61	-
	10,000 Hours	30.26	31.84	34.16	0.71
ΔCapacitance (%)	2,000 Hours	+0.10	+1.14	+4.13	-
	6,000 Hours	+0.50	+2.97	+8.03	-
	10,000 Hours	+0.98	+4.47	+11.0	2.11
Dissipation Factor (%)	0 Hours	2.0	2.8	3.7	-
	2,000 Hours	1.9	2.4	3.0	-
	6,000 Hours	1.7	2.4	3.1	-
	10,000 Hours	1.7	2.4	3.2	0.3
DC Leakage Current 25°C (μA), 100V	0 Hours	0.011	0.018	0.031	-
	2,000 Hours	0.019	0.20	0.94	-
	6,000 Hours	0.045	0.15	0.68	-
	10,000 Hours	0.10	0.26	0.77	0.18
DC Leakage Current 125°C (μA)	0 Hours	0.72	1.1	1.6	-
	250 Hours	0.19	1.1	2.1	-
	1,000 Hours	1.5	2.7	5.0	-
	2,000 Hours	0.18	0.80	7.8	-
	3,000 Hours	0.14	0.35	1.9	-
	4,000 Hours	0.14	0.24	0.98	-
	6,000 Hours	0.10	0.21	1.0	-
	8,000 Hours	0.18	0.30	0.95	-
	10,000 Hours	0.12	0.26	0.74	0.15

However, it was pointed out earlier in this report that this failure mode was eliminated via the extended cathode surface area as evinced by the remake groups performance through 6,000 hours as outlined in Table XXXVIII.

D. MSFC Meeting

A meeting was held on Wednesday, March 13, 1974 at the Marshall Space Flight Center between representatives of the Sprague Electric Company and NASA. Persons who attended included the following:

Sprague Electric Company	NASA
John L. Moresi	Dr. A. M. Halladay
John P. Moynihan	M. Nowakowski
Francis J. Gamari	Fred Laracuente

The purpose of this meeting was to discuss the progress of this contract and consign several prototype capacitors to NASA for testing. Constructional aspects of the capacitor design and monometallic cathode assemblies were discussed and examined. Electrical parameters of the prototype capacitors were measured by NASA during the meeting. The readings agreed closely with readings taken by the Sprague Electric Company. These preliminary tests indicated that the parts could meet initial Military Specification limits as well as withstanding -2V reverse voltage.

SECTION 4

WORK TO BE PERFORMED DURING THE NEXT REPORT PERIOD

Contract completed.

SECTION 5

EXPENDITURES AND FORECAST

Total contract funds were utilized in performing this contract effort.