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MDC-G8497

AMARV HIGH RELIABILITY
PIECE PART FINAL REPORT

Advanced Maneuvering Reentry Vehicle - (AMaRV) Program

Contract F04701-76-C-0100

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY - HUNTINGTON BEACH
5301 Bolsa Avenue
Huntington Beach, California 92647

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Prepared for

HEADQUARTERS
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Provides an evaluation of the cost effectiveness of the implementation of SAMSO-STD-73-2C, with tailoring on the AMaRV program. Contains historical background on the development of the control documents used for parts management and test. Conclusions drawn from results of the program, lessons learned, and recommendations for future programs are contained in the text. Appendices include parts screening and destructive physical analysis (DPA) summary data.

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FOREWORD

This report has been prepared as a task of the Advanced Maneuvering Reentry Vehicle (AMaRV) Program contract F04701-76-C-0100. AMaRV is being procured by the Advanced Ballistic Reentry Systems (ABRES) Program of the Ballistic Missile Organization (BMO) of the Air Force. The ABRES Program has been recently transferred to BMO from the Space and Missile Systems Organization (SAMSO).

PREFACE

The purpose of this report is to provide civilian program managers and government project officers with a consolidated and candid summary of the lessons learned on one program regarding the planning, procurement, screening and use of high-reliability piece parts procured to SAMSO STD 73-2C. The results discussed in this report deal with the piece part activities on the Advanced Maneuvering Reentry Vehicle (AMaRV) managed by the Maneuvering Vehicle Branch within the Advanced Ballistic Reentry Systems (ABRES) Program Office at Norton AFB, California.

At the start of the AMaRV Program in September 1976, it was realized by BMO (SAMSO at the time) that a marked improvement in electronic piece part reliability was required on the program. The reasons were two-fold, first AMaRV had established performance requirements that would require piece parts to function under environmental conditions (shock, vibration, acceleration and temperature) that exceeded any previous program yet attempted by SAMSO. Second, the fact that only three flight vehicles were being fabricated under the basic program required a high assurance that these expensive vehicles would function during their 30 minute flight time.

In an attempt to provide reliable electronic parts, SAMSO STD 73-2C, dated 2 September 1975 was placed on contract with McDonnell Douglas Astronautics Company. The objective of the standard was to establish "the criteria and minimum requirements for the preparation and implementation of a Parts, Materials, and Processes Control Baord (PMPCB) Program for use during the design, development, fabrication and test" of the AMaRV components.

Although the general intent of the PMPCB Program was established, the implementation was, to say the least, very difficult. Subsequent sections in this report clearly state, I believe, the many unexpected and burdensome problems encountered with the parts program. It is clear that both government and industry do not fully understand the total impact of such high-reliability programs and what effect they can have on cost and schedule. For AMaRV, much of this misunderstanding can be attributed to the fact that the SAMSO STD 73-2C was relatively new and that the AMaRV schedule was structured with minimal time spans between PDR and CDR.

The need for high-reliability electronic piece parts in weapon systems is not going away. We will always have a SAMSO STD 73-2C or equivalent piece part compliance document for space and missile systems, so it is important that their requirements are understood and met, that deliveries are made on schedule and, above all, that they function as planned.

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Norton AFB, California

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MIL-E-8189	Electronic Equipment, Missiles, Boosters, and Allied Vehicles, General Specification For
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MIL-HDBK-217C	Military Standardization Handbook Reliability Prediction of Electronic Equipment

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SAMSO-STD73-2C	Electronic Parts, Materials and Processes for Space and Missile Applications; Standard Control Program For
SAMSO-STD73-4	SAMSO Preferred Parts List
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STC0015	Parts, Materials and Processes Control Program for AMaRV
1B98287	List, Parts and Material Selection, AMaRV
1B98288	List, Subcontractor Parts, AMaRV

INSTITUTE OF PRINTED CIRCUITS

IPC-CM-770	Guidelines for Printed Circuit Board Mounting

LIST OF ACRONYMS

AA	Accelerometer Assembly
ABRES	Advanced Ballistic Reentry Systems
ACE	Advanced Control Experiment
AMaRV	Advanced Maneuvering Reentry Vehicle
ATP	Authority to Proceed
AVE	Aerospace Vehicle Equipment
BMO	Ballistic Missile Office
CA	Cable Assemblies
CDR	Critical Design Review
CDRL	Contract Data Requirements List
CPIF/AF	Cost Plus Incentive Fee/Award Fee
DDU	Data Delay Unit
DPA	Destructive Physical Analysis
EIA	Electronic Industries Association
EP&D	Electrical Power and Distribution
ER	Established Reliability
ETU	Engineering Test Unit
ETV	Engineering Test Vehicle
FPM	Forward Power Monitor
FTV	Flight Test Vehicle
G&N	Guidance and Navigation
I&C	Instrumentation and Communication
IFS	In-Flight Switch
IU	Interface Unit
LDPX	Linear Position Transducer
LPD	Loose Particle Detection
MDAC-HB	McDonnell Douglas Astronautics Company - Huntington Beach
MDS	Motor Driven Switch
NASA	National Aeronautics and Space Administration
NCR	Non-Conformance Report
NRS	Nose Recession Sensor
NSPAR	Non-Standard Part Approval Request
PAT	Production Acceptance Test
PCMU	Pulse Code Modulation Unit
PD	Power Divider
PDA	Percent Defective Allowable
PDR	Preliminary Design Review
PDU	Power Distribution Unit
PIND	Particle Impact Noise Detection
PMP	Parts Materials and Processes
PMPCB	Parts, Materials, and Processes Control Board
PMPSL	Parts, Materials, and Processes Selection List
PPMPL	Program Parts, Materials, and Processes List
QA	Quality Assurance
QCI	Quality Conformance Inspection
QPL	Qualified Products List
RFP	Request for Proposal
RGC	Reentry Guidance Computer
RIMUE	Reentry Inertial Measurement Unit Electrical
RM	Remote Multiplexer
RMU	Rate Measurement Unit
SAMSO	Space and Missile Systems Organization

LIST OF ACRONYMS (Cont'd)

SCO	Sub Carrier Oscillator
SCU	Signal Conditioner Unit
SEM	Scanning Electron Microscope
SJB	Separation Adaptor Junction Box
SOW	Statement of Work
SPWG	Space Parts Working Group
SXMTR	S-Band Transmitter
TCXO	Temperature Compensated Crystal Oscillator
WBS	Work Breakdown Structure

SECTION 1

INTRODUCTION

With increased dependence upon high reliability of electronics for the success of the nation's defense and space objectives, electronic piece part policies and methods of control have evolved over the past two decades. At this time it is generally agreed between government and industry that further improvements are needed. The purpose of this report is to describe the conduct and results of the electronics piece parts activities of the Advanced Maneuvering Reentry Vehicle (AMaRV) Program and to extract conclusions and recommendations. The objective is to provide a reference for future planning and management by the Advanced Ballistic Reentry Systems (ABRES) Program Office.

The report may be useful to other Program Offices of BMO and SAMSO and perhaps even other government procuring agencies. However, it is not the intent nor within the scope of the report to provide conclusions and recommendations with universal applicability.

The next section of the report contains a chronology of activity. The conclusions in Section 4.0 regards topics which were specified by BMO. The recommendations in Section 5.0 are the contractors. Selected topics for recommendations were also required by BMO. The appendices are per BMO requirements.

SECTION 2

DEVELOPMENT OF PIECE PARTS PROGRAM FOR AMARV

2.1 HISTORY OF AMARV PARTS PROGRAM

This section describes the characteristics of the AMaRV Parts Program. Included are descriptions of 1) establishing requirements and plans, 2) implementing procurement and test; and 3) schedule and cost impacts. Section 2.2 that follows provides background.

2.2 Background

The AMaRV Program is an advanced development which includes one vehicle for ground test qualification and three flight test vehicles for a total of four vehicles. The program objectives are both demonstrative and technological. AMaRV is typical of scores of ABRES flight test programs conducted over the past 25 years in terms of general objectives and quantity of flight test vehicles. However, the unit cost of AMaRV is greater than the typical ABRES vehicle because of the complexity of AMaRV's performance requirements. Consequently the importance of high reliability is somewhat greater for AMaRV than for the typical ABRES flight test program.

The AMaRV vehicle design includes both operational prototypical features and experimental features. The electronics components applicable to an operational requirement are functionally similar to an operational design. All electronics components have environmental capability to operational requirements except for nuclear hardness.

The AMaRV system includes three avionics subsystems - 1) Guidance and Navigation (G&N), 2) Instrumentation and Communication (I&C), and 3) Electrical Power and Distribution (EP&D). Table 2-1 defines the components of each subsystem, component quantities and contractor responsibility. Also shown are the piece part quantities for each component to indicate the relative complexity.

The AMaRV acceleration environment requirements are classified because they relate to system performance capability. Qualitatively the AMaRV dynamic environment requirements (shock, vibration and acceleration) are much higher than typical airborne vehicles (including ballistic reentry vehicles) while environmental requirements for temperature, altitude, EMI and humidity are typical of all reentry vehicles. With minor exception, qualification environment levels for AMaRV are per MIL S-1541A. Vibration levels for avionic equipment are as follows:

FREQUENCY IN HERTZ (HZ)	LEVEL
20 - 36	+12db/Octave
36 - 280	.4 g^2/Hz
280 - 700	+3db/Octave
700 - 1500	1.0 g^2/Hz
1500 - 1400	-3db/Octave

TABLE 2-I AMaRV AVIONICS COMPONENTS

Component	Acronym	Responsibility		Component Quant.			Pc. Parts Quant.	
		Design & Mfg.	Parts Procur.	ETV (1)	FTV (2)	Total (3)	Per Comp.	Total
GUIDANCE AND NAVIGATION	G&N							
1) Reentry Inertial Meas. Unit Elec.	RIMUE	S	S	1	3	4	1,796	7,184
2) Reentry Guidance Computer	RGC	S	S	1	3	4	2,266	9,064
3) Interface Unit	IU	C	C	1	3	4	846	3,384
4) Rate Measurement Unit	RMU	S	C	1	3	4	1,049	4,196
5) Accelerometer Assembly	AA	S	C	1	3	4	630	2,520
6) Temp Comp Crystal Oscillator	TCXO	S	S	1	3	4	75	300
INSTRUMENTATION & COMMUNICATION	I&C							
1) Pulse Code Modulation Unit	PCMU	S	S	1	3	4	1,743	6,972
2) Data Delay Unit	DDU	S	S	1	3	4	1,037	4,148
3) Remote Multiplexer	RM	S	S	1	15	16	787	3,148
4) S-Band Transmitter	SXMTR	S	S	1	9	10	237	2,370
5) Signal Conditioner Unit	SCU	C	C	1	3	4	841	3,364
6) Subcarrier Oscillator	SCO	S	S	1	3	4	8	32
7) Nose Recession Sensor	NRS	S	S	1	2*	3	1,092	4,368
8) Linear Position Transducer	LDPX	S	C	2	6	8	47	376
9) Power Divider	PD	C	C	1	3	4	17	68
10) Forward Power Monitor	FPM	C	C	1	3	4	32	128
ELECTRICAL POWER AND DISTRIBUTION	EP&D							
1) Power Distribution Unit	PDU	C	C	1	3	4	262	1,048
2) Sep. Adapt. Junction Box	SJB	C	C	1	3	4	20	80
3) In-Flight Switch	IFS	C	C	1	3	4	18	72
4) Motor-Driven Switch	MDS	S	C	1	3	4		
5) Cable Assemblies	CA	C	C	28	84	112	141	15,792
							GRAND TOTAL	69,325

(1) ETV = Engg Test Vehicle used for Qualification
(2) FTV - Flight Test Vehicles
(3) Total excludes spares which are minimal
* NRS not used on FTV-3
C = Contractor; S = Subcontractor

2.2 Background (Cont'd)

The AMaRV program contract is Cost Plus Incentive Fee/Award Fee (CPIF/AF). The program schedule is shown in Figure 2-1.

In summary, the conclusions regarding electronics piece parts as contained in this report are highly applicable to future ABRES programs. However, conclusions and recommendations are less germane to advance development of vehicles with low unit mission costs, i.e., low unit vehicle cost and low launcher cost such as tactical missiles. Although the low quantity nature of AMaRV is similar to many unmanned spacecraft programs, the mission requirements (particularly long life) and unit costs can vary significantly. Obviously the approach for electronic piece parts for full scale development and production of systems where unit quantities are large compared to AMaRV, require a totally different approach. Perhaps the most similar type of program outside of ABRES is advanced development of strategic interceptors.

2.2.1 SAMSO-STD73-2C for the AMaRV Program

The principle parts management requirements document on the AMaRV program was SAMSO-STD73-2C, Electronic Parts, Materials and Processes for Space and Missile Applications; Standard Control Program For. This standard was supported by SAMSO-STD73-4A, List of Preferred Parts for Space and Missile Systems, and MIL-E-8189H, Electronic Equipment Missiles, Boosters for Allied Equipment; General Specification For. The latter document established the order of precedence for selection of parts. SAMSO-STD73-2C was tailored for use on the AMaRV program by the initial contract Statement of Work. Additional tailoring was performed following authority to proceed which led to the issuance of MDAC-HB STC0015 "B" Revision for AMaRV Parts Control. This tailoring was performed by the Parts Materials and Processes Control Board (PMPCB) and approved by the AMaRV Program Office. The STC0015 document is discussed in detail in Section 2.4 of this report.

2.2.2 Tailored SAMSO-STD73-2C for AMaRV

SAMSO-STD73-2C was tailored by contract work statement for the AMaRV program. The tailoring involved revision to applicable documents, definition of standard parts, establishment of the Parts, Materials and Processes Control Board (PMPCB) for AMaRV, PMPCB representation, procedures approval, screening test definition, Destructive Physical Analysis (DPA) requirements, and failure analysis. Details of the tailoring are as follows for the noted paragraphs:

A. Replacement of IPC-CM-770 with MIL-STD-275, Printed Wiring for Electronic Equipment, and MIL-STD-1495, Multilayer Printed Wiring Boards for Electronic Equipment.

B. Deleting of paragraph 4.4 which defined requirements for the Parts, Materials, Processes Advisory Group (PMPAG). For AMaRV, the requirements paragraph 4.3 Parts, Materials, Processes Control Board (PMPCB) applied.

C. Deletion of "Table 1" from paragraph 3.4.a (Standard Parts).

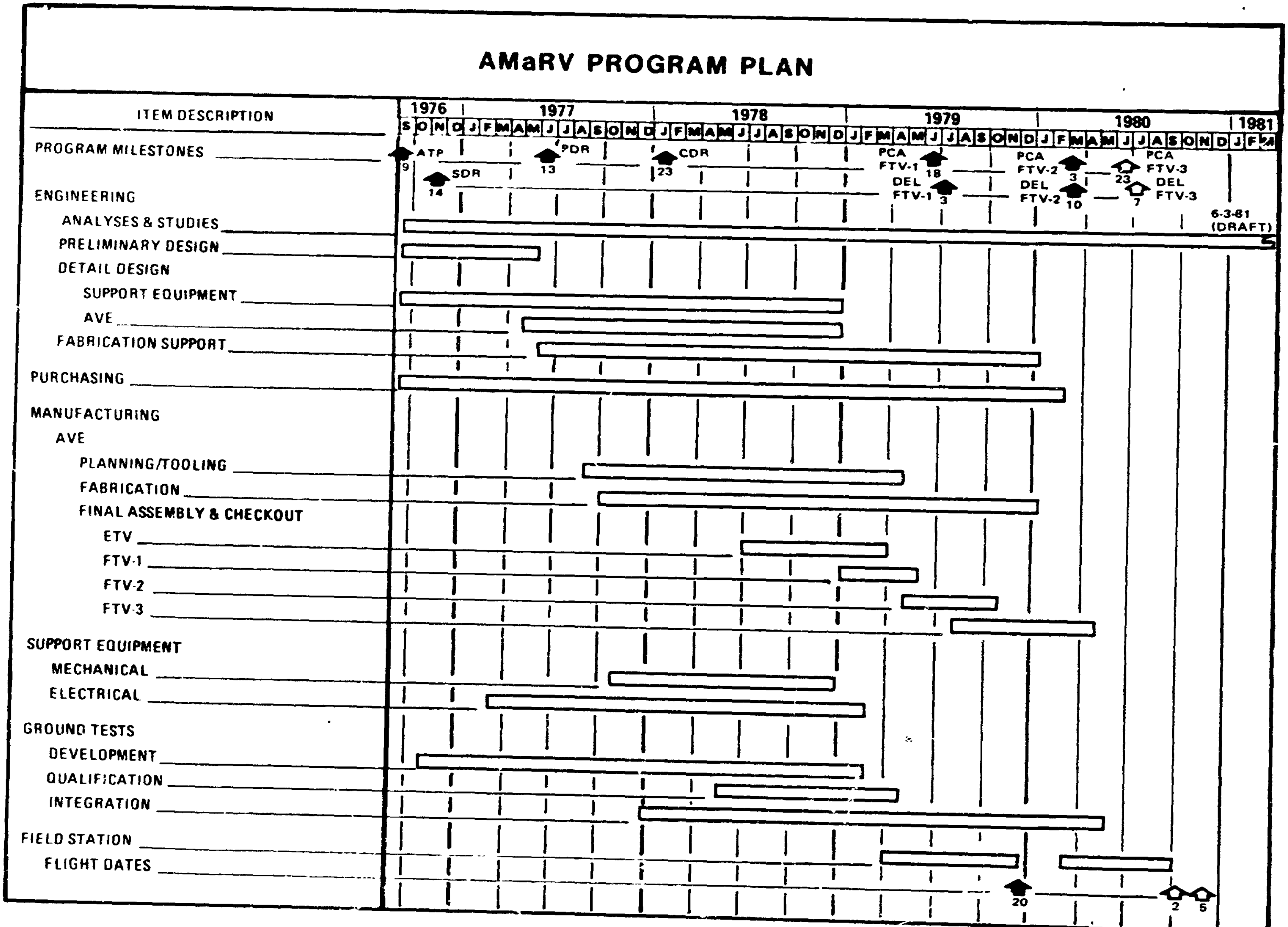

FIGURE 2-1 AMaRV PROGRAM SCHEDULE

2.2.2 Tailored SAMSO-STD73-2C for AMaRV (Cont'd)

D. Addition of the following to paragraph 3.4.6:

"All parts shall be screened per Table 1 of this standard. Standard parts are defined as:

1. JANTXV Semiconductors as listed in SAMSO-STD73-4A.
2. MIL-M-38510, Class B microelectronic devices as a minimum.
3. Established reliability parts.

E. 4.3 PMPCB - add:

"Representatives on the PMPCB shall be limited to the Prime Contractor, SAMSO, and Aerospace Corp. representatives. Subcontractor/vendor personnel will participate as required by the Board."

F. 5.4.2.1, Derating - add:

"Procedures shall be developed and, as approved by SAMSO, implemented by the contractor to assure application of derating factors."

G. 5.4.4.2, Parts Screening Matrix - add:

"Screening tests for standard parts as called for in the applicable military specifications will be acceptable provided that these screening tests comply with the requirements of Table I of this standard."

H. 5.4.4.4, Destructive Physical Analysis (DPA) - add:

"Ceramic and mica capacitors require DPA."

I. 5.4.4.1, DPA Samples

Sample size is changed to read "2% or 3 units, whichever is larger." Also add at end of paragraph: "Parts and photographs of all DPA samples shall be maintained and used for comparison with parts from subsequent lots."

J. 5.4.4.5, Scanning Electron Microscope (SEM) Inspection - add:

"The SEM shall be used at the wafer level as integrated circuits and RF power transistors and as a part of DPA.

K. 5.4.4.6, Bond Testing - add:

"For DPA samples of all transistors and microelectronics, the contractor shall conduct 100% bond pull tests."

2.2.2 Tailored SAMSO-STD73-2C for AMaRV (Cont'd)

L. 5.4.4.7, Contractor Responsibility - delete first two sentences and add:

"The Contractor shall review all vendor manufacturing processes prior to procurement of the item. The Contractor shall participate in precap visual inspection on those parts designated by the PMPCB and shall monitor the screening tests performed by the vendor by reviewing the resulting screening test data."

M. 5.4.5, Parts, Materials and Processes Qualification - add:

"The Contractor shall provide the PMPCB the environmental levels to which each part has been qualified."

N. 5.4.5.1, Parts Qualification - add:

"The Contractor shall review all Group B and C data prior to submitting the summary report to the PMPCB."

O. 5.4.7, Failure Analysis - delete existing paragraph and replace with the following:

"Failure Analysis of parts shall be accomplished as authorized by the procuring agency. Generally, analysis will be concerned with failures occurring subsequent to screening tests. Analysis of screening test failures are not anticipated unless the reject rate is excessive. Failure reporting shall include all failures subsequent to screening tests. Only a summary report of the results of each screening test will be necessary."

2.2.3 Data Articles Supporting SAMSO-STD73-2C

The data articles which were imposed in support of SAMSO-STD73-2C are CDRL A021 Parts, Materials and Processes (PMP) selected for design and CDRL A022, Program Parts, Materials and Processes List (PPMPL). Copies of these CDRL's are in Appendix A.

2.2.3.1 Non-Standard Part Approval Requests

The Non-Standard Part Approval Request (NSPAR) was used for the submittal of request for part approval. NSPAR's contained Step 1 and Step 2 and Step 3 data (Ref. CDRL's Appendix A). Step 1 data included design requirements required for identifying and justifying candidate parts and included an Alert search. Step 2 data included the final procurement document generated to obtain the part. Step 3 data included all of the life test information for those parts requiring life testing on the program.

There were 369 active NSPAR's on the AMaRV program of a total of 636 part types.

2.2.3.2 Program Parts List

MDAC-HB prepared and maintained two Parts, Materials, and Processes Selection Lists (PMPSL's) for the AMaRV program. Drawing 1B98287 was the PMPSL for contractor procured parts and 1B98288 the parts list for subcontractor design. The parts lists reflected parts that were actually used on the program.

2.3 Parts, Materials and Processes Control Board (PMPCB)

The AMaRV Parts, Materials and Processes (PMP) Program was administered by a Parts, Materials and Processes Control Board (PMPCB). The PMPCB was operated in compliance to the requirements of SAMSO-STD73-2C and MIL-STD-891.

The AMaRV PMPCB was established in the second month of the AMaRV contract with the first meeting held October 8, 1976. The Parts Board consisted of one representative from SAMSO, one representative from Aerospace Corporation and one representative (who also was the Chairman) from MDAC-HB. The AMaRV PMPCB held 86 formal meetings for which minutes were recorded and distributed. Matters with impact on cost and schedule were forwarded to the MDAC and SAMSO Program Offices for final disposition.

The Parts Board took several months establishing a charter and an operating plan and identifying the boards data needs. One of the first major activities was the development of the AMaRV PMP plan including STC0015 Parts, Materials and Processes control plan, AMaRV. The PMPCB reviewed non-standard part request (NSPAR) forms including step 1, 2 and 3 data. In-line in-depth review and approval of all step 1 and step 2 data made it necessary for the Parts Board to meet weekly or more often, and was a pacing item in initiating parts procurement on the program. A total in excess of 700 part types including those cancelled were reviewed. The PMPSL's were also approved by the PMPCB.

The PMPCB agreed to not follow the Materials and Processes aspect in the same detail as parts. Materials and Processes were reviewed on an informal basis including spot checks at subcontractors' location during trips to those locations.

2.4 AMaRV PMP Control Documentation

MDAC-HB standard practice drawing STC0015, Parts, Materials, and Processes Control Program for AMaRV was prepared and issued to define the baseline PMP requirements for the AMaRV program. STC0015 provided an interpretation and clarification of SAMSO-STD73-2C as modified for the AMaRV program.

2.4.1 Development of STC0015 for AMaRV

The initial issue of STC0015 was prepared in 1976. Revision A was not used. The advance "B" revision was prepared for the implementation of modified requirements to SAMSO-STD73-2C and was presented to the AMaRV PMPCB at meeting number 5, November 23, 1976, for review. At PMPCB meeting number 6, November 30, 1976, all comments were incorporated and the STC0015 "B" revision was issued on December 3, 1976 and transmitted to the AMaRV subcontractors for negotiation.

2.4.1 Development of STC0015 for AMaRV (Cont'd)

As the program progressed it was found that SAMSO-STD73-2C and STC0015 "B" did not clearly define the specific test data to be submitted to the PMPCB for review. To clarify these requirements the "C" revision was issued October 12, 1977. A copy of each of the STC0015 "B" and "C" revisions is contained in Appendix A.

STC0015 does not contain the complete PMP requirements for AMaRV. It was prepared as a baseline document containing the requirements most common to all equipment. It was supported by the AMaRV PMP plan and the subcontractor specifications and work statements which contained supplemental requirements and PMP modifications as appropriate for each subcontractor. The additional requirements, consistent with SAMSO-STD73-2C and not included in STC0015, contained in subcontractor specifications and work statements, as applicable. were:

A. Traceability

Microelectronic devices (including hybrids) shall be traceable to diffusion lot.

B. Scanning Electron Microscope (SEM)

In-process SEM inspection will be performed at the wafer level for hybrids, integrated circuits and RF power transistors to the requirements and acceptance criteria of MIL-STD-883, Method 2018. SEM examination will also be performed during Destructive Physical Analysis (DPA). Procedure to be submitted to PMPCB for approval.

C. Lead Bond Testing

Microelectronic devices (including hybrids) and transistor manufacturers are required to institute an in-process control procedure which demonstrates a pull force strength suitable to the wire material and diameter. In-process lead pull tests shall be performed before and after every two (2) hours (or less) of production. Lead bond pull tests will also be performed during Destructive Physical Analysis (DPA). Procedures are to be submitted to the PMPCB for approval and shall include sample size, defectives allowed, lot control/disposition in event of failure, and other pertinent details.

D. Glass Passivation

All microcircuits shall have glass passivation as a minimum over their substrate and metallization excluding the bonding pads.

2.4.2 Subcontractor Modification

AMaRV subcontractors were classified in five (5) categories with the subcontractor specification requiring adherence to STC0015 with "exception" and/or addition of above requirements as applicable. The modification of each applicable subcontractor requirements is shown in Table 2-2.

Categories I and II are Guidance and Navigation Equipment. Category I, Critical - New Design, was established on the basis that a failure of the Reentry Guidance Computer (RGC), Reentry Inertial Measurement Unit Electronics (RIMUE), or Interface Unit (IU) would result in total loss of the mission. Category II, Critical - Existing Design, is the same mission criticality as Category I, the difference being that the Rate Measurement Unit (RMU) was existing design and it was not practical to impose all the requirements that were imposed on New Design (Category I).

Categories III, IV and V were Instrumentation and Communication Equipment. Category III was non-critical with failure resulting in loss of a small portion of the data. Failure of Category IV, Existing Design, would result in loss of all data (PCMU) or a significant portion of data (Remote Multiplexer - RM and S-Band Transmitter - SXMTR) and as a result be critical to the success of the mission. Failure of the Data Delay Unit (DDU), Category V - Semi-Critical New Design, would result in potential loss of a portion of data.

2.4.3 Evolution of STC0015

The requirements in STC0015 developed as the program progressed. This section summarizes some of the developments that took place on the principle requirements paragraphs of STC0015. These particular paragraphs are highlighted because they represent SAMSO-STD73-2C requirements which required additional definition and clarification. Comments are by STC0015 paragraph number and title.

3.1 Electronic Parts, Materials and Processes Program

The PMPCB controlled AMaRV Parts, Materials and Processes. PMPCB review of materials and processes was to a lesser degree than parts. The PMPCB delegated primary responsibility of the review of M&P to MDAC-HB with sample PMPCB review.

3.2 Program Parts, Materials and Processes List (PMPSL)

Two PMPSL's were released - one for MDAC hardware 1B98287, and one for subcontractors 1B98288. First issue of both received interim approval January 26, 1978. Part types in each list are shown in Table 2-3.

TABLE 2-2

SUBCONTRACTOR PMP REQUIREMENTS

CATEGORY*	SPECIFICATION PARAGRAPHS TO INCLUDE	STATEMENT OF WORK (SOW) TO INCLUDE**
I (RGC, RIMU, RIMUE, J-BOX, IU) CRITICAL - NEW DESIGN	STC0015 Wafer SEM Bond Pull Wafer Lot Traceability Glass Passivation	A052 A053
II (RMU) CRITICAL - EXISTING DESIGN	STC0015 Delete Pre-Cap Visual (3.8)	A053
III (XDCRS) NON-CRITICAL	STC0015 Delete Pre-Cap Visual (3.8) " DPA (3.12) " LPD (3.13) " Parts Substitution (3.3.1.1)	A053
(SCO's)	STC0015 Delete Pre-Cap Visual (3.8) " Parts Substitution (3.3.1.1) " LPD (3.13)	A053
(NRS)	STC0015 Delete Pre Cap Visual (3.8)	A052 A053
IV (PCM, RM, AA, XMTTR) CRITICAL - EXISTING DESIGN	STC0015	A053
V (DDU) SEMI-CRITICAL - NEW DESIGN	STC0015	A052 A053

*Refer to Table 2-1 for component name and part count.

**A052 is step 1 and step 2 data for NSPAR's and A053 is input data for PMPSL's.

2.4.3 Evolution of STC0015 (Cont'd)

ELECTRONIC GENERIC

TABLE 2-3 PART TYPES ON PMPSL'S

PARTS LIST	HYBRIDS	I.C.	TRAN-SISTOR	DIODE	CAPAC-ITOR	RESISTOR	MAGNETICS	RELAYS
MDAC 1B98287	6	28	20	24	19	15	20	3
Sub-contractor 1B98288	7	120	44	57	50	56	55	0
Total	13	148*	64*	81*	69*	71*	75	3

*Includes some duplication of generic types. Duplication held to minimum by pooling.

3.3.1 Program Standard Parts

Lockheed monitored line parts were added as standard parts (PMPCB Meeting No. 10, January 28, 1977), but later removed (Meeting No. 20, March 31, 1977) because the government preferred to avoid liability. Listing in SAMSO-STD73-4 was deleted as a condition of being a standard part (PMPCB Meeting No. 11, February 4, 1977).

3.3.1.2 Non-Standard Part Approval

All parts on the PMPSL's required approval by the PMPCB. This resulted in creation of Non-Standard Part Approval Request (NSPAR) for each part on PMPSL whether they were standard or non-standard. Typical of this were the hybrids which were New Design for the RIMUE.

3.3.2.1 Microelectronics

The requirements for in-process controls to satisfy 73-2C made it necessary to procure microelectronics as new buy since no parts were available off-the-shelf which satisfied requirements.

3.3.2.2 Discrete Semiconductor Devices

Transistors and diodes were to be procured as original buy to JANTXV levels per MIL-S-19500 as a goal. It became more practical to procure most discretes as JANTXV off-the-shelf and rescreen them to Tables II and III of STC0015. Some devices were only available

2.4.3 Evolution of STC0015 (Cont'd)

3.3.2.2 Discrete Semiconductor Devices (Cont'd)

to JANTX. The rescreen option was not in SAMSO-STD73-2C as modified for AMaRV, but adopted as a result of PMPCB action to relieve lead time problems.

3.3.2.3 Capacitors

Selection was to be from MIL-STD-198C as a goal, to failure rate level "R" or better. Capacitors were procured to established reliability military specifications, off-the-shelf from QPL sources, and rescreened to Table IV of STC0015.

3.3.2.4 Resistors

Selection was to be from MIL-STD-199B as a goal, failure rate Level "R" or better. Resistors were procured to established reliability specifications, off-the-shelf from QPL sources, and rescreened to Table V of STC0015.

3.3.2.5 Magnetic Devices

Magnetic devices were procured to Grade 4 or 5, Class S or V to MIL-T-27. No selection criteria for magnetic parts other than screening was specified in SAMSO-STD73-2C. The requirements specified in STC0015 were the standard MDAC-HB requirements. Magnetic parts were screened to Table VI of STC0015.

MDAC recommended deletion of no load test on magnetic devices (PMPCB 23, April 28, 1977). This was approved by the PMPCB (Meeting No. 25, May 25, 1977).

3.3.2.6 Relays

Selection was in accordance with MIL-R-39016B. Relays were screened to Table VII of STC0015.

3.3.4.1 thru 3.3.4.4 Materials and Processes Selection and Approval

M&P documentation was initially reviewed by MDAC and the PMPCB in detail. Critical processes were given a closer scrutiny. This was later amended to MDAC review and approval of all subcontractors M&P documents with PMPCB retaining prerogative to review certain processes upon reouest.

2.4.3 Evolution of STC0015 (Cont'd)

3.3.4.5 Printed Wiring

Printed wiring boards were required to conform to MIL-STD-275C and MIL-STD-1495. Special material and process specifications were frequently required by subcontractors due to unique conditions associated with high density packaging. These specifications met the Military and MDAC specifications in all other areas other than those where deviations were requested. The PMPCB initially questioned this approach and as a result monitored in-process tests results closely.

3.4 Parts Derating

A uniform parts derating policy was established using MDAC derating guide MDC G0155 as a guide. Subcontractors complied to the MDAC derating policy with some modifications requested and approved by the PMPCB to allow for existing designs.

3.5.1 Parts Qualification

Program standard parts were considered qualified with Group B and C data required. Non-standard parts of common configuration, materials and processes were qualified by similarity. Non-standard parts of unusual package design, materials or processes were to receive customized qualification test.

In PMPCB Meeting No. 12, February 10, 1977, MDAC recommended the deletion of environmental tests for qualification, since the environmental tests performed during screening would suffice. The PMPCB concurred with this recommendation. In PMPCB Meeting No. 14, February 24, 1977, MDAC reported that it was the intention to qualify virtually all AMaRV parts by similarity. The PMPCB deleted the requirement for Group B and C data for standard microelectronic and semiconductor devices, and added the following requirements for justification of qualification by similarity.

Qualification of a subject part by similarity may be justified by submittal of: (a) existing acceptable test data at the part level, or evidence of successful use in a similar application(s), or evidence of QPL listing on a device type(s) in the same family from the same supplier as the subject part; (b) documentation (e.g., construction analysis) which established design similarity in configuration, process and materials between the subject part and another device type(s) qualified as in (a) above except that, data need not be from the same supplier as required in (a) above.

The following data should be provided to justify qualification by similarity:

2.4.3 Evolution of STC0015 (Cont'd)

3.5.1 Parts Qualification (Cont'd)

- Identification of the similar part(s).
- Description of similarity of processes, facilities, parts, etc.
- C. Qualification levels to which the similar part(s) is qualified.
- D. Data of similar part(s) qualification or test.

The above requirements were incorporated in the "C" revision of STC0015 with minor changes. The group B & C data requirements for ER and JANTXV parts was clarified in June 1977 to include the following:

Required

A. Manufacturer's certification of compliance to MIL-Spec for parts.

B. Certification that all parts of a given part number are from a single manufacturing lot.

C. Screening summary data for both the original screen and the rescreen as specified in STC0015, paragraph 3.14.1

D. Summary of Groups A, B and C test results showing number of parts entering and number of parts failing each group. This summary is required only for JANTXV parts and will be waived if A, B and C data are obtained.

Desired

E. The military specification data for Groups A and B test inspections for each date code lot as follows:

1. Part number
2. Lot size
3. Lot number
4. Military specification and slash sheet numbers
5. Test data for each inspection test
6. Date of each test
7. Quantity failed in each test

The PMPCB agreed that Step 3 data need not be submitted for parts considered qualified.

3.6 and 3.7 Parts Screening and Parts Rescreening

All parts were required to be 100% screened or rescreened per screening Tables I through X as a minimum. A summary of the AMaRV piece part screening data is in Appendix B.

2.4.3 Evolution of STC0015 (Cont'd)

3.6 and 3.7 Parts Screening and Parts Rescreening (Cont'd)

In PMPCB Meeting No. 9, January 24, 1977 - the MDAC recommendation to procure JANTXV and ER parts off-the-shelf and rescreened by independent screening houses in lieu of new buy was presented to the PMPCB and approved. This required deletion of pre-cap and two hour in-process bond pull for the affected devices. Paragraph 3.7.1 entitled Rescreening Options ER and JANTXV Devices, was inserted at STC0015 "C" revision. New buy parts with full surveillance was to be the first order of selection where possible.

In PMPCB Meeting 14, February 24, 1977, it was recommended that lot Percent Defective Allowable (PDA) requirements be removed from X-ray and PIND. This was approved by the PMPCB with the following conditions:

1. PMPCB was to be notified if X-ray rejects exceed 10% of the lot.

2. PMPCB was to be notified if PIND rejects exceed 20% of the lot or more than 5 runs required.

3.8 Pre-Cap Visual Examination

It was required that pre-cap visual inspection be witnessed by the subcontractor on a near 100% part basis. Witnessing of pre-cap visual was interpreted to mean that the subcontractor was to be on site at the part vendor's facility physically observing the precap visual operations on AMaRV parts. Other critical processes which were required to be monitored could be monitored on a sample basis whereby it was assured that the manufacturer was equipped and trained adequately, and that proper procedures, etc. were applied to the AMaRV parts build.

Supplier pre-cap need not be accomplished on 100% of the parts if by periodic random sampling the supplier is convinced the vendor is accomplishing a thorough job. The supplier personnel sent to participate in precap visual should be a trained engineer understanding that this operation is important to reduce screening and DPA failures.

3.9 Quality Conformance Testing

A life test requirement was established for all parts except for resistors and capacitors procured to military established reliability specifications. A sample size of 5 was set for each lot and was modified for some devices where high cost was involved.

In PMPCB Meeting No. 25, 1977, it was agreed that Quality Conformance Inspection (QCI) tests should be deleted where lot Group C life test data are obtained for JANTXV and ER parts which were rescreened.

2.4.3 Evolution of STC0015 (Cont'd)

3.10 Supplier Responsibility

On-site monitoring by the procuring agency of critical processes was required. Pre-cap visual inspection, previously discussed in detail, was the principal item covered in this paragraph.

3.11 Incoming Receiving Inspection

The PMPCB expressed need for relief to receiving inspection requirements due to close timing of procurement and delivery. This was to be reviewed on an individual parts basis. Incoming inspection was waived for parts provided as pooled parts, and was to be performed only by the purchaser of the parts.

At PMPCB Meeting No. 41, 16 September 1977, MDAC presented a proposed modification to the receiving tests for the MDAC standard connectors which clarified visual inspection requirements, allowed existing electrical tests to be used, and deleted sample electrical tests at temperature extremes. This modification was approved by the PMPCB.

At PMPCB Meeting No. 47, 26 October 1977, the PMPCB approved final electricals for passives to be conducted at the rescreen lab in lieu of repeating tests at incoming inspection although not monitored 100%. STC0015 "C" revision offered the alternative of performing receiving inspection in part or full at a facility other than the monitored.

3.12 and 3.12.1 Destructive Physical Analysis and DPA Sample Size

Destructive Physical Analysis (DPA) was required on a sample from each lot of selected part types. The PMPCB agreed in Meeting No. 9, 24 January 1977, that DPA samples can be taken from life test samples provided flight parts are from that same lot. In PMPCB Meeting No. 31, 1 July 1977, the PMPCB agreed that DPA samples for MDAC magnetics could be reduced from 3 to 2 per lot since sufficient similarity exists for these devices. Failure analyses on DPA failures were to be performed only as requested by the PMPCB. A summary of DPA results is contained in Appendix C.

3.13 Loose Particle Detection

All semiconductors of void type construction were subjected 100% to Loose Particle Detection (LPD) test, also referred to as Particle Impact Noise Detection (PIND), in accordance with MDAC Standard STC0016.

SAMSO-STD73-2C required PIND on power transistors and relays only. STC0015, per MDAC recommendation, required PIND to be performed on all semiconductors except those of voidless construction, in addition to relays. Due to stringent operator qualification requirements, it was the PMPCB's preference to have as few companies as practical perform

2.4.3 Evolution of STC0015 (Cont'd)

3.13 Loose Particle Detection (Cont'd)

LPD to STC0016. Operator qualification, facility, and procedure approval were required prior to testing. MDAC, Litton and Singer performed most LPD. LPD tests are considered part of screening tests. LPD failures received failure analysis only as requested by the PMPCB.

As a result of high incidence of failure during LPD testing some parts received parylene rework. Parylene is a polymerized thin film coating of para-xylylene. Its main desirable properties are its high insulating characteristics and lack of interaction with sensitive electronic elements and its ability to be vapor deposited.

Parylene was utilized on several of the AMaRV semiconductor devices. In all such cases its application was to salvage parts which had failed PIND test and which could not be re-procured within program schedule constraints.

Although parylene rework was successfully implemented in the above mentioned instances, its cost effectiveness is doubtful in the general case. The rework consists of opening a small hole in the hermetically sealed device, vapor depositing parylene and resealing the package with solder. Internally the part has no remaining conductive surfaces and is, therefore, immune from particle induced electrical shorts.

3.14.1 Failure Analysis and Reporting

All parts failures subsequent to screening (including LPD) were reported to the PMPCB. Failures during receiving electricals or subsequently were reported to the PMPCB with an indication of the nature of the failure (e.g., rise-time exceeded spec by 15%, open occurred at temperature, etc.). Failure analyses was to be conducted only in the event of specific request by the PMPCB. Corrective action required approval of the PMPCB prior to its implementation. The PMPCB made every effort to expedite approval when schedule critical, often within 72 hours of submittal of failure analysis, results.

3.15.1 Shelf Life Control

Parts with screen/rescreen dates over two year's prior to installation in next assembly require rescreen to Tables I through X, pre-cap visual excepted. MDAC standard connectors were exempted from the 2 year requirement. Quality Assurance was to assure that 2 year limit was not exceeded.

2.5 AMaRV Piece Parts Procurement Plan

The AMaRV program consisted of three flight vehicles and an engineering test vehicle. Consequently four flight sets of each component type were built.

At the start of the AMaRV program, the parts procurement plan was to require each supplier to be responsible for the specification and purchase of their individual parts. This was modified in two respects as the planning evolved. First, during subcontract negotiation it became evident that it would be technically superior, more economical and quicker for MDAC to furnish parts to the RMU and Accelerometer Assembly subcontractors. These parts were procured to MDAC specifications. Second, after the major supplier parts lists had matured, all active parts that were common to more than one user were pooled. Common active parts include integrated circuits, transistors and diodes. The user with the earliest need date was selected as the buyer and MDAC certified the conformance to program requirements of all pooled parts. The option of pooling passive parts was considered but was dropped because the lot charges for passives are generally small, because passive part values or quantities are often changed at a late stage of design and because of the administrative expense.

To provide increased assurance, all screening was performed by the part manufacturer except for ER and JANTXV parts. This enabled monitoring and witnessing at critical points. Use of a single laboratory for rescreening of ER and JANTXV parts was considered but it was concluded that a competitive environment would be of greater advantage than the commonality benefits. Additionally, there was concern for the capacity limits of a single laboratory. Therefore, after establishing an approved screening lab list. most suppliers conducted a competitive procurement for rescreening. In general, no single component supplier used more than one screening lab.

The procurement plan included two considerations with respect to parts selection. First, for existing design, parts selection was reviewed and ofted changed if a part was prohibited by SAMSO-STD73-2C or if the part did not meet derating requirements. However, in general, the existing part types were approved, but the parts were upgraded to include SAMSO-STD73-2C requirements and the part specifications were modified accordingly. Second, the only parts usage that was contractually directed by MDAC to suppliers was for external connectors and these were purchased by subcontractors to MDAC specifications which are multiple source. Standardization was a key objective during the formative phase of new design and parts selections were directed to increase common usage when circuitry performance changes were intolerable and redesign was minor. Finally, each AMaRV user was encouraged to perform destructive physical analysis (DPA) as part of receiving inspection unless the user lacked DPA facilities and/or experience.

The AMaRV procurement approach is summarized in Figure 2-2. Figure 2-3 provides an additional measurement of the parts program magnitude resulting from the procurement plan just described. There were a total of 17 component types and 9 buying agencies. Seven components used pooled parts. Three screening laboratories, Continental Testing Laboratories, Fern Park, Florida; DCA Reliability Laboratories, Sunnyvale, California; and Assurance Technology Corporation, Carlisle, Massachusetts, were used on the AMaRV Program.

- MAXIMIZE RESPONSIBILITY OF COMPONENT SUPPLIERS
- MDAC FURNISHED PARTS FOR SELECTED COMPONENT SUPPLIERS
- POOLING OF COMMON ACTIVE PARTS
- SCREENING BY PART MANUFACTURER EXCEPT ER AND JANTXV
- COMPETITIVE SELECTION OF RESCREENING LABORATORIES
- MODIFIED PARTS PRACTICES FOR EXISTING DESIGN
- MINIMAL SUBCONTRACT DIRECTED PARTS SELECTION BEYOND REQUIREMENTS OF SAMSO-STD73-2C
- WHEN FACILITIZED, THE PART USER PERFORMS DPA

FIGURE 2-2

AMARV PARTS PROCUREMENT APPROACH

COMPONENT TYPES BY MDAC	5 (PLUS CABLE ASSY'S)
COMPONENT TYPES FROM SUPPLIERS	12 (9 SUPPLIERS)
TOTAL COMPONENT TYPES	17
SUPPLIERS FURNISHED PARTS BY MDAC	3
COMPONENT DESIGNERS THAT BUY PARTS	7
SUBTIER PARTS PURCHASERS	2
TOTAL NUMBER OF BUYING AGENCIES	9
NUMBER OF POOLING PARTICIPANTS	4 (7 CO[illegible]NTS)
NUMBER OF POOL BUYERS	3
NUMBER OF SCREENING LABORATORIES	3

FIGURE 2-3

AMARV PARTS PROGRAM PARTICIPANTS

2.6 Parts Pooling Program

The MDAC-HB proposal for AMaRV did not include a plan to implement a Parts Pooling Program. However, during the early review of the combined parts lists following contract start, it became clear to the PMPCB that the parts pooling concept for select part types was a practical approach to parts procurement for AMaRV.

2.6.1 Background

Several approaches to parts pooling were considered. The PMPCB suggested that MDAC provide all parts to all AMaRV subcontractors similar to the ABRV Program in order to assure that the requirements of the AMaRV High Reliability Parts Program would receive closer and more immediate PMPCB attention. MDAC Program Office expressed concern that this approach would limit each subcontractor's design freedom to select the most cost effective and schedule effective device because additional coordination would be required. As a result, the following parts pooling program was promulgated:

A. Microcircuits and semiconductors that had common usage among two or more AMaRV contract agencies would be provided to all users by the user with the earliest need date.

B. MDAC would provide all electronic parts to the subcontractors for the RMU and AA since it was not cost effective to implement the subcontractor's effort.

C. PMPCB approved MDAC specifications for passive parts would be offered to subcontractors for procurement, thereby reducing specifications, test lab negotiations, and other associated costs.

For "A" above, (microcircuits and semiconductors), MDAC evaluated over 200 device types from four subcontractors before selecting the part pool candidates. As additional subcontractors become part of AMaRV, their parts lists were reviewed for the parts pool program. Eventually, three contractors provided 17 digital I.C.'s, 6 analog I.C.'s, 8 transistors and 4 diodes (total quantity was 7284 devices) to 9 users. MDAC collected all information regarding device type and quantity and negotiated with the procuring subcontractor and the user subcontractor. The procuring subcontractor was charged with all High Reliability responsibilities and delivery to MDAC for further distribution to the user subcontractors. The user subcontractors were charged with receiving the devices that were identified with another company's part number, installing them in the next assembly and reporting any part failures. For Lessons Learned and Recommendations refer to sections 4.0 and 5.0 respectively.

2.6.2 Management

Management of the parts pooling program consisted of constant revision of part numbers and quantities over a 12 month period due to the following factors:

A. The preliminary parts list of those subcontractors who were added later in the program was evaluated for parts pool candidates. The parts pool program was impacted not only because of the additional quantities and device types that could be pooled, but also because the subcontractor's preliminary design was not sufficiently mature to establish parts usage.

B. Even among the major subcontractors, the designs continued to evolve which necessitated revisions of parts quantity and device types. Automated parts listing as recommended in section 5.0 would have been beneficial.

C. Subcontractors, who had agreed to the pool parts quantities and types, would later change a parameter. This essentially negated that pool part with that user.

D. Vendor requested changes required coordination among all users thereby prolonging the response time.

The management of the pool parts program included the acceptance at the procuring subcontractors facility, the distribution of the parts to the users and the users receiving inspection. The PMPSL became the authority for Quality Assurance (QA) to accept the pool parts program. An additional QA inspection point was required for the procuring subcontractor to sell off the parts and their documentation to MDAC. Typical problems were:

A. The user subcontractor sometimes rejected parts during receiving inspection because test conditions were varied. Substantial coordination was required to resolve nonconformances.

B. Users could not readily accept another company's drawing system and part numbering system.

SECTION 3

IMPACT OF SAMSO-STD73-2C ON AMARV

3.1 SCHEDULE IMPACT OF SAMSO-STD73-2C

Parts acquisition had a major impact on the AMaRV Program schedule. Schedule impacts are measurable in three serial phases: Design, Acquisition and Final Acceptance. Parts timetables are shown in Figures 3-1 through 3-4.

The design phase involved activities leading to placement of piece part purchase orders. The elements of the period that were impacted by the parts program requirements were Step 1 data approval and negotiations of purchase orders. For AMaRV, the 73-2C requirements (particularly screening requirements) were not well understood by candidate vendors. Nor were requirements always compatible with vendor methods, facilities and expertise. Consequently, negotiations were extensive resulting in late placement of purchase orders. This was aggravated by the necessity of iterations with the PMPCB when specification changes were required to resolve negotiations. When specification preparation was delayed by design considerations, schedule recovery was attempted by conducting source selection and negotiations in parallel with PMPCB processing of Step 1 data. This approach had mixed success because the Step 1 approval process sometimes required a specification change which, in turn, necessitated a recycle of supplier selection and negotiation.

Program schedule for purchase order release was keyed to Preliminary Design Review (PDR) at the tenth month of the program and to supplier PDR's. Step 1 data approval was a prerequisite. However, several supplier PDR's were postponed for reasons such as; direction to redesign, parts definition incomplete, and strike. As a result, the Step 1 data preparation was correspondingly delayed causing a substantial mismatch between the planned and actual purchase order dates. The schedule goals were based upon lead time forecasts as a function of part type. The planned and achieved dates for placement of the last purchase order for each part type were as follows:

	Planned	Achieved	Mo. Late
Hybrids	PDR - 3 mo	PDR - 1 mo	2
Int. Circuits	PDR - 2 mo	PDR + 4 mo	6
Semiconductors	PDR - 1-1/2 mo	PDR + 6 mo	7-1/2
Passives	PDR + 1 mo	PDR + 7 mo	6

Hybrid purchase orders were delayed due to difficulty in establishing requirements and technical difficulties during prototype development. Consequently, screening and delivery was late necessitating production workarounds.

Integrated circuit specifications were relatively complex and acquiring control board approval took longer than planned. Additionally, a large impact resulted from the negotiations of requirements with the parts manufacturers. The in-process control requirements placed on piece parts by SAMSO-STD73-2C resulted in protracted fabrication time.

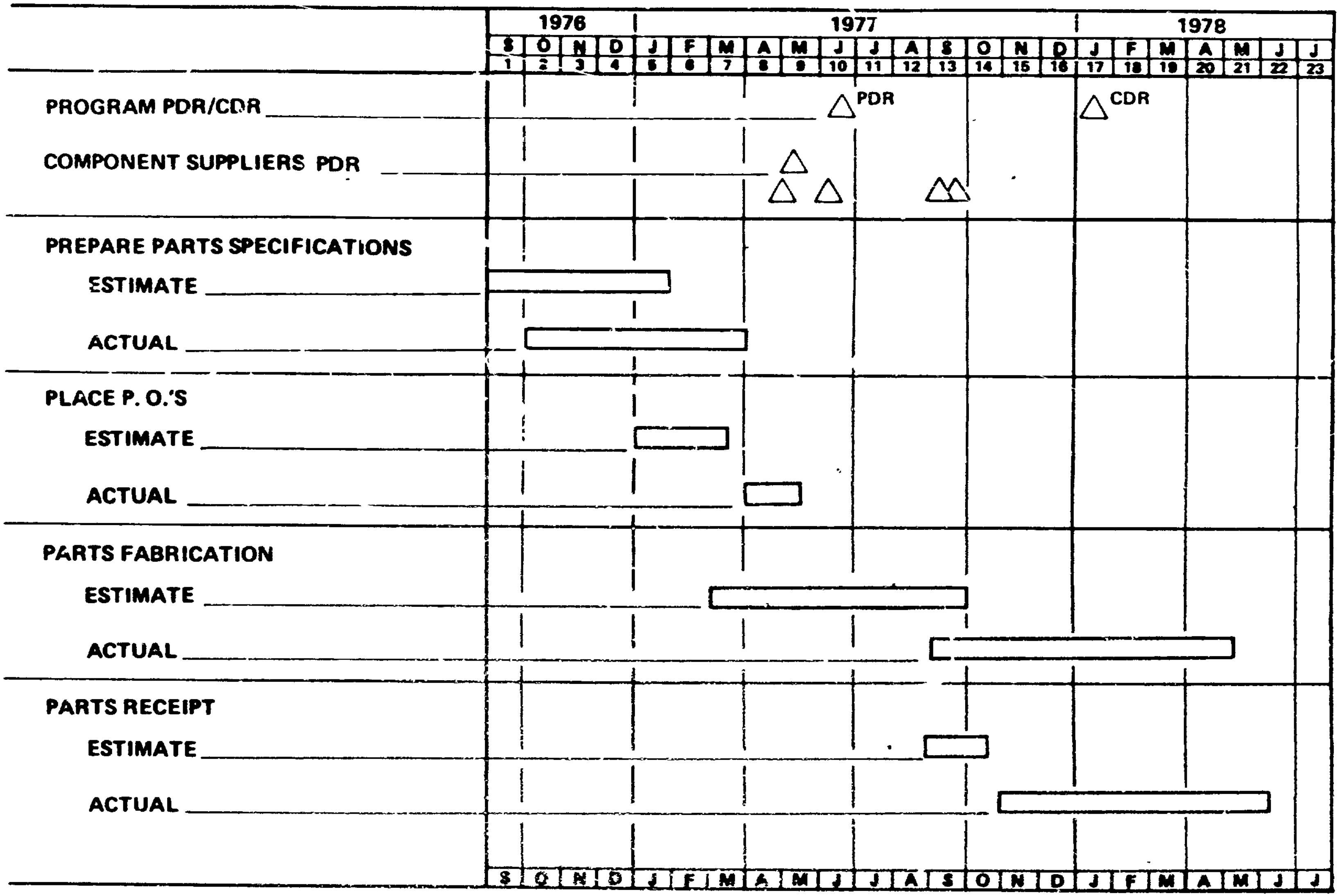

FIGURE 3-1. AMaRV PARTS TIMETABLE — HYBRIDS

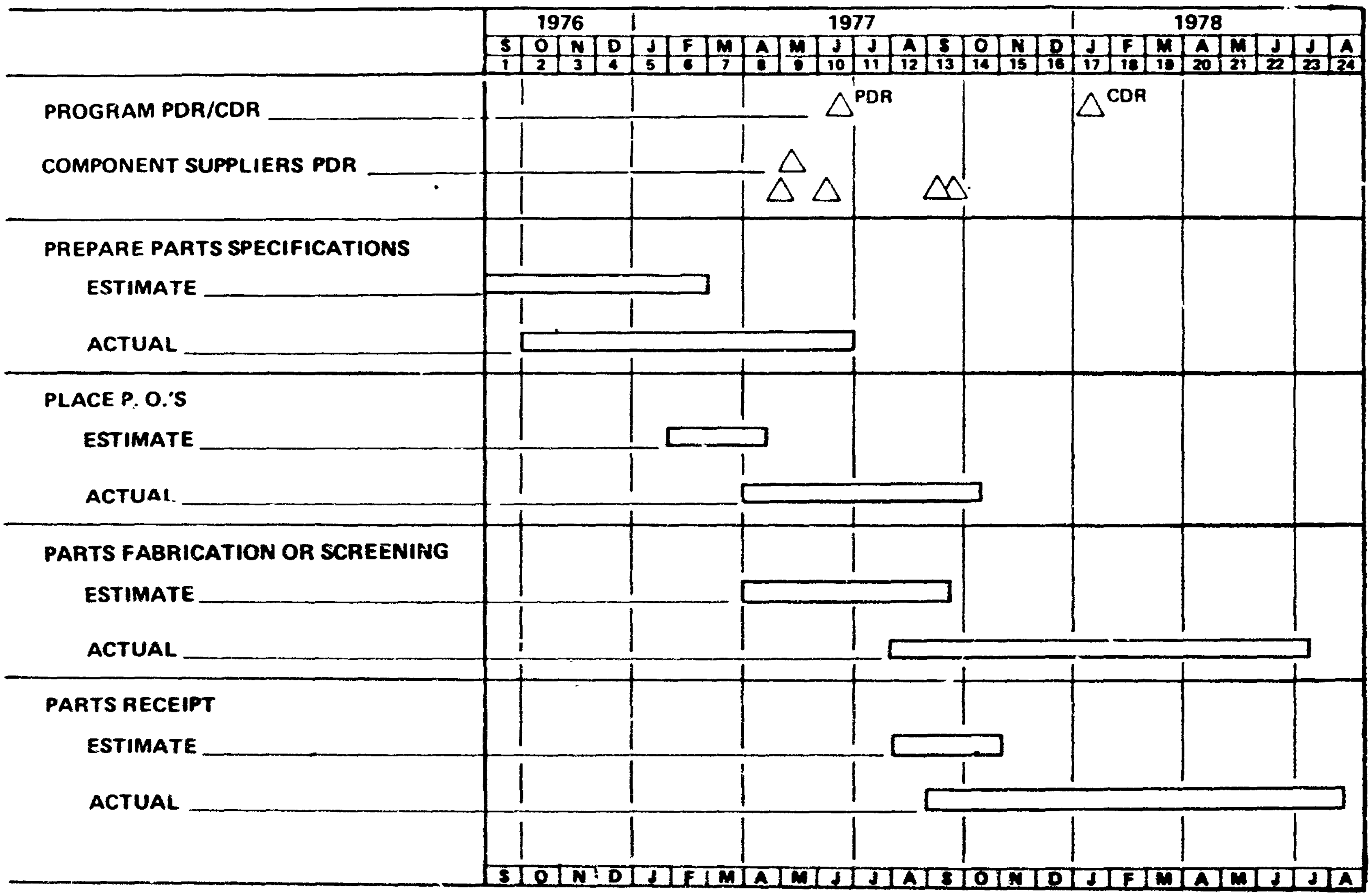

FIGURE 3-2. AMaRV PARTS TIMETABLE – INTEGRATED CIRCUITS

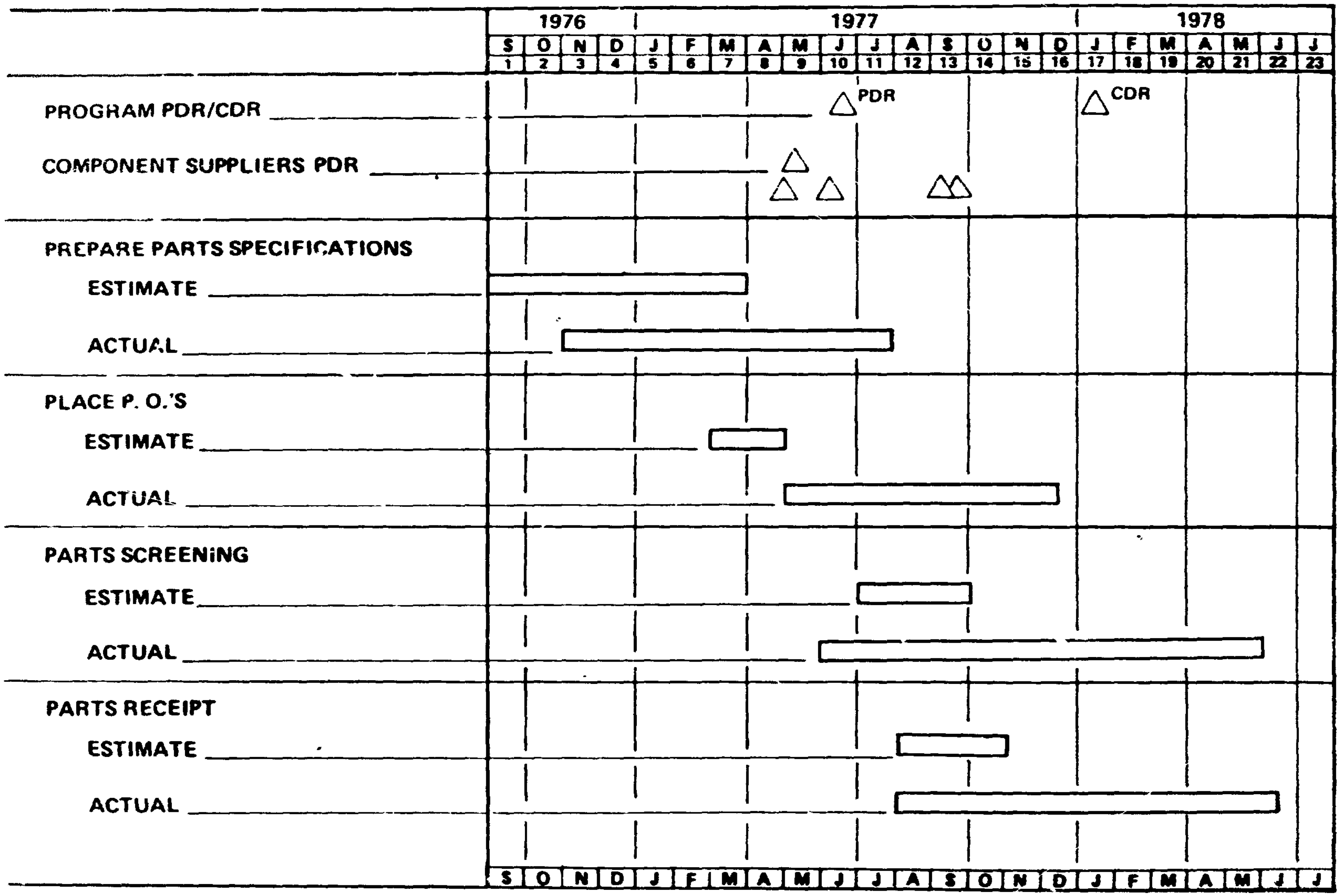

FIGURE 3-3. AMaRV PARTS TIMETABLE – TRANSISTOR, DIODE

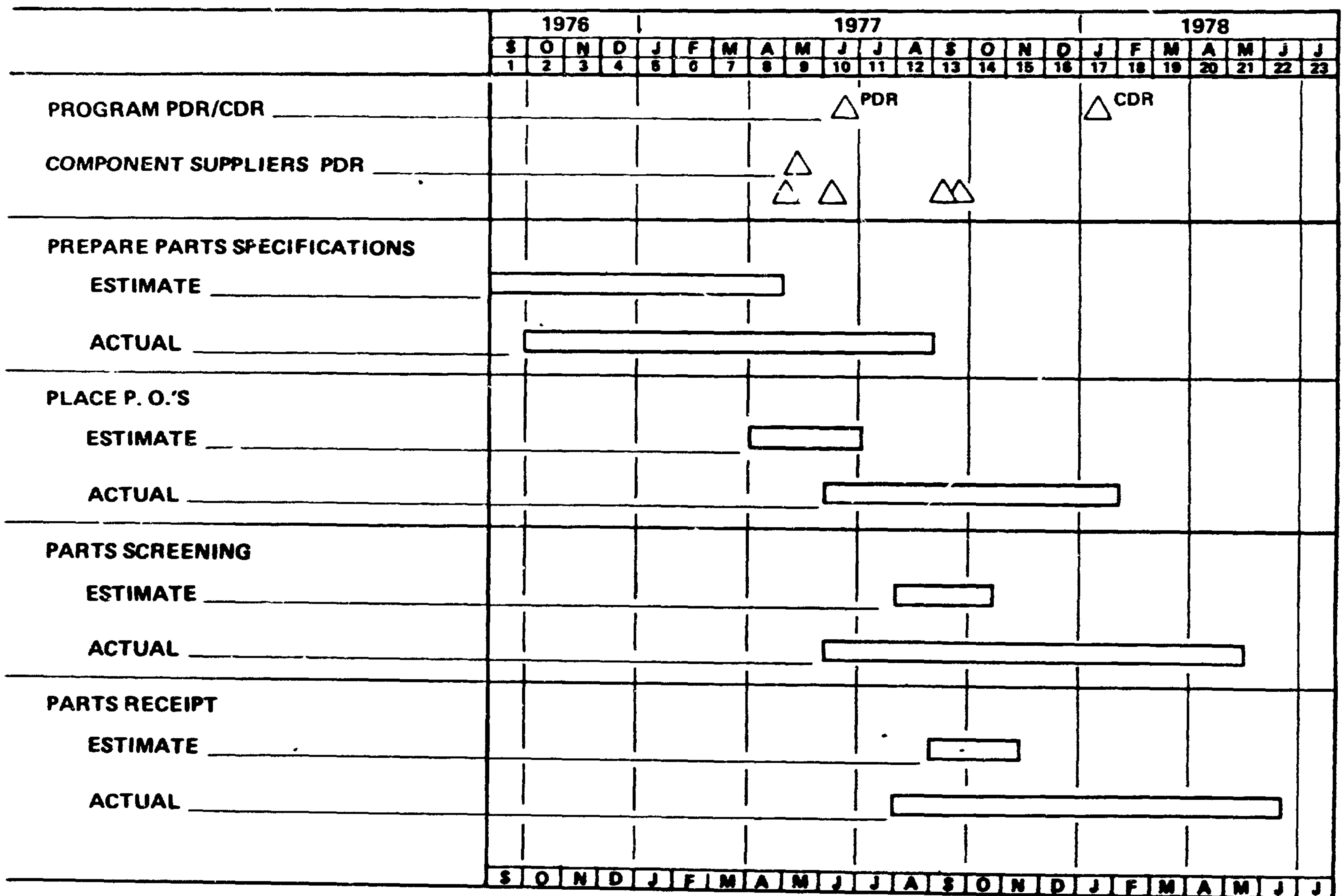

FIGURE 3-4. AMaRV PARTS TIMETABLE – PASSIVES

3.1 SCHEDULE IMPACT OF SAMSO-STD73-2C (Cont'd)

Transistors and diodes were later than planned because of the rigorous specification approval cycle and because of lot failures. The six months planned for final purchase order to final delivery was not realized. The placement of purchase orders for this part category proved to be much more time consuming than anticipated due largely to the reluctance of the parts industry to comply with AMaRV requirements.

Passives and magnetics were allocated the least lead time (four months) and although specifications were complete in August, purchase orders were not complete until January. A substantial part of the slip for resistors and capacitors was caused by single source procurement and the finding that particular values were in short supply. The quality resistor and capacitor manufacturers were generally unwilling to modify their production schedules even when their stock of a particular item was exhausted.

In summary, AMaRV parts acquisition was eight to ten months later than planned. Lot failures clearly had severe impact. Typical examples are the parts listed below. Each of these parts experienced failures during testing that was unique to SAMSO-STD73-2C requirements.

A. 1D40509-1, 2N5277, NPN Power Transistor

This power transistor had a fallout on PIND testing in excess of 90%. Ultimately, the parts were parylened.

B. 1D40506, X5KR503 (D5K1), Unijunction

Two lots failed the pre-screen DPA. The third lot was acceptable. Typical lead times for this type of parts should be in excess of 20 weeks.

C. 1D40508-1, LF156, Operational Amplifier

Several lots were scrapped due to SEM failures. The proposed fix for this part was to substitute a rescreened LF156/883.

D. A532A126-101 (2N4399), Transistor

This pool part had PIND failures causing a parylene rework. The parylene rework was considered successful though an expensive approach.

E. 1B98772-501, Hybrid

This part also failed PIND tests and had to be parylened. This required resubmittal to electrical tests and 1000 hr. life test. In addition, wire bond tests on 1000 hour life test samples produced failures resulting in extensive failure analysis prior to acceptance of the parts. Wire bond strength was less than required by the military specification, but by analysis was determined to be adequate for program needs.

3.1 SCHEDULE IMPACT OF SAMSO-STD73-2C (Cont'd)

F. 1D40503-1, Transistor

The first lot of this device failed pre-cap visual causing the rebuild of another lot. The second lot and the third lot both failed PIND test resulting in parylene rework.

G. 1D40512-527, JANTXV1N5816

Failures of this part during the 1000 hour life test were such that a second lot had to be created. After screening and reviewing the data, the second lot had such a large fallout that it was also scrapped. The final result was to redesign the circuit to delete use of this part.

Effectively the AMaRV parts program consumed all of the positive slack and margin built into the initial schedule and put into effect numerous work-around options. Quantities of parts for the AMaRV program were relatively small. This coupled with very extensive requirements, caused significant delays in parts delivery. Special parts (those with requirements tighter than MIL-Spec) were even more difficult to obtain. Significant problems were encountered with PIND testing and temperature testing. Failures in these areas caused many lots to be scrapped and new lots reordered. In some cases as many as four lots were required to produce sufficient quantities for the program. Workaround plans were established for all these lots which included parylening, relaxing of parameters, etc. Each of these plans were presented to the PMPCB for their concurrence. The inability of vendors to deliver parts to AMaRV requirements on schedule resulted in a close surveillance by program management and responsible supervision, taking much time away from other tasks.

3.2 Results of Qualification/ATP Failures With and Without 73-2C

Piece part failures occurred during Production Acceptance Testing (PAT) and Qualification Testing of AMaRV components (black boxes) and electronic systems. There were 12 failures during PAT and 6 failures during Qualification Testing, due to piece parts (Table 3-1). The implementation of 73-2C should result in a reduction in the failures encountered during PAT and qualification testing and a savings as shown in the following section.

3.3 Savings on Component/ETU Acceptance and Qualification

It is fair to assume that piece part failures in equipment acceptance and qualification test were reduced due to the controls and testing imposed by SAMSO-STD73-2C. It is not practical, however, to accurately predict what the AMaRV failures would have been without SAMSO-STD73-2C controls. The Advanced Controlled Experiment (ACE) program was similar to AMaRV but with less degree of complexity. The ACE program parts control level was M38510, Class "B" for integrated circuits, JANTX for transistors and diodes, and established reliability level P, R or S for capacitors and resistors. These are the least level of reliability considered reasonable for AMaRV and are, therefore, used for the basis of comparison.

TABLE 3-1

ELECTRONIC PART FAILURES

P/N	GENERIC P/N	NAME
PRODUCTION ACCEPTANCE TESTING		
C31016F	-------	Photomultiplier Tube
1D40512-509	1N4148	Diode
A574A644-101	-------	PWM Hybrid Module
1D40545-1	-------	Thick Film Assembly
1D40547	-------	Thick Film Assembly
1D40545-501	-------	Thick Film Assembly
LF356	LF356	Operational Amp
XN1B98939-501	LF156	Operational Amp
E1073-04	-------	Transformer
1D40452-1	------	50 Ohm Termination
A574A644-101	-------	PWM Hybrid Module
A574A644-001	-------	PWM Hybrid Module
QUALIFICATION TESTING		
971217-0111	54C929	CMOS RAM
A574A637-101	-------	TACE Hybrid Module
1D40387	-------	Thick Film Assembly
1B98786-1	LM108A	Operational Amp
1D98770-1	MN368	Instrumentation Hybrid
A574A636	-------	GLFE Hybrid Module

3.3 Savings and Component/ETU Acceptance and Qualification (Cont'd)

Cost savings were calculated using the following formula:

$$[(A \times F) = Am] \times C$$

where: A = ACE failures

F = Complexity factor

Am = AMaRV failures

C = Cost of repair & retest

The complexity factor represents a relative complexity of the ACE and AMaRV programs based on the types and quantity of parts used which are accountable under the ACE and AMaRV parts programs. For the purpose of this report a complexity factor of four (4) was used. With this factor the following cost savings were calculated:

Acceptance Test -	$400,000
Qualification Test -	$320,000
Total	$720,000

3.4 Cost Impact of SAMSO-STD73-2C

The costs associated with the implementation of SAMSO-STD73-2C on the AMaRV program are shown in Table 3-2. The costs shown are those which have been determined to be in excess of those that would have been realized without 73-2C and include baseline differential, contract changes, and overrun. The figures include labor and material costs. Distribution of MDAC labor costs is shown in Figure 3-5.

MDAC	$3,610,000
SUBCONTRACTORS	$4,140,000
GRAND TOTAL	$7,750,000

TABLE 3-2

COSTS ATTRIBUTED TO SAMSO-STD73-2C

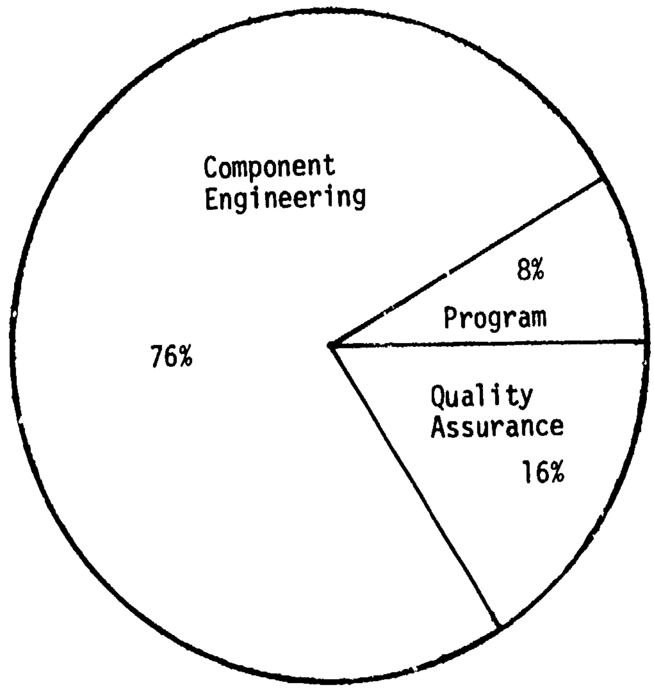

FIGURE 3-5

DISTRIBUTION OF LABOR COSTS

SECTION 4

CONCLUSIONS AND LESSONS LEARNED

4.1 CONCLUSIONS

The implementation of SAMSO-STD73-2C on the AMaRV program resulted in numerous lessons learned. This section contains the lessons learned and assessments of the effectiveness of the program

4.2 Lessons Learned

SAMSO-STD73-2C is a comprehensive document with many areas open for interpretation. This presented a problem in implementation and a need for an interpretive document such as STC0015. The efforts to properly interpret and modify SAMSO-STD73-2C for AMaRV presented a learning period during which the principal lessons learned were as follows:

A. SAMSO-STD73-2C parts lead times and the typical ABRES program schedule requirements are inconsistent. Experience has shown that parts procured to the control and screening requirements of 73-2C require lead times in excess of 18 months in some cases, particularly integrated circuits and hybrids. Typical ABRES program schedules require parts within one year of program ATP.

B. The parts manufacturing industry is generally anti 73-2C. Part manufacturers are disenchanted with relatively small quantity purchases of parts with ultra high reliability requirements. Their commercial market dwarfs the 73-2C market and some are non responsive to requests for bid. The requirement to look over their shoulder and become involved with processes which are proprietary, and the generation of unique documentation for relatively small quantities results in a reluctance of vendors to accept orders.

C. Parts specification preparation and approval processing is less expensive and time consuming if done by the prime contractor; particularly for active parts because of the difficulty in early communications of a <u>real</u> understanding of what is required.

   The best way to assure standardization of parts procurement documentation is for the prime contractor to prepare all parts specification. This prevents the misunderstanding and/or omission of requirements due to miscommunication.

D. The pooled parts approach requires rigorous management of the parts selection list. Early establishment of an approved PMPSL by the prime contractor is essential to the management of a pooled parts program. Selection can then be limited to parts on the PMPSL thereby nurturing the parts pooling concept. The use of parts not on the PMPSL would require approval of the prime contractor/PMPCB offering the opportunity to influence the use of items already on the PMPSL. This makes the PMPSL the pooling control document and a useful tool to Quality Assurance in the acceptance of parts.

4.2 Lessons Learned (Cont'd)

E. A single 73-2C interpretive document is extremely difficult to manage with multiple parts buying agencies. STC0015 was a baseline parts control document with modification of requirements necessary for each subcontractor/supplier. Managing each subcontractor against a set of varied requirements presented a difficult task. A separate document for each subcontractor/supplier is not seen as an answer either. The most manageable approach would be to have several control documents; one for new and modified flight critical design, one for existing critical design, and one for non-critical new, modified and existing design.

F. Historical performance of existing design is difficult to factor into 73-2C approval/deviation criteria. The effort to impose 73-2C requirements on parts in flight qualified existing design equipment presents problems both economically and schedule wise. The advantage in using existing design is lost if redesign and re-qualification is necessary. This type of equipment should be given consideration for exemption from 73-2C requirements.

G. Generalization of 73-2C requirements to part types and part applications is often off-optimum. An example of this is in the case of screening requirements specified in Table I of 73-2C. No distinction is made between test requirements for linear & digital integrated circuits, and also for NPN and PNP transistors. There are tests which are beneficial for one type but not both. Specific recommendation on this subject are to be found in section 5.4 of this report

H. PMPCB authority is not well defined. The operation of the PMPCB must be closely monitored and controlled. The AMaRV PMPCB was given considerable authority and leeway of operation. It can be assuredly stated that the AMaRV PMPCB performed a thorough job in management of AMaRV piece parts, but it can also be stated that many tasks/action items were generated by the PMPCB which resulted in cost to the program in excess of scope. This can be avoided by a closer review by customer and contractor program offices of PMPCB action for out of scope activity.

I. The PMP plan is a critical document affecting all contractor/subcontractor departments and should have major management attention and must be complete and understood early. The PMP plan with all program requirements and modifications for each subcontractor is a complex document. It must be completed and coordinated early in the program and must be fully understood by all contractor/subcontractor departments. Otherwise, it is difficult to manage. Many departments are affected and it is necessary that they be aware of their required tasks.

J. Materials and processes issues and parts applications are inappropriate subjects for a PMPCB activity. They should be treated in design reviews instead.

4.2 Lessons Learned (Cont'd)

K. PMPCB data requirements should be recognized as a major cost. Initially, five sets of each data item was required for distribution at each PMPCB meeting. This included Step 1, 2 and 3 data, original and revisions, Screening Summary Reports, DPA data, NCR's, Failure Analysis Reports, status sheets, and PMPCB minutes. Actually, a large amount of detail screening data was also distributed. At least half a million pages of data were distributed for the AMaRV parts program. Several data clerks were occupied full time during the peak data periods of the program, receiving and logging data, obtaining copies, sorting into sets, and delivering to PMPCB meetings. The reproduction costs alone were significant, not to mention the hours consumed to review data by all those receiving copies. Much of this activity was redundant.

L. Original screening data is not readily obtainable with off-the-shelf parts. Many parts were purchased from distributors from whom the data was not available. It was available from the part manufacturers at additional cost and delay and, therefore, was often not obtained. The requirement for original screening data should be deleted.

M. Confusing and/or conflicting quality requirements exist between SAMSO-STD73-2C and other quality documents such as SAMSO-STD73-5B and MIL-Q-9858. These particularly occur in the requirements for inspection, receiving test, and non-conformance documentation. SAMSO-STD73-2C as interpreted for AMaRV required the contractor to perform 100% precap visual inspection following manufacturer precap visual inspection. SAMSO-STD73-5 requires effective use of existing inspection techniques, the elimination of redundancy, and establishment of confidence in manufacturers procedures and then monitor on sample basis. SAMSO-STD73-2C requires 100% receiving test on all parts, while MIL-STD-1435, a sub tier document of 73-5 stipulates maximum use should be made of monitored part manufacturer final testing in lieu of incoming receiving test.

N. Parts program requirements should be clearly defined and understood as early as possible. Several months were consumed interpreting SAMSO-STD73-2C following ATP. This resulted in a delay in firming requirements and transmitting them to subcontractors. By that time the contractor/subcontractors had committed themselves in part documentation in an effort to meet schedule. This resulted in change orders, documentation changes, and resubmittal for review, all resulting in program delay.

O. The PMPSL is a very useful working tool only if it receives a baseline approval early in the program.

4.2 Lessons Learned (Cont'd)

P. Non-standard part approval requests (NSPAR's) were over used. The PMPCB required than an NSPAR be submitted for every part on the PMPSL's, standard parts as well as non-standard parts. This presented a distorted view of the ratio of non-standard to standard parts used. The use of NSPAR's should be limited to non-standard parts only.

Q. Parts rescreening provides the optimum approach to parts acquisition to meet program reliability and schedule needs. Parts for the AMaRV program were procured by two methods: 1) New buy, monitored line parts manufactured and screened to AMaRV specifications, and 2) Off-the-shelf Military Specification parts rescreened by an independent screening house. The new buy parts were primarily complex parts, hybrids and integrated circuits, and sole source procurements, where vendor problems created major program impact. Off-the-shelf parts were generally available and the re-screen time was reasonably predictable.

4.3 Assessment of Government Role in Future Piece Parts Program

Experience on programs which had full or tailored SAMSO-STD73-2C PMP programs should provide the applicable government agencies with important lessons for future procurements. The problems encountered with interpretation of requirements, the reluctance of some subcontractors to understand, much less comply, and the difficulty and long lead times experienced in obtaining parts to meet requirements, are strong evidence to the need to take a good look at SAMSO-STD73-2C to see if there is a more practical and cost effective approach. This responsibility should lie with the government organizations and Parts Review Agencies who have the experience with SAMSO-STD73-2C implementation and have actively participated on a PMPCB.

4.3.1 <u>Inter-Agency Support</u>

Each government agency has a hi-reliability PMP Program requirements document, and each of these tailor versions for different contracts. There are different documents imposed by the same agency and different interpretations of the same document by different program offices within the same government agency. This imposes severe impact on the contractor/subcontractor/supplier who are attempting to standardize their parts activities. One set of uniform requirements among agencies for each reliability level should be the goal. To do this there should be more communication between agencies. The efforts of the Space Parts Working Group (SPWG) coupled with Electronics Industries of America (EIA) is an approach. However, the coordination efforts of these groups should be more timely. A special task team consisting of government agencies including NASA and industry with experience on sophisticated PMP programs such as SAMSO-STD73-2C should be assigned the task to expedite the formulation of a uniform PMP control program. Dedicate specific people full time to accomplish the task and utilize part time committee people only as necessary. Another solution would be to fund an organization in private industry which has implemented parts program for Air Force and NASA to prepare a proposed program.

4.3.2 Request for Proposal (RFP) Preparation

Parts program requirements contained in request for proposals should be pre-tailored to take schedule into consideration. Implementation of SAMSO-STD73-2C on programs requiring hardware fabrication within one year is not practical due to lead times for parts. Pre-RFP activity should include meetings with potential bidders to clarify the parts control bid baseline. One of the problems experienced on AMaRV was due to the unclear definition of data requirements. The RFP should be explicit on the parts data required for review. Once defined and understood, it can be bid as baseline and any additional requests after start of contract will be negotiable.

The inter-relationship of the numerous specifications applicable to parts should be more clearly defined in RFP's. Often there are redundant and conflicting requirements with precedence not defined. SAMSO-STD73-2C and SAMSO-STD73-5 are examples. A matrix of requirement relationships and precedence would be helpful. Scope of control should be defined clearly in regard to the part types to fall within the control program.

The RFP should specify that all effort associated with PMP control program shall be identified under one block in the work breakdown structure for bidding and accountability purposes. This method is discussed in more detail in Section 5.7.

4.3.3 Proposal Evaluations

Proposal evaluation becomes a routine and equitable task when performed to a clearly defined set of baseline requirements. A common checklist of tasks to be performed and grading system can be used by the evaluator. When bidders propose varied interpretation of generally defined requirements, it is difficult to properly evaluate the bid. Bidders conferences mentioned earlier in Section 4.3.2 would result in bidding a more uniform task baseline and facilitate proposal evaluation. It would also be cost effective and a minimum impact on schedule to allow contractors to utilize existing parts control programs when they meet the reliability requirements imposed by the customer.

4.4 PMPCB Effectiveness

The PMPCB highlighted many potential problems on the AMaRV program. The PMPCB required that the complete history of failures be maintained on all parts so that future investigation could be conducted. Significant time was spent and schedule delays were caused by having the Parts Board activity in series. The Parts Board could have been just as effective by having fewer meetings in which sampling of the various documents was accomplished.

Numerous hours were spent in PMPCB meetings in discussions unrelated to improving the quality of the parts. In many cases, program schedules drove the decision to the best solution after many exhaustive debates in the PMPCB. Generally the PMPCB activity was an "over kill" on some problems.

4.5 Effectiveness of Screening Labs

Screening labs were used on the AMaRV program as an alternate approach to having contractor personnel at every parts supplier to witness precap visual and various in-process inspection points. In lieu of the on-site surveillance the plan used was to procure JANTXV, M38510B, or ER level R or S components or their equivalent and have them rescreened to their basic specification at an independent test laboratory. Rejection rate was higher than expected resulting in returning total lots of parts or providing some type of work-around plan such as parylening for loose particle detection, etc. From a technical standpoint it is thought that the utilization of an outside screening laboratory was very successful and provided a much higher confidence in the parts finally used in manufacturing of the AMaRV vehicle.

The use of an outside screening laboratory resulted in a cost savings compared to on-site surveillance. The surveillance method would have been impossible in a few cases as there are some suppliers that will not allow outside personnel to witness many of their processes.

To meet the AMaRV requirements the best technical and cost effective procedure was to use an outside screening laboratory.

4.6 Effectiveness of Parts Pooling

The pool parts program accounted for 13% (35 of 271) of the total microcircuit and semiconductor device types broken down as follows:

Device Types	Number Pooled	Number Total	Percentage
Digital Microcircuits	17	114	15
Analog Microcircuits	6	25	24
Transistors	8	59	14
Diodes	4	73	5

MDAC coordinated the quantities and device types and negotiated with the procuring subcontractor to provide the parts for all users. These subcontractors were selected to provide parts to nine users. The pool parts program had the following advantages:

A. Reduction of specifications.

B. Reduction of lots and DPA samples.

C. Reduction of test lab negotiations.

D. Reduction in surveillance cost.

E. Reduction in cost of failure analysis monitoring.

F. Potential piece part cost savings.

G. Potential piece parts schedule.

4.6 Effectiveness of Parts Pooling (Cont'd)

The AMaRV parts pooling program had the following disadvantages:

A. There was continuous revision of device types and quantities which necessitated constant negotiations between MDAC and the procuring subcontractor, and between the procuring subcontractor and the parts vendor. This was caused by (1) the lack of design maturing and (2) contract award to subcontractors after the pool part program had been established.

B. There was considerable cost risk in the event of late parts delivery. Each user could properly claim schedule impact for late parts delivery over which he has no control. This can only be avoided by assuring that part deliveries are on schedule.

C. Increased documentation coordination with each user was required to (1) demonstrate parts conformance with high reliability requirements to each users quality department and (2) obtain user concurrence with the dispositions of part nonconformances.

D. Since the user subcontractor must coordinate design details and part parameters to the prime contractor, the lead time for a new pool part was increased.

The following conclusions were drawn from AMaRV part pooling experience:

A. Sufficient design maturity and parts identification are essential to initiate the program to minimize unnecessary efforts associated with incorrect part numbers and unnecessary quantities.

B. The technical benefits of stricter parts management are realized, but are likely to cause major cost and schedule impacts.

4.7 Cost Effectiveness of SAMSO-STD73-2C

The estimated cost savings to acceptance and qualification test as a result of SAMSO-STD73-2C controls was discussed in paragraph 2.9. Total cost attributed to SAMSO-STD73-2C were shown in Table 3-2. The estimation of the cost effectiveness on the total program must take into consideration both of these items as well as the total savings realized in failure reduction.

The determination of cost effectiveness involves a comparison of AMaRV to a program of similar magnitude without 73-2C controls. The same basis of comparison is used for cost effectiveness estimation that was used for ATP/Qualification savings where the ACE program was used as a comparison vehicle. Piece part failures for the ACE and AMaRV program were tabulated. The quantities of ACE failures at each stage, i.e., receiving, next assembly, box and vehicle were multiplied by a complexity factor of four (4) to arrive at an adjusted figure representing estimated failures for AMaRV without 73-2C controls. The evaluation of cost effectiveness using the failure rate quality

4.7 Cost Effectiveness of SAMSO-STD73-2C (cont'd)

factors from MIL-HDBK-217 was given consideration; however, the failure avoidance would have been less. Therefore, a relative complexity AMaRV/ACE factor was adopted for this study. The difference between the adjusted ACE failures and actual AMaRV failure are considered failures which were avoided due to 73-2C controls. The figure has been further adjusted by subtraction of those failures considered in the ATP/Qual cost savings.

Based on the failure figures thus calculated, the failure cost avoidance amounted to $1,340,000. The total cost avoidance/savings as compared to the costs attributed to SAMSO-STD73-2C are shown in Table 4-1

At the time of writing this report there had not been a mission failure traceable to a piece part failure. Two of three flight tests remain. Should the remaining flights be successful, it is not reasonable to assume that there would have been a mission failure if SAMSO-STD73-2C had not been imposed on the program. It is too early therefore to assess the cost effectiveness of the additional screening and controls on the completed program. Even upon program completion, an evaluation can only be based on a speculation of what might have happened if SAMSO-STD73-2C had not have been implemented.

Cost Avoidance - Failures	$ 370,000
Cost Avoidance - Reorder	$ 250,000
Cost Avoidance - ATP/Qual Test	$ 720,000
Total Cost Avoidance/Savings	$1,340,000
Cost of SAMSO-STD73-2C	$7,750,000

TABLE 4-1

COST SAVINGS VS. COST OF SAMSO-STD73-2C

SECTION 5

RECOMMENDATIONS FOR FUTURE PROGRAMS

5.1 RECOMMENDATIONS

The MDAC-HB recommendations are shown in Table 5-1 and in the following subsections.

During the proposal preparation phase for AMaRV, MDAC had difficulty in interpreting the RFP parts program requirements and in scoping the parts program which we incorporated in our bid. This appears to be an industry wide problem. In-depth seminars and bidder's briefings taking place during the pre-proposal and proposal phases and involving BMO and the prime contractors would lead to mutual understanding of the parts program requirements prior to the program planning and bid phase and would result in a significant improvement of the quality of the prime contractor's proposals. Of particular difficulty to MDAC in interpreting BMO's desires was the parts program requirements for Existing Design Components. Clarification of this area during the proposal phase would be of particular benefit. The scope of the PMPCB activity is left undefined and has a great influence on the scope of the parts program. If not controlled, it can drive parts program costs out of scope. Recommended modifications to the PMPCB are discussed in Section 5.2.

The PMPCB had a problem in agreeing on the magnitude and polarity of the benefits provided by specific requirements. It is generally possible to determine whether a particular requirement benefits or degrades quality, but difficult to quantify how much. Of particular concern on the AMaRV program has been the data requirements. Much of the required data are obtained so that it will be available for reference if a problem develops. AMaRV experience has shown this to be a very costly luxury. In many cases, data are extremely difficult to obtain and significant delays as well as costs have been experienced because of data requirements. MDAC recommends that parts data requirements on future ABRES programs be minimized. Data resulting from the screening (or rescreening) accomplished specifically for the program should be required for all parts. Other part/lot data should be obtained only when required for disposition of a lot problem. Step I data should be streamlined as much as possible. These data serve no real function once a part is approved for use and thus have a very short useful life. The format should be tailored to the needs for the several categories of nonstandard parts.

5.2 Modified PMPCB Operation

Future PMPCB activity should be clearly defined prior to ATP of any program. The charter should be established well in advance. If this is not possible, a time limit should be presented to the Parts Board by program management for establishing an agreed upon charter. Massive amounts of data should be minimized by requiring Parts Board members to informally spot check data. Mechanized status sheets should be maintained to give all Parts Board members visibility of potential problem areas. PMPCB activity should be centered on parts. The less complex part type such as passive components should be reviewed and require a much less stringent parts control program. Parts Board meetings should be limited to significant parts problems instead of an education program as to why different part types are being used in flight systems. Informal visits of Parts Board members to design areas should be encouraged in place of personal presentations. If the methods described above

TABLE 5-1 RECOMMENDATIONS

RECOMMENDATION	REASON
1. Unified government parts program standards should be considered: Air Force-Army-Navy-NASA.	This would allow contractors to standardize parts control programs. Each government agency varies in requirements such as minimum screening, DPA sample size, accept/reject criteria, etc.
2. Industry (part users and part makers) should participate in preparation of the defining documents of the parts program.	This would allow all involved agencies to participate and reach a level of agreement on requirements. It would present a method of preventing costs from becoming prohibitive.
3. BMO should hold seminars/bidders' conferences to acquaint contractors and the parts industry with detailed and specific parts program definition.	Contractors would be familiar with requirements and, therefore, bid/ and implement more cost effective parts control programs.
4. Special tailoring of parts program requirements for existing design should be clearly defined prior to the proposal period.	To allow preparation of representative parts programs in subcontractor RFP's and result in more accurate response.
5. BMO should define components for which existing design with existing parts practices are acceptable (e.g., C-Band beacon).	Same as item 4.
6. The control of materials and processes and of parts applications (except those involved with part manufacture and test) should be separated from the parts program.	Materials and processes are best reviewed during design review.

TABLE 5-1 RECOMMENDATIONS (Cont'd)

RECOMMENDATION	REASON
7. The relationship of tasks required by SAMSO-STD73-2C, SAMSO-STD73-5, and MIL-Q-9858 should be defined for PMP and redundancy & conflict deleted.	This will reduce duplication of effort and reduce cost. Parts application, derating, and box mechanical and thermal design should be the responsibility of the design technology, and the subject of design review. Parts selection, specification, test, and acceptance should be monitored by the PMPCB.
8. Parts screening and incoming acceptance tests should be patterned for each part type and not be too universal. Sample sizes for DPA and QCI should be flexible to part complexity and cost.	Some tests/inspections are not as affective on some parts as others (for specific recommended modifications to screening refer to section 5.4). Incoming receiving tests for connectors differ from what is practical for electronic parts.
9. Data requirements shoud be minimized and defined in the CDRL.	Data acquisition and review can present a sizeable cost impact. Data not defined in the CDRL should be out of scope and subject to negotiation.
10. The definition of program standard part should be more clearly defined and include all parts which are procured to program requirements thus reducing the "non-standard" part count and proliferation of NSPAR data.	Standard part definition varies from program to program. Too many NSPAR's were processed on AMaRV, some for standard parts.
11. NSPAR data should be minimized with more reliance placed on screening (or rescreen) and acceptance test data. Step 1 data should be in a simple standard form. Groups A, B, and C data and original screening data should be obtained only where there is cause to suspect a problem.	NSPAR data can become voluminous and of varied content if not controlled. Reproduction costs can also be reduced.

TABLE 5-1 RECOMMENDATIONS (Cont'd)

RECOMMENDATION	REASON
12. Parts programs should be contracted as cost plus fixed fee (CPFF).	Parts are procured to fixed customer requirements with waivers/deviations only as approved by the customer. There is incentive for design of equipments, whereas most parts are existing design.
13. Parts selection lists and status sheets should be computer automated.	It is virtually impossible to manually maintain a large amount of parts data accurately and in timely fashion.
14. Operation of the PMPCB should be closely monitored to prevent initiation of action which results in out of scope work.	Experience on AMaRV showed that PMPCB activity had a strong influence on program activity and cost.
15. The prime contractor should prepare all part specifications and supply all pooled parts.	This will provide a central control point with standardized procurement documentation and ability to minimize the use of different types of parts. All data would be available in one file.
16. Wider use should be made of the off-the-shelf rescreen process with: a. Contractor surveillance only on hybrids and complex integrated circuits. b. Rescreen all transistors and diodes. c. Rescreen complex passives only.	This has proven to be an effective method of supplying reliable parts. Vendor problems are minimized and rescreen schedules are shorter than new-buy and more predictable.
17. Formal qualification of parts should only be required when determined necessary by the PMPCB.	Most parts types used are of a design previously qualified or can be qualified by similarity.

are impossible or impractical to apply to curtail the impact of PMPCB operations on program scope, it is recommended that the government consider contracting the parts program tasks as cost plus fixed fee.

The overlap of the PMPCB scope with the QA organization and the design and review activities of the electronics components should be minimized. In particular it is felt that circuit design/and derating and black box mechanical/thermal design are best handled by the design activities and the design working groups whereas the principal efforts of the PMPCB should be directed towards parts selection, specification, test requirements, deviation evaluation and other considerations relating to part quality/reliability.

5.3 Improved Documentation

The specific types of documentation and format required for a contract should be clearly defined in the request for quote. There were a number of documents used on AMaRV for which no contract data description existed causing variations in style and format. Typical of these were the parts procurement documents, DPA procedures, screening summary reports, parts status reports, and the PMPCB meeting minutes. The amount of documentation to be submitted, reviewed by the PMPCB, and filed by contractor/subcontractor should be minimized. Too many types and copies of data were handled on the AMaRV program. The submittal for review of multiple copies of every document should be replaced by submittal of one copy of a sample from each type of document, i.e., typical specification for each part type complete with requirements, a typical procedure, a standardized test summary, and a mechanized standard parts status report for the complete program parts list. The format for presentation of NSPAR data, Step 1, 2 and 3 should also be to a standardized format and require submittal of a minimum number of copies.

5.3.1 PMPCB Minutes

The PMPCB minutes were the principal record of PMP transactions for the AMaRV program. The content, however, varied throughout the program, requiring additional memoranda to be released to provide a complete record. The PMPCB meeting minute format and content should be established to record all key transactions, agreements, data submittal and results of review, and action items and resolutions that occur, with no variation in content throughout the program.

5.3.2 Status Reports

Status report content should contain only the detail necessary to track milestones. Tracking status in too much detail results in a time consuming task, and often in an incomplete report. The recommended key milestones are:

5.3.2 Status Reports (Cont'd)

Date Approved by the PMPCB
Purchase Order Number
Purchase Order Date
Quantity
Will Ship Date
Parts Need Date
Parts Into Screen/Rescreen Date
Parts Out of Screen/Rescreen Date
Parts Receipt Date
Parts Into DPA Date
Parts Out of DPA Date
Parts In Stock Date

5.3.3 Test Summary

Test summary sheets should be of uniform format and should list the appropriate screen/rescreen tests in the correct sequence. All discrepancies involving in vs. out quantities should be explained.

5.3.4 Procurement Documents

Parts Procurement Documents (Specifications) should be complete and uniform in content. Specification drawing format is controlled by the applicable engineering drawing requirements for the contract and may offer some leeway from contract to contract. Nevertheless, the parts procurement document should clearly define the applicable program screen/rescreen requirements.

5.4 Improvements to Parts Screening

In the tailoring of the SAMSO-STD-73-2C Parts Screening Program for AMaRV, MDAC-HB incorporated a desired test sequence which included electrical measurements both before and after burn-in, and also after temperature cycling. This sequence is necessary to determine the effects of the two noted tests. Other recommended improvements to the SAMSO-STD-73-2C screening matrix, Table I are:

A. Divide integrated circuits into linear and digital categories with the same tests as shown in Table I except eliminate High temp reverse bias for digital devices. High temp reverse bias is not an effective test for this type device.

B. Require PIND testing for all active devices except for those of voidless construction. This was a requirement on AMaRV and proved to be an effective screen.

C. Require high temp reverse bias (HTRB) for PNP devices only. PNP devices are more susceptible to channeling and ionic contamination and HTRB is effective in detecting these anomalies.

5.4 Improvements to Parts Screening (Cont'd)

D. Delete radiographic inspection for carbon film and metal film resistors, filters and inductors. It results in numerous rejections requiring MRB action or conditions which are essentially benign. None of the X-ray rejects for these type devices would have been a usage problem.

E. Delete Destructive Physical Analysis (DPA) for mica capacitors. There is no more reason to perform DPA on mica capacitors than on other types omitted.

F. Add DPA for connectors. It has proven to be worthwhile on other programs and is currently required on tailorings of SAMSO-STD73-2C for recent programs such as SGS-II.

G. Perform internal visual examination at receiving inspection on a sample basis only. This examination by SAMSO-STD73-2C criteria, i.e., 10X minimum is not effective. Many rejects were made for cosmetic reasons only. Few were of functional nature.

From experience gained on the AMaRV and other screening programs such as Delta, Saturn, Skylab, and the Payload Assist Module (PAM), MDAC concludes that the most effective screening tests are temperature cycle, burn-in and PIND test followed by Destructive Physical Analysis (DPA). Electrical measurements should be taken before and after burn-in and temperature cycle.

5.5 Alternative to SAMSO-STD73-2C

The proposed Military Standards, MIL-STD-1546 and MIL-STD-1547, which are to propose to replace SAMSO-STD73-2C have been in coordination for over a year. MDAC-HB has commented on these standards through participation on the Space Parts Working Group (SPWG). These comments are included in the report as Appendix D.

5.6 Management of Non-Conforming Parts

AMaRV part non-conformances were processed by the utilization of a non-conformance report (NCR). This report listed all pertinent data such as the anomaly, any information that would lead to an expedient solution, next assembly information and any additional procurement information. The non-conformance reports were reviewed by members of the PMPCB and the solution recorded on the report. The completed non-conformance report was then transmitted to the program office for review by program management. The NCR system was established so that all required disciplines were involved in the review and disposition. This proved to be an effective system, requiring a minimum of time from all members of the PMPCB.

Records were kept of all NCR's, a total of 686 were prepared.

5.6 Management of Non-Conforming Parts (Cont'd)

Part non-conformances or any actions requiring failure analysis should be handled with as much expediency as possible. Often, this type of activity can be accomplished by telephone conversation and need only to be identified in the minutes of Parts Board meetings. Parts non-conformances should be transmitted to program management as soon as they occur. Non-conformances should be resolved by a joint effort of the program members and the PMPCB. MRB activity should be simple and should include the Parts Board in a parallel mode, not in series. Operating systems need to be established so that the Quality Assurance organization, Parts Board, and the complete program all work to the same procedure.

5.7 Work Breakdown Structure

It is recommended for future programs that all of the effort associated with the Parts Management Program be contained within one work breakdown structure (WBS) block, or set of WBS blocks of limited number. All tasks performed by the groups supporting the parts program, i.e., Components, Design Engineering, Effectiveness, Quality Assurance, etc., would be listed in the parts program WBS block(s). This method of task WBS definition of the overall parts program could be bid more accurately and managed more efficiently after program ATP.

5.8 Parts Pooling

As the AMaRV prime contractor, MDAC has considered the parts pooling concept for future programs. The following are the MDAC recommendations associated with parts pooling programs:

A. Special parts (hybrids, tubes, oscillators, crystals) should be exempted from the pool parts program in that they require the procuring subcontractor to develop the expertise that already exists within the user subcontractor.

B. In order to realize maximum parts costs reduction, one agency should provide all parts to all users and the decision to do this must be made during the proposal phase. Primary cost reduction is due to a single buy effort of one purchaser, not from quantity price breaks.

C. MDAC endorses the parts pool concept as the optimum approach to provide high reliability parts at the most cost effective price. MDAC recommends that the prime contractor assume the responsibility for the drawing requirements, the quality assurance provisions, the procurement activity and the distribution of pool parts.

APPENDIX A
STC0015 AS IMPLEMENTED ON AMARV

A-1 INTRODUCTION

MDAC-HB Standard Practice STC0015 "Parts, Materials and Processes Control Program for AMaRV" is the basic PMP control document for AMaRV. As explained in the body of the Piece Parts Report, Section 2, STC0015 contained the requirements most common to the Avionics Equipment and was modified by supplemental requirements or deletion of requirements in equipment specifications. Two revisions of STC0015 were implemented. The "B" revision was prepared in the early months of the program by MDAC-HB and coordinated with and approved by the PMPCB. As the program progressed, further clarification of requirements necessitated release of the "C" Revision. Both revisions are therefore contained in this appendix. In addition, copies of AMaRV CDRL's A021 and A022 are included in this appendix.

1. SCOPE

This document contains requirements for the control of electrical/electronic parts, materials and processes (PMP) for the AMaRV Program. The requirements for the selection, qualification, screening and acceptance tests are defined herein.

1.1 Requirement Identifier

The requirements defined in this document shall be identified by the identifier STC0015-3

2. REFERENCE DOCUMENTS

The following documents, and subsidiaries thereof, form a part of this Standard Practice document to the extent specified herein. In the event of conflict between documents referenced here and detail content of Section 3, the detail content of Section 3 shall be considered a superseding requirement.

SPECIFICATIONS

Military

MIL-B-121	Barrier Material, Grease Proofed, Water Proofed, Flexible
MIL-B-131	Barrier Materials Water Vapor Proofed, Flexible, Heat-Sealable
MIL-E-8189	Electronic Equipment Missiles, Boosters, and Allied Vehicles, General Specification for
MIL-R-10509	Resistor, Fixed Film (High Stability), General Specification for
MIL-C-14157	Capacitor, Fixed, Paper (Paper Plastic) or Plastic Dielectric, Direct Current (Hermetically Sealed in Metal Cases), Established Reliability, General Specification for

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LIST OF CURRENT SHEETS

NO.	REV.	NO.	REV.	NO.	REV.	NO.	REV.	NO.	REV.	NO.	REV.
1	B	7	A	13	New	19	New	25	New	31	New
2	A	8	A	14	New	20	New	26	New	32	New
3	A	9	A	15	New	21	New	27	New		
4	A	10	B	16	New	22	New	28	New		
5	A	11	B	17	New	23	New	29	New		
6	B	12	New	18	New	24	New	30	New		

CUSTODIAN: MDAC-W

PROCUREMENT SPECIFICATION	TITLE	CLASSIFICATION
	PARTS, MATERIALS AND PROCESSES CONTROL PROGRAM FOR AMaRV	STANDARD PRACTICE
		STC0015 SHEET 1 of 32

MIL-C-14409	Capacitor, Variable (Piston Type, Tubular Trimmer), General Specification for
MIL-F-15733	Filter, Radio Interference, General Specification for
MIL-S-19500	Semiconductor Device, General Specification for
MIL-F-22191	Barrier Materials, Transparent, Flexible, Heat Sealable
MIL-C-39001	Capacitor, Fixed Mica Dielectric, Established Reliability, General Specification for
MIL-C-39003	Capacitor, Fixed, Electrolytic, Tantalum (Solid-Electrolyte) Established Reliability, General Specification for
MIL-R-39005	Resistor, Fixed Wirewound (Accurate). Established Reliability, General Specification for
MIL-C-39006	Capacitor, Fixed, Electrolytic (Nonsolid Electrolyte) Tantalum, Established Reliability, General Specification for
MIL-R-39007	Resistor, Fixed, Wirewound (Power Type), Established Reliability, General Specification for
MIL-R-39008	Resistor, Fixed, Composition (Insulated), Established Reliability, General Specification for
MIL-R-39009	Resistor, Fixed, Wirewound (Power Type, Chassis Mounted), Established Reliability, General Specification for
MIL-C-39010	Coil, Fixed, Radio Frequency, Molded, Established Reliability, General Specification for
MIL-T-39013	Transformers and Inductors (Audio and Power), Established Reliability, General Specification for
MIL-C-39014	Capacitor, Fixed Ceramic Dielectric (General Purpose), Established Reliability, General Specification for
MIL-R-39015	Resistor, Variable, Wirewound (Lead Screw Actuated), Established Reliability, General Specification for
MIL-R-39016	Relay, Electromagnetic, Established Reliability, General Specification for

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MIL-R-55182	Resistor, Fixed, Film, Established Reliability, General Specification for
MIL-M-38510	Microcircuits, General Specification for
MIL-B-81705	Barrier Materials, Flexible, Electrostatic Free, Water Vapor Proof, Heat Sealable
MIL-C-83421	Capacitor, Fixed, Supermetalized Plastic Film Dielectric (DC, AC or DC and AC), Hermetically Sealed in Metal Cases, Established Reliability, General Specification for
MIL-M-0038510	Microcircuits, General Specification for

STANDARDS

Military

MIL-STD-143	Standards and Specifications, Order of Precedence for the Selection of
MIL-STD-198	Capacitors, Selection and Use of
MIL-STD-199	Resistors, Selection and Use of
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-275	Printed Wiring for Electronic Equipment
MIL-STD-701	List of Standard Semiconductor Devices
MIL-STD-750	Test Methods for Semiconductor Devices
MIL-STD-794	Part and Equipment, Procedures for Packaging and Packing of
MIL-STD-883	Test Methods and Procedures for Microelectronics
MIL-STD-1495	Multilayer Printed Wiring Boards for Electronic Equipment

OTHER GOVERNMENT AGENCIES

SAMSO-STD 73-2C	Electronic Parts, Materials and Processes for Space and Missile Applications: Standard Control Program for
SAMSO-STD 73-4A	List of Preferred Parts for Space and Missile Programs
MSFC-STD-355	Radiographic Inspection of Electronic Parts

MDAC STANDARDS

STC0016	Loose Particle Detection, Requirements for
CAP 200	DPA Procedures

3. REQUIREMENTS

3.1 Electronic Parts, Materials and Processes (PMP) Program

Electronic PMP selection and application shall be in accordance with the requirements defined herein. The PMP selection, approval, and application program will be administered by means of a PMP Control Board (PMPCB).

Parts standardization shall be a prime goal when standardization incurs little or no design penalty and for parts which prove to have substantial commonality between AMaRV contractor designs.

3.1.1 Scope of PMP Control

The parts types controlled by this program are those listed below.

Hybrid Microelectronics
Integrated Circuits
Transistors
Diodes
Capacitors
Resistors
Filters
Inductors
Coils
Transformers
Connectors
Terminal Junctions
Crystals
Relays
Fuses
RF Switches
Microswitches
Wire Terminals
Contacts
Printed Wiring Boards
Terminals
Solenoid Operated Values
Synchros
Resolvers
RF Parts
Wire
Pyrotechnic Devices

3.2 Program Parts, Materials, and Processes List (PMPSL)

A program parts, materials, and processes selection list (PMPSL) shall be prepared in accordance with the applicable supplier data article specified in the statement of work. The number of PMP types shall be minimized consistent with good design practice. The PMPSL shall be maintained and updated during the program to reflect actual usage as opposed to proposed usage. The PMPSL shall be approved by the PMPCB.

3.3 Parts, Materials and Processes (PMP) Selection

Parts, materials, and processes shall conform to the applicable documents listed in MIL-E-8189H and shall be selected in the order of precedence specified in MIL-STD-143. PMP selection shall give consideration to current ALERTS.

3.3.1 Program Standard Parts

Parts that meet the following criteria shall be considered Program Standard Parts:

a. Establi[illegible] reliability resistors, capacitors and relays in accorda[illegible] MIL-STD-199B, MIL-STD-198C and MIL-R-39016B respecti[illegible]

b. JANTXV [illegible] listed in SAMSO-STD 73-4A.

c. Monolithi[illegible], multichip and hybrid microcircuits meeting the requirements of MIL-M-38510C, Class B as a minimum.

All other parts are considered non-standard.

3.3.1.1 Use of Program Standard Parts

A maximum effort shall be m[illegible]e to use standard parts when available. When other than standard parts must be used in new design circuitry, selection shall give consideration to the future substitution of standard parts for non-standard parts. For circuitry of existing design, standard parts shall be substituted for non-standard where physically and functionally equivalent standard parts are available.

3.3.1.2 Non-Standard Part Approval

The PMPSL shall be reviewed for approval/disapproval. The PMPCB retains the authority to request specific supporting data on any non-standard part of concern.

3.3.2 Parts Selection

3.3.2.1 Microelectronics

Priority of selection of microelectronic devices, shall be Class "S" (MIL-M-0038510), Class "A" (MIL-M-38510), and Class "B" (MIL-M-38510). Hybrid devices shall meet the requirements of MIL-M-38510, Class "B" as a minimum. All microelectronic devices shall receive the 100% screening tests per Table I as a minimum.

3.3.2.2 Discrete Semiconductor Devices

Discrete semiconductor devices shall be selected from JANTXV devices qualified and procured to MIL-S-19500 as a goal. First order of selection should be of the types listed in SAMSO-STD 73-4A. Second order shall be from MIL-STD-701. All discrete semiconductor devices shall be 100% screened per Tables II (transistors) and III (diodes) as a minimum.

3.3.2.3 Capacitors

Capacitors shall be selected from MIL-STD-198C as a goal. Failure rate "R" or better shall be used. Capacitors shall receive the 100% screening tests per Table IV as a minimum.

3.3.2.4 Resistors

Resistors shall be selected from MIL-STD-199B as a goal. Failure rate "R" or better shall be used. Resistors shall receive the 100% screening tests per Table V as a minimum.

3.3.2.5 Magnetic Devices

Transformers and inductors shall be selected and tested as Grade 4, or 5, Class S, or V, operating temperature and failure rate, per MIL-T-39013. Other electromagnetic devices shall be designed and tested to equivalent grade and class device. Magnetic devices shall receive the 100% screening tests per Table VI as a minimum.

3.3.2.6 Relays

Electromechanical relays shall be selected in accordance with MIL-R-39016B.

3.3.3 PMP Design Considerations and Prohibited Items

Deviations to prohibited items require MDAC/PMPCB approval.

3.3.3.1 Microcircuits

a. Plastic Sealing Material - Microcircuits which are sealed or encapsulated with plastic shall not be used.

b. Chip Attachment - The silicon chip shall be attached to the case by means of a eutectic alloy; epoxy or ceramic (pyroceram) cements shall not be used for this purpose.

c. Glassivation - First priority shall be given to microcircuits which utilize glass passivation of their internal elements.

3.3.3.2 Discrete Semiconductor Devices

a. Plastic Sealing Material - Semiconductors which are sealed or encapsulated with plastic shall not be used.

b. Chip Mount - Devices which have the chip mounted away from the header shall not be used.

c. Mesa Construction - Mesa type construction for transistors shall not be used.

d. Alloy Type Construction - Alloy type construction for transistors shall not be used.

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e. Germanium Transistors - Germanium transistors shall not be used.

f. Voidless, Metallurgically Bonded Double Heat Sink Diodes - Voidless, metallurgically bonded double heat sink diodes shall be used whenever possible.

g. Semiconductors in Hot-Weld Metal Cases - Semiconductors in Hot-Weld Cap-TO Header, Hermetically Sealed Metal Cases (Hot-Weld TO Can) particularly power transistors of the studmount case styles such as TO-3, TO-59, TO-61, TO-111, etc. shall not be used unless the following requirements are met:

1. The device shall include an effective weld-splash barrier ring. Additionally, it is recommended that a protective coating of internal elements be used, provided adequate thermo-mechanical evaluation and qualification testing at the part level is performed to assure that no potential failure mechanisms of a more undesirable type have been introduced into the device for that application.

2. Subject parts to all of the screening tests of Table II.

3. Perform 100% mechanical shock test (such as MIL-STD-202, Method 213A, Condition F) of each lot followed by Acoustic Loose Particle Detection (ALPD) screening.

4. Conduct Radiographic (X-Ray or Vidicon) inspection of each part after completion of screening requirements.

h. Glassivation - First priority shall be given to those diodes and transistors which utilize glass passivation of their internal elements.

3.3.3.3 Capacitors

a. Metallized Film - Capacitors employing metallized film construction shall not be used.

b. Wet Slug Electrolytic - Wet slug, electrolytic capacitors shall not be used.

3.3.3.4 Resistors

a. Talon Leads - Talon lead construction shall not be used.

b. Palladium-Silver - Palladium-silver resistor elements shall not be used.

c. Variable Resistors - Variable resistors and trimmer potentiometers shall not be used.

3.3.3.5 Magnetic Devices

a. Potting and Impregnation - Parts shall be vacuum-impregnated and potted or metal-encased. Pre-baking and cure-baking procedures shall be used. Thermally-setting adhesive tapes and compounds shall be cured as specified by the manufacturer of the tapes or compounds.

b. Open-Type Construction - The use of impregnated open-type construction shall not be used.

c. Magnetic Wire - The use of wire sizes smaller than 40 AWG is not recommended. Wire shall be procured to MIL-W-583 as either Class S or Class V as applicable per MIL-T-39013. The Class will be dependent on the maximum hot spot temperature of the electromagnetic device in the environment specified. All magnet wire windings shall be wound in the same direction.

d. Lead Wire - Whenever the winding wire is smaller than 26 AWG, lead wire 26 AWG or larger shall be used and shall be secured by tape and/or lacing cord. On toroidal devices, leads shall be wrapped and tied prior to bringing them out of the windings.

e. Insulation System - The use of a dual insulation system is discouraged. When an impregnant does not permeate an insulator, the result is a dual insulation system. In some cases, the dielectric strength (test voltage) of a combination of dielectrics is less than the strength of each dielectric when tested separately. The thickness of insulation shall be governed by the maximum instantaneous working voltage across the insulation of the device.

f. Cores - Powder cores to be used outside environmentally controlled areas should be stabilized from -55 to +125°C. Tapewound cores should be encased in aluminum boxes with a glass epoxy insert and dampened with an inert silicone cushoning compound. Tapewound, bobbin and powder cores should have a protective finish which will seal the core and shall withstand a 1,000 volt test. All cores should have a Curie temperature greater than +170°C.

3.3.3.6 Relays

a. Relays which utilize cadmium or zinc internally or externally shall not be used.

b. Relay cans shall be of welded construction - not soldered. Relays with molybdenum contact material shall not be used.

c. Relays shall be designed so that cutting of insulation cannot occur during the canning operation.

d. Relay backfill gas shall be monitored (per detail specification requirements) for oxygen and moisture content.

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e. Whenever the possibility exists that contact erosion may be deposited on the terminal glass beads, a protective device (splatter shield) shall be used.

3.3.4 Materials and Processes Selection and Control

3.3.4.1 Materials and Processes Selection and Approval

The PMPCB shall review and approve the supplier's materials and processes selections, substantiating test data, and supporting technical analyses. The supplier shall prepare and maintain a detailed description of the production processes, steps, and controls applied to the fabrication of parts which are not Program Standard Parts and for the fabrication of the supplier's hardware. This shall include documentation which sets forth the materials, procedures, calibrations, techniques, measurements, tests, inspections, safety rules, equipment and apparatus with necessary tolerances used for current production and quality assurance of each basic process step. Rework and repair procedures shall also be documented. The supplier shall establish and maintain an effective method of identification, control, inspection and test of critical items and critical processes. Critical items and critical processes are those which require special attention because of complexity, application of state-of-the-art techniques, and the impact of potential failure or anticipated reliability problems.

3.3.4.2 Materials and Processes Control

3.3.4.2.1 Processes Control Documentation

The supplier shall identify the critical processes and critical control points in the production processes which will affect the quality or reliability of the part or assembly. Suitable control records shall be maintained and corrective actions taken when these records indicate that the process is not in control.

3.3.4.2.2 Cleanliness

The supplier shall have available standards which define the processes and criteria required for the control of contamination. The Quality Program shall include surveillance during fabrication, packing, storage, and unpacking of hardware to assure that required contamination standards are met and that conditions adverse to maintaining contaminant free hardware are discovered and eliminated.

3.3.4.2.3 Materials and Processes Inspection

Materials shall be adequately controlled and inspected prior to fabrication to ensure reliability of the electronic equipment. During fabrication the tools and processes, as well as materials, shall be adequately controlled and inspected. The configuration and workmanship of the completed hardware shall be verified by inspection.

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3.3.4.3 Materials Control

3.3.4.3.1 Conforming Materials

The supplier shall maintain a positive system of identifying the inspection status by means of stamps, tags, routing cards, or other control devices. In controlling the status of materials, the supplier shall establish suitable controls to assure that identification of status is applied under the jurisdiction of authorized inspection personnel.

3.3.4.3.2 Nonconforming Materials

Nonconforming materials shall be controlled by a positive system of identification to prevent their inadvertent use or intermingling with conforming materials.

3.3.4.4 Prohibited Materials

Corrosive (acetic acid evolving) silicone sealants, adhesives and coatings are prohibited from use on electronic or electrical equipment. Non-corrosive Room Temperature Vulcanizing (RTV) silicone rubber compounds may be used if they meet the requirements of MIL-A-46146.

3.3.4.5 Printed Wiring

Printed wiring boards shall conform to the requirements of MIL-STD-275C and MIL-STD-1495.

3.4 Parts Derating

A uniform parts derating policy shall be used encompassing power, voltage, current, temperature, mechanical and duty cycles. It shall include degradation sensitive parameters and maximum rating variations expected over the stated mission life. The MDAC Derating Guide Category 1, MDC G0155, shall be used by designers on the AMaRV Program. Power derating will be at least 50 percent. Other derating parameters will be similarly conservative. Methods for checking the derating factors utilized in design, shall be submitted for approval.

3.5 PMP Qualification

3.5.1 Parts Qualification

Program Standard Parts as defined in 3.3.1 are considered qualified. Non-standard parts of commonly used configuration, materials and processes can be qualified by analysis or similarity, and do not require qualification test. Non-standard parts of unusual packaging design, materials or processes shall receive a customized qualification test. All qualification is to be specified on a part by part basis. Qualification will be limited to tests specifically applicable to AMaRV environments and applications. Qualification must be current at time of parts acquisition. Any testing performed within the preceding 6 months that will verify the materials and processes can be used as a valid basis for qualification. A Qualification Plan is to be submitted to the

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REVISION (A) MAY 1 ? 1976 (B) DEC 3 1976

APPROVAL DATE SEP ? 1975

CODE IDENT 18355

3.5.1 Parts Qualification - Continued

PMPCB for approval. With the exception of pyrotechnic devices, the total sample size for qualification shall not exceed twelve (12). Group B and C data will be obtained on all standard microelectronic and semiconductor devices. Certificate of compliance statements will be obtained on all ER parts. The following tests comprise the maximum that will be required for qualification.

a. Lead bond integrity
b. Seal, fine and gross
c. Thermal shock
d. Temperature cycling
e. Visual examination
f. Mechanical shock
g. Vibration, variable frequency
h. Constant acceleration
i. Life test
j. End point electrical parameters

3.5.2 Materials and Processes Qualification

Critical materials and processes shall be qualified for use on AMaRV by combining the following procedures.

a. Selection of materials and processes using applicable military-specified materials and processes.

b. Selection of materials previously qualified for use on Air Force space and missile programs in similar environments and applications as required by the AMaRV program.

c. Process specifications and procedures shall have been successfully demonstrated prior to usage on qualified flight hardware.

d. Satisfactory completion of tests on engineering and qualification hardware when the supplier is using new processes, new or exotic materials, or new and unique applications of materials or processes.

e. Supplier audit and certification

Any critical process required to accomplish rework or retrofit shall be qualified and certified in the same manner.

3.6 Parts Screening

Electronic parts are to receive 100% screening tests per Tables I through X as a minimum. The supplier shall submit a screening matrix and shall indicate for each part type on the PMPSL the applicable screening tests shown in the matrix. The order shown in Tables I-X does not imply a test sequence.

3.7 Parts Re-Screening

With the exception of Class "S", all parts that do not receive a close contractor/supplier surveillance of the part vendors fabrication and screening tests of the parts shall be re-screened to the requirements of Tables I-X. Class "S" parts will require DPA per Par. 3.12.

3.8 Pre-Cap Visual Examination

Parts shall receive pre-cap visual inspection to the following procedures and methods as applicable:

	Part Type	Document	Method	Condition
a.	Hybrid	MIL-STD-883A	2017	-
b.	Integrated Circuit	MIL-STD-883A	2010.2	B
c.	Transistor	MIL-STD-750B	2072	-
d.	Diode	MIL-STD-750B	2073 & 2074	-

e. Capacitors - All ceramic capacitors shall be given an internal visual inspection prior to encapsulation. The inspection shall be conducted using suitable magnification and lighting. Any of the following defects shall be cause for rejection: cracks, chips, inadequate solder filet, inadequate solder wetting or solder voids.

f. Resistors - Power Wire Wound - All power wire wound resistors shall be given an internal visual examination prior to sealing or encapsulation. The inspection shall be conducted using suitable magnification and lighting. Any of the following defects shall be cause for rejection:

1. Weld anomalies, resistance wire to end cap: cracking, deformation, pitting, excessive surface melting, blow holes, or off center.
2. Weld anomalies, lead to end cap such as: cracking, deformation, pitting, blow holes, or off center.
3. Wire anomalies such as: nicks, cuts, kinks, corrosion, breaks, loops/sag, crossover or uneven spacing.

g. Resistors, Wire Wound Precision - All precision wire wound resistors shall be given an internal visual examination prior to sealing or encapsulation. The inspection shall be conducted using suitable magnification and lighting. Any of the following defects shall be cause for rejection:

1. Weld anomalies, resistance wire to end cap such as: cracking, deformed, pitted, blow hole, excessive surface melting or off center.
2. Improper number of Pi sections.
3. Even distribution of resistance wire on each Pi section.

h. Filters - All filters shall be given an internal visual examination prior to sealing or encapsulation. The inspection shall be conducted using suitable magnification and lighting. Examination shall be made for cracks or position of ceramic chips or parts, isolation of feed-through from case, inadequate soldering and contamination.

i. Magnetic Devices - All magnetic devices shall be given an internal visual examination prior to sealing or encapsulation. The inspection shall be conducted using suitable magnification and lighting. Examination shall be made of core, neatness of winding, insulation system, solder terminations and lead placement workmanship.

j. Relays - An internal inspection shall be conducted to verify that the internal design, construction, and workmanship are in accordance with requirements. Relays shall be examined for such defects as foreign particles, weld splatter and loose or improper placement of lead wires. The inspection shall be conducted using suitable magnification and lighting.

3.9 Quality Conformance Testing

Each lot of parts shall receive quality conformance inspection and test following screening consisting of electrical and operating life testing on a sample basis in accordance with the applicable part category military specification or standard. Lot sample size for operating life test shall be 5. For high cost parts the sample size may be smaller as approved by the PMPCB. Established Reliability (ER) resistors and capacitors for which quantities are otherwise accumulated for life testing are excepted from this requirement. Data from the above tests shall be submitted to PMPCB for review. These tests need not be repeated on standard parts which have up to date Quality Conformance tests.

3.10 Supplier Responsibility

All vendor manufacturing processes shall be reviewed by the supplier prior to production of the item. The supplier shall monitor critical processes and screening tests including precap visual at the vendor facility and shall be responsible for authorizing shipment of devices from the vendor.

3.11 Incoming Inspection Requirements

Upon receipt, parts shall receive incoming inspection and testing to applicable part specifications and lot acceptance criteria. As a minimum requirement, this shall consist of inspections and tests as follows:

a. 100 percent external inspection at 10x magnification (minimum) for permanent and legible marking, body finish, lead finish, insulation, lead straightness, pinholes, excessive material, misalignment, and any other visual or mechanical defects.

b. 100 percent electrical testing at +25 ± 5 degrees C.

c. Sample electrical tests at temperature extremes specified for thermal cycling.

3.12 Destructive Physical Analysis (DPA)

A Destructive Physical Analysis shall be performed on a sample basis by the supplier on each lot date code of hybrids, integrated circuits, semiconductor devices, filters, magnetic components, tantalum, ceramic, and mica capacitors, relays and crystals. Other devices may be added for analysis with PMPCB approval. The supplier shall prepare and implement DPA procedures to define the methods and lot accept/reject criteria for inspecting the internal materials, design, construction and workmanship of the part. DPA procedures shall be submitted for MDAC/PMPCB approval. DPA as a minimum shall include:

a. Review of vendor screening data.

b. Review acoustic loose particle detection data on all DPA semiconductor devices.

c. X-Ray, or review existing X-Ray on DPA sample.

d. Seal leakage tests as applicable.

e. External terminal strength tests.

f. Dissection and visual examination and analysis of part construction.

g. Internal lead bond pull tests on all transistor and microelectronic devices per MIL-STD-883, Method 2011, Condition D.

h. SEM inspection of integrated circuits and semiconductor devices which have expanded contact metalization in accordance to MIL-STD-883, Method 2018.

3.12.1 DPA Sample Size

The sample size shall be 2 percent or three units, whichever is larger, of all screening lots except crystals where 1 percent or two devices, whichever is larger, will be analyzed. For high cost parts the sample size may be smaller as approved by the PMPCB. DPA samples and documentation shall be retrievable to MDAC for the duration of the contract. DPA data shall be used to verify similarity of any subsequent lot procurement. Lots not meeting acceptance criteria shall not be used in qualification or flight hardware.

3.13 Loose Particle Detection

All semiconductor type devices except those of solid voidless construction shall be subjected to loose particle detection (LPD) in accordance with MDAC Standard STC0016. LPD shall be performed during screening as noted in the screening tables or as part of receiving inspection.

3.14 Failures

3.14.1 Failure Analysis and Reporting

All parts failures subsequent to screening shall be reported to the PMPCB. Failure analysis shall be performed and the results reported to the PMCPB. The analysis and corrective action must be approved prior to continuing with the parts flow. Summary reports on lot screening shall be submitted to the PMPCB and shall include: a) part number, b) part type, c) manufacturer, d) lot number, e) certification of conformance to screening tests, f) list of tests performed, g) number of parts tested, h) number of parts failing tests, i) total number of defective parts. Detailed failure analysis shall be conducted for parts failing subsequent to screening. When warranted, parts failures shall be reported to industry through the GIDEP Alert System. Where the supplier is not a participant in GIDEP, MDAC may issue an Alert.

3.14.2 Disposition of Failed Parts

Procedures shall be established to assure that all failed parts are segregated from acceptable parts.

3.15 Traceability and Lot Control

3.15.1 Shelf Life Control

Parts must be installed in the next assembly within two years of screening, or re-screening will be required.

3.15.2 Traceability

The supplier shall establish a traceability system that allows determination of individual parts (by lot) installed in each unit.

3.16 Preservation and Packaging

Preservation, packaging and packing shall be in accordance with MIL-STD-794. The following guidance supplements the MIL-STD-794 paragraph on electronic parts susceptible to damage by excessive electrostatic forces:

a. Many electronic devices such as thin or thick film resistors, semi-conductors (MOS devices), field effect transistors or circuitry containing any of these can be degraded by static-electricity.

   The supplier shall assure that design engineering identifies such items and communicates the essential precautions to all in-plant handling and packaging personnel.

b. All items which are subject to degradation by electrostatic discharge and which are to be packed in bags or wraps manufactured from MIL-F-22191, MIL-B-121, MIL-B-131, or other static-generating materials shall be wrapped individually and properly in anti-static material meeting the requirements of MIL-B-81705, Type II. Anti-static packaging material shall in all cases be intimate to the item.

c. A label, advising that the contents can be destroyed by static electricity and should be handled only by personnel instructed in the necessary precautions, shall be affixed to each unit package.

3.17. Handling and Storage

3.17.1 Use of Special Handling and Storage Procedures

To prevent part/material degradation, special handling and storage procedures shall be formulated by components, quality and materials handling specialists. These procedures shall apply until the parts/materials lose their individuality when assembled into modules, boards, or higher indentured items. The identified handling shall be retained through inspection, kitting, and assembly on "build to" documentation.

3.17.2 Criteria for Establishing Procedures

The following criteria shall be used when establishing handling and storage procedures for parts/materials:

a. Control of environment, such as temperature, humidity, contamination, and pressure.

b. Measures and facilities to segregate and protect parts/materials routed to the materials review crib or to a laboratory for inspection, or returned to the vendor from unacceptable shipments.

c. Housekeeping practices, including provisions for the routine disposal of used packaging materials.

d. Control measures to limit personnel access to parts/materials during the receiving inspection and storage cycle.

e. Facilities for the interim storage of parts/materials including shelving with protective cushioning if required.

f. Use of an integrated system of containers to separate and protect individual parts/materials.

g. Special handling of all parts/materials, individually or in quantity, when required.

h. The minimizing of mechanical shock or vibration as items are transported from place to place.

i. Careful handling of package or items on shelves or benches.

j. Protective features of transportation equipment designed to ensure that packages will not be accidentally dropped or dislodged in transit.

k. Cushoning of bench surfaces on which parts/materials are handled during operations such as test, assembly, and inspection.

3.18 Deviations

Deviations to the requirements herein require PMPCB approval prior to incorporation into design. A request for deviation with justification and supporting documentation shall be submitted to MDAC for approval.

3.19 Change of Parts, Materials or Processes

All changes in parts, materials or processes shall be processed in accordance with the approved change control procedures for all affected documents and require PMPCB approval.

3.20 Definitions

Supplier - The producer of equipment items.

Vendor - The manufacturer of parts or materials.

TABLE I
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - MICROCIRCUITS AND HYBRIDS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
	INTERNAL VISUAL	MIL-STD-883	2010	B	
	STABILIZATION BAKE	MIL-STD-883	1008	C, 24 HRS MIN	
	TEMPERATURE CYCLING	MIL-STD-883	1010	C	
3/	THERMAL SHOCK	MIL-STD-883	1011.1	A	
	CONSTANT ACCELERATION	MIL-STD-883	2001	E, Y_1 MIN	
	HERMETIC SEAL	MIL-STD-883	1014	A or B & C2	
1/	HIGH TEMPERATURE REVERSE BIAS	MIL-STD-883	1015.1	A or C	
	INTERIM ELECTRICALS	2/			
4/	BURN IN	MIL-STD-883	1015	160 HRS @ 125°C MIN	
	INTERIM ELECTRICALS	2/			
4/	RADIOGRAPHIC	MIL-STD-883	2012.1		
	EXTERNAL VISUAL	MIL-STD-883	2009		
5/	LOOSE PARTICLE DETECTION	STC0016-1			

1/ TO BE SPECIFIED FOR APPLICABLE DEVICE TYPES

2/ PER DETAIL SPECIFICATION

3/ APPLICABLE TO ALL GLASS/CERAMIC PACKAGES

4/ PDA ≤ 10%

5/ PDA ≤ 20%

TABLE II
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - TRANSISTORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
	INTERNAL VISUAL	MIL-STD-750	2072		
	STABILIZATION BAKE			24 HRS, 200°C	
	TEMPERATURE CYCLING	MIL-STD-202	107D	C, 10 CYCLES	
3/	THERMAL SHOCK	MIL-STD-750	1056.1	A	
	CONSTANT ACCELERATION	MIL-STD-750	2006	30,000, X_1, Y_1 AXES	
	HERMETIC SEAL	MIL-STD-750 MIL-STD-883	1071.1 1014	G or H, & C2 A or B & C2	
1/	HIGH TEMPERATURE REVERSE BIAS	MIL-STD-750	1039	A	
	INTERIM ELECTRICALS	2/			
4/	BURN IN	MIL-STD-750	1039	B	
	INTERIM ELECTRICALS	2/			
4/	RADIOGRAPHIC	MSFC-STD-355	APPEND A		
	EXTERNAL VISUAL	MIL-STD-750	2071		
5/	LOOSE PARTICLE DETECTION	STC0016-1			

1/ TO BE SPECIFIED FOR APPLICABLE DEVICE TYPES
2/ PER DETAIL SPECIFICATION
3/ APPLICABLE TO ALL GLASS/CERAMIC PACKAGES
4/ PDA $\leq$ 10%
5/ PDA < 20%

TABLE III
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - DIODES

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
	INTERNAL VISUAL	MIL-STD-750	2072		
	~~STABILIZATION BAKE~~			24 HRS, 200°C	
	TEMPERATURE CYCLING	MIL-STD-202	107D	C, 10 CYCLES	
3/	THERMAL SHOCK	MIL-STD-750	1056.1	A	
	CONSTANT ACCELERATION	MIL-STD-750	2006	30,000, X_1, Y_1 AXES	
	HERMETIC SEAL	MIL-STD-750 MIL-STD-883	1071.1 1014	G or H, & C2 A or B & C2	
1/	HIGH TEMPERATURE REVERSE BIAS	MIL-STD-750	1039	A	
	INTERIM ELECTRICALS	2/			
4/	BURN IN	MIL-STD-750	1039	B	
	INTERIM ELECTRICALS	2/			
4/	RADIOGRAPHIC	MSFC-STD-355	APPEND A		
	EXTERNAL VISUAL	MIL-STD-750	2071		
5/	LOOSE PARTICLE DETECTION	STC0016-1			

1/ TO BE SPECIFIED FOR APPLICABLE DEVICE TYPES
2/ PER DETAIL SPECIFICATION
3/ APPLICABLE TO ALL GLASS/CERAMIC PACKAGES
4/ PDA $\leq$ 10%
5/ PDA < 20%

TABLE IV
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - CAPACITORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
CERAMIC	CAPACITANCE	MIL-STD-202	305	-	
	INSULATION RESISTANCE	MIL-STD-202	302	RATED DC VOLTAGE	
	TEMPERATURE CYCLING	MIL-STD-202	102	D	
	DISSIPATION FACTOR	MIL-C-39014	4.7.4	-	
	POWER VOLTAGE CONDITIONING	MIL-C-39014	4.7.2.2	2X RATED VOLTAGE	
	RADIOGRAPHIC INSPECTION	MIL-C-39014	4.7.2.3		
	EXTERNAL VISUAL EXAMINATION	MIL-C-39014	4.7.1	-	
1/	INTERNAL PRECAP VISUAL	-	-	-	
1/	DEAGING PDA < 10%	-	-	140°C, 1 HOUR MIN.	
GLASS	CAPACITANCE	MIL-STD-202	305	-	
	INSULATION RESISTANCE	MIL-STD-202	302	RATED DCV	
	DISSIPATION FACTOR	MIL-C-23269	4.7.7		
	HERMETIC SEAL	MIL-C-23269	4.7.2.1		
	POWER VOLTAGE CONDITIONING	MIL-C-23269	4.7.3	5X RATED VOLTAGE 300V 4X RATED VOLTAGE <300V	
	EXTERNAL VISUAL EXAMINATION PDA < 10%	MIL-C-23269	4.7.1		

TABLE IV (CONTD)
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - CAPACITORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
MICA	CAPACITANCE	MIL-STD-202	305	-	
	INSULATION RESISTANCE	MIL-STD-202	302	RATED DC VOLTAGE	
	DIELECTRIC WITHSTANDING VOLTAGE	MIL-STD-202	301	200% RATED DCV	
	TEMPERATURE CYCLING	MIL-STD-202	102	D	
	DISSIPATION FACTOR	MIL-C-39001	4.7.6	2X RATED VOLTAGE, AT 125°C, 48 HRS MIN.	
	POWER VOLTAGE CONDITIONING	MIL-C-39001	4.7.7		
	EXTERNAL VISUAL EXAMINATION	MIL-C-39001	4.7.1	-	
	1/ HERMETIC SEAL	-	-	-	
PAPER PLASTIC	CAPACITANCE	MIL-STD-202	305	-	
	DIELECTRIC WITHSTANDING VOLTAGE	↕	301		
	INSULATION RESISTANCE	↕	302	RATED DC VOLTAGE	
	HERMETIC SEAL	↕	112	A	
	TEMPERATURE CYCLE	↕	102	C	
	1/ RADIOGRAPHIC	MSFC-STD-355	10	APPENDIX E	
	DISSIPATION FACTOR	MIL-C-14157	4.6.8	-	
	EXTERNAL VISUAL EXAMINATION	MIL-C-14157	4.6.1	-	
	1/ POWER VOLTAGE CONDITIONING	-	-	RATED VOLTAGE, 100 HRS MIN., 85°C	
POLY-CARBONATE	CAPACITANCE	MIL-STD-202	305	-	
	INSULATION RESISTANCE	↕	302	RATED VOLTAGE	
	HERMETIC SEAL	↕	112	A	
	THERMAL SHOCK	↕	107	B	
	1/ RADIOGRAPHIC	MIL-STD-202	209	-	

TABLE IV (CONTD)

ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - CAPACITORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
POLY-CARBONATE (CONT)	DISSIPATION FACTOR	MIL-C-83421	4.7.9	-	
	TEMPERATURE COEFFICIENT	↑	4.7.2.2	-	
	POWER VOLTAGE CONDITIONING	↓	4.7.2.4	140% RATED VOLTAGE AND 125°C TEMP	
	EXTERNAL VISUAL EXAMINATION	MIL-C-83421	4.7.1	-	
TANTALUM NON-SOLID	CAPACITANCE	MIL-STD-202	305	-	
	HERMETIC SEAL	MIL-STD-202	112	A	
	TEMPERATURE CYCLE	MIL-STD-202	102	D	
	DC LEAKAGE	MIL-C-39006	4.7.3	RATED VOLTAGE	
	HIGH TEMPERATURE SURGE	↑	4.7.13		
	DISSIPATION FACTOR		4.7.5	-	
	POWER VOLTAGE CONDITIONING	↓	4.7.2	RATED VOLTAGE AND TEMP	
	EXTERNAL VISUAL EXAMINATION	MIL-C-39006	4.7.1	-	
	RADIOGRAPHIC	MSFC-STD-355	10	APPENDIX E	
TANTALUM FOIL	CAPACITANCE	MIL-STD-202	305	-	
	HERMETIC SEAL	↕	112	A	
	TEMPERATURE CYCLE	MIL-STD-202	102	D	
	DC LEAKAGE	MIL-C-39006	4.7.3	RATED VOLTAGE	
	DISSIPATION FACTOR	↑	4.7.5	-	
	POWER VOLTAGE CONDITIONING	↓	4.7.2	RATED VOLTAGE AND TEMP	
	EXTERNAL VISUAL EXAMINATION	MIL-C-39006	4.7.1	-	
	RADIOGRAPHIC	MSFC-STD-355	10	APPENDIX E	

TABLE IV (CONTD)
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - CAPACITORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
TANTALUM SOLID	CAPACITANCE	MIL-STD-202	305	-	
	HERMETIC SEAL	↕	112		
	TEMPERATURE CYCLE	MIL-STD-202	102	C	
	DC LEAKAGE	MIL-C-39003	4.7.5	RATED VOLTAGE	
	DISSIPATION FACTOR	↑	4.7.7	-	
	POWER VOLTAGE CONDITIONING	↓	4.7.2	RATED VOLTAGE AND TEMP	
	EXTERNAL VISUAL EXAMINATION	MIL-C-39003	4.7.1		
	RADIOGRAPHIC INSP.	MSFC-STD-355	10	APPENDIX E	
VARIABLE	CAPACITANCE	MIL-STD-202	305		
	DIELECTRIC WITHSTANDING VOLTAGE	↑	301	2 x RATED VOLTAGE	
	INSULATION RESISTANCE		302	RATED VOLTAGE	
1/	ACCELERATION		217		
	TEMPERATURE CYCLE		102		
1/	VIBRATION		201		
1/	RADIOGRAPHIC	↓	209		
	HERMETIC SEAL	MIL-STD-202	112	A	
	EXTERNAL VISUAL EXAMINATION	MIL-C-14409	4.6.1	-	
	QUALITY FACTOR	MIL-C-14409	4.6.5	-	
	POWER VOLTAGE CONDITIONING	-	-	RATED VOLTAGE AND TEMP 50 HRS.	
1/	MECHANICAL PERFORMANCE	-	-	-	

1/ THE REQUIREMENT/OR TESTS SHALL BE ADDED TO THE PROCURING AGENCY SPECIFICATION.

TABLE V
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - RESISTORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
COMPOSITION	DC RESISTANCE	MIL-STD-202	303	-	
	EXTERNAL VISUAL EXAMINATION	MIL-R-39008	4.7.1	-	
	POWER VOLTAGE CONDITIONING	-	-	RATED POWER, 70°C 100 HRS	
CARBON FILM	DC RESISTANCE	MIL-STD-202	303	-	
	HERMETIC SEAL	MIL-STD-202	112	C	
		MIL-STD-883	1014	D	
	TEMPERATURE CYCLE	MIL-STD-202	102	C	
	EXTERNAL VISUAL EXAMINATION	MIL-R-10509	4.6.1	-	
1/	OVERLOAD	-	-	3X POWER, 5 SECONDS	
1/	POWER VOLTAGE CONDITIONING	-	-	RATED POWER AND TEMP, 100 HOURS	
	RADIOGRAPHIC INSPECTION	MSFC-STD-355	20	APPENDIX D	
METAL FILM	DC RESISTANCE	MIL-STD-202	303	-	
	HERMETIC SEAL	MIL-STD-202	112		
		MIL-STD-883	1014	D	
	TEMPERATURE CYCLE	MIL-STD-202	102	150°C "C"	
	OVERLOAD	MIL-R-55182	4.7.3	-	
	EXTERNAL VISUAL	MIL-R-55182	4.7.1	-	
1/	POWER VOLTAGE CONDITIONING	-	-	RATED POWER AND TEMP, 100 HOURS	
	RADIOGRAPHIC INSPECTION	MSFC-STD-355	20	APPENDIX D	

TABLE V (CONTD)
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - RESISTORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OF PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
W.W. POWER	DC RESISTANCE	MIL-STD-202	303	-	
	RESISTANCE TEMPERATURE CHARAC.	MIL-STD-202	304	-65°C to 125°C	
	THERMAL SHOCK	MIL-STD-202	107		
	POWER VOLTAGE CONDITIONING	MIL-R-39007	4.7.2	RATED WATTAGE AT 25°C, 100 HOURS	
	EXTERNAL VISUAL EXAMINATION	MIL-R-39007	4.7.1		
	1/ INTERNAL (PRECAP) VISUAL EXAM.	-	-	-	
W.W. ACCURATE	DC RESISTANCE	MIL-STD-202	303		
	TEMPERATURE CYCLE	MIL-STD-202	102	C	
	POWER VOLTAGE CONDITIONING	MIL-R-39005	4.7.2	RATED WATTAGE AND TEMP FOR 100 HOURS	
	EXTERNAL VISUAL EXAM.	MIL-R-39005	4.7.1		
	1/ OVERLOAD	-	-	1.5X, 5 SECONDS	
	1/ INTERNAL (PRECAP) VISUAL EXAM.	-	-	-	
VARIABLE W.W.	DC RESISTANCE	MIL-STD-202	303		
	HERMETIC SEAL	MIL-STD-202	112	A	
	THERMAL SHOCK	MIL-STD-202	107	B	
	1/ RADIOGRAPHIC	MIL-STD-202	209	-	
	1/ VIBRATION	MIL-STD-202	201		
	EXTERNAL VISUAL EXAMINATION	MIL-R-39015	4.7.1	-	
	1/ INTERNAL (PRECAP) VISUAL EXAM.	-	-	-	
	PEAK NOISE	MIL-R-39015	4.7.3		
	1/ POWER VOLTAGE CONDITIONING	-	-	RATED POWER & TEMP, 100 HOURS	

TABLE V (CONTD)
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - RESISTORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
VARIABLE 1/ W.W. (CONT)	MECHANICAL PERFORMANCE	-	-	-	
		-	-	-	

1/ THE REQUIREMENT/OR TESTS SHALL BE ADDED TO THE PROCURING AGENCY SPECIFICATION.

TABLE VI
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - MAGNETICS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
FILTERS	1/ INTERNAL VISUAL	-	-	-	
	INSERTION LOSSES	MIL-F-15733	4.6.9	-	
	DC RESISTANCE	MIL-STD-202	303	-	
	DIELECTRIC WITHSTANDING	MIL-F-15733	4.6.5	-	
	HERMETIC SEAL	MIL-STD-202	112	A	
	1/ POWER BURN IN/STAB	-	-	-	
	TEMP CYCLE/THERM SHOCK	MIL-STD-202	107B	B	
	1/ VIBRATION	-	-	-	
	1/ RADIOGRAPHIC	-	-	-	
	EXTERNAL VISUAL	MIL-F-15733	4.6.1	-	
INDUCTORS	1/ INTERNAL VISUAL	-	-	-	
	INDUCTANCE	MIL-T-39013	4.8.2.4		
	DIELECTRIC WITHSTANDING	MIL-T-39013	4.8.6	-	
	INSULATION RESISTANCE	MIL-T-39013	4.8.8		
	HERMETIC SEAL	MIL-T-39013	4.8.5		
	1/ POWER BURN-IN/STAB				
	TEMP CYCLE/THERM SHOCK	MIL-T-39013	4.8.17		
	1/ NO LOAD BURN-IN				
	1/ RADIOGRAPHIC INSPECTION				
	EXTERNAL VISUAL	MIL-T-39013	4.8.1.1		

TABLE VI (CONTD)
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - MAGNETICS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OF PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
COILS 1/	INTERNAL VISUAL				
	INDUCTANCE	MIL-C-39010	4.7.3		
	DIELECTRIC WITHSTANDING	"	4.7.4		
	INSULATION RESISTANCE	"	4.7.6		
	TEMP CYCLE/THERM SHOCK	"	4.7.2		
1/	NO LOAD BURN-IN				
	EXTERNAL VISUAL	MIL-C-39010	4.7.1		
TRANSFORMERS					
1/	INTERNAL VISUAL				
	ELECTRICALS	MIL-T-39013	4.8.2		
	DIELECTRIC WITHSTANDING	MIL-T-39013	4.8.6		
	INSULATION RESISTANCE	"	4.8.8		
	HERMETIC SEAL	"	4.8.5		
1/	POWER BURN-IN/STAB				
	TEMP CYCLE/BURN IN	MIL-T-39013	4.8.17		
1/	NO LOAD BURN-IN/STAB				
	EXTERNAL VISUAL	MIL-T-39013	4.6.1		

1/ THE REQUIREMENT/OR TESTS SHALL BE ADDED TO THE PROCURING AGENCY SPECIFICATION.

TABLE VII
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - RELAYS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
	INTERNAL VISUAL EXAM	(1) PER COMPONENT	SPEC.		
	CONTACT RESISTANCE	(1) PER COMPONENT	SPEC.		
	DC RESISTANCE (COIL)	MIL-STD-202	303		
	DIELECTRIC WITHSTAND VOLTAGE	MIL-STD-202	301		
	INSULATION RESISTANCE	MIL-STD-202	302	B	
	OPERATE AND RELEASE TIME	(1) PER COMPONENT	SPEC.		
	PICK UP AND DROP OUT VOLTAGE	(1) PER COMPONENT	SPEC.		
	HERMETIC SEAL	MIL-STD-202	112	C, PROC. III	
	SIM. RUN IN/TEMP CYCLE	(2) MIL-R-39016	4.8.2.2		
	VIBRATION	(1) PER COMPONENT	SPEC.		
	PARTICLE DETECTION	(1) PER COMPONENT	SPEC.		
	EXTERNAL VISUAL EXAM.	(1) PER COMPONENT	SPEC.		

(1) THE VARIABLES OF THE TEST METHOD ARE DEPENDENT UPON THE SPECIFIC COMPONENT BEING EXAMINED, SO THE APPLICABLE COMPONENT CONTROLLING DOCUMENT MUST BE USED TO DEFINE THE TEST PARAMETERS.

(2) EXCEPT USE RELAYS TEMP. RATING AS HIGH TEMP. AND LOW TEMP.

TABLE VIII

ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - CONNECTORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
	DIELECTRIC WITHSTANDING VOLTAGE	MIL-STD-202	301	TEST VOLTAGE AS SPECIFIED BY PART SPECIFICATION	
	INSULATION RESISTANCE	MIL-STD-202	302	B (500VDC) OR AS SPECIFIED BY PART SPECIFICATION	

TABLE IX
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - CRYSTALS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OF PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
	INTERNAL (PRECAP) VISUAL	MIL-C-3098	PARA 4.8.2.2		
	PARAMETER (ACTIVE)	(1)			
	INSULATION RESISTANCE	(1)			
	ACCELERATION	MIL-STD-883	2001.1	E	
	HERMETIC SEAL	MIL-STD-202	112	C	
	SIMULTANEOUS RUN-IN/ TEMP CYCLE	(1)	(1)		
	TEMP CYCLE/THERMAL SHOCK	MIL-STD-202	107D	B	
	VIBRATION	(1)			
	AGING	MIL-C-3098	PARA 4.8.16		
	RADIOGRAPHIC INSPEC.	MSFC-STD-355C	APPENDIX M		
	EXTERNAL VISUAL	MIL-C-3098	PARA 4.8.2.1		

(1) PER DETAILED PART SPECIFICATION

TABLE X

ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - MICROSWITCHES

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
	INTERNAL VISUAL EXAM	(1) PER COMPONENT SPEC.			
	CONTACT RESISTANCE	(1) " "	"		
	DIELECTRIC WITHSTAND VOLTAGE	MIL-STD-202	301		
	INSULATION RESISTANCE	MIL-STD-202	302	B	
	HERMETIC SEAL	MIL-STD-202	112	C, PROC. III	
	TEMP CYCLE/THERMAL SHOCK	(1) PER COMPONENT SPEC.			
	VIBRATION	(1) " "	"		
	MECHANICAL PERFORMANCE	(1) " "	"		
	RADIOGRAPHIC INSPECTION	(1) " "	"		
	EXTERNAL VISUAL EXAM	(1) " "	"		

(1) THE VARIABLES OF THE TEST METHOD ARE DEPENDENT UPON THE SPECIFIC COMPONENT BEING EXAMINED, SO THE APPLICABLE COMPONENT CONTROLLING DOCUMENT MUST BE USED TO DEFINE THE TEST PARAMETERS.

MCDONNELL DOUGLAS STANDARD

1. SCOPE

This document contains requirements for the control of electrical/electronic parts, materials and processes (PMP) for the AMaRV Program. The requirements for the selection, qualification, screening and acceptance tests are defined herein.

Ⓒ 1.1 Requirement Identifier

The requirements defined in this document shall be identified by the identifier STC0015-5

2. REFERENCE DOCUMENTS

The following documents, and subsidiaries thereof, form a part of this Standard Practice document to the extent specified herein. In the event of conflict between documents referenced here and detail content of Section 3, the detail content of Section 3 shall be considered a superseding requirement.

SPECIFICATIONS

Military

Ⓒ MIL-T-27 — Transformer and Inductor (Audio, Power, and High Power Pulse) General Specification For

MIL-B-121 — Barrier Material, Grease Proofed, Water Proofed, Flexible

MIL-B-131 — Barrier Materials Water Vapor Proofed, Flexible, Heat-Sealable

MIL-C-3098 — Crystal Unit, Quartz, General Specification For

MIL-E-8189 — Electronic Equipment Missiles, Boosters, and Allied Vehicles, General Specification for

Ⓒ LIST OF CURRENT SHEETS

NO.	REV.	NO.	REV.	NO.	REV.	NO.	REV.	NO.	REV.	NO.	REV.
1	C	8	B	15	A	22	A	29	A	36	NEW
2	B	9	B	16	A	23	A	30	A	37	NEW
3	B	10	C	17	A	24	A	31	A	38	NEW
4	B	11	C	18	A	25	A	32	A		
5	B	12	A	19	A	26	A	33	NEW		
6	C	13	A	20	A	27	A	34	NEW		
7	B	14	A	21	A	28	A	35	NEW		

REVISION Ⓐ MAY 17 1976 Ⓑ DEC 3 1975 Ⓒ OCT 12 1977

APPROVAL DATE SEP 25 1975

CUSTODIAN: MDAC-W

PROCUREMENT SPECIFICATION	TITLE	CLASSIFICATION
—	PARTS, MATERIALS AND PROCESSES CONTROL PROGRAM FOR AMaRV	STANDARD PRACTICE
		STC0015 SHEET 1 of 38

CODE IDENT 18355

60 1733 (17 MAR 72)

MIL-R-39015	Resistor, Variable, Wirewound (Lead Screw Actuated), Established Reliability, General Specification for
MIL-R-39016	Relay, Electromagnetic, Established Reliability, General Specification for
MIL-R-55182	Resistor, Fixed, Film, Established Reliability, General Specification for
MIL-M-38510	Microcircuits, General Specification for
MIL-B-81705	Barrier Materials, Flexible Electrostatic Free, Water Vapor Proof, Heat Sealable
MIL-C-83421	Capacitor, Fixed, Supermetalized Plastic Film Dielectric (DC, AC or DC and AC), Hermetically Sealed in Metal Cases, Established Reliability, General Specification for
MIL-M-0038510	Microcircuits, General Specification for
MIL-T-23648	

STANDARDS

Military

MIL-STD-143	Standards and Specifications, Order of Precedence for the Selection of
MIL-STD-198	Capacitors, Selection and Use of
MIL-STD-199	Resistors, Selection and Use of
MIL-STD-202	Test Methods for Electronic and Electrical Component Parts
MIL-STD-275	Printed Wiring for Electronic Equipment
MIL-STD-701	List of Standard Semiconductor Devices
MIL-STD-750	Test Methods for Semiconductor Devices
MIL-STD-794	Part and Equipment, Procedures for Packaging and Packing of
MIL-STD-883	Test Methods and Procedures for Microelectronics
MIL-STD-1495	Multilayer Printed Wiring Boards for Electronic Equipment

HANDBOOKS

MIL-HDBK-217	Reliability Stress and Failure Rate Data for Electronic Equipment

COMPLETELY REVISED (B)

OTHER GOVERNMENT AGENCIES

SAMSO-STD 73-2C	Electronic Parts, Materials and Processes for Space and Missile Applications: Standard Control Program for
SAMSO-STD 73-4A	List of Preferred Parts for Space and Missile Programs
MSFC-STD-355	Radiographic Inspection of Electronic Parts
JW 1177	Wire, Magnetic, Electrical

MDAC STANDARDS

STC0016	Loose Particle Detection, Requirements for
MDC G0155	Derating Guides and Application Information for Aerospace Vehicle Equipment (AVE) Electronic Parts and Components

3. REQUIREMENTS

3.1 Electronic Parts, Materials and Processes (PMP) Program

Electronic PMP selection and application shall be in accordance with the requirements defined herein. The PMP selection, approval, and application program will be administered by means of a PMP Control Board (PMPCB).

Parts standardization shall be a prime goal when standardization incurs little or no design penalty and for parts which prove to have substantial commonality between AMaRV contractor designs.

3.1.1 Scope of PMP Control

The parts types controlled by this program are those listed below.

Hybrid Microelectronics
Integrated Circuits
Transistors
Diodes
Capacitors
Resistors
Filters
Inductors
Coils
Transformers
Connectors
Terminal Junctions
Crystals
Relays
Fuses
RF Switches
Microswitches
Wire Terminals
Thermistors

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Contacts
Printed Wiring Boards
Terminals
Synchros
(B) Resolvers
Wire
Pyrotechnic Devices

3.2 Program Parts, Materials, and Processes List (PMPSL)

A program parts, materials, and processes selection list (PMPSL) shall be prepared in accordance with the applicable supplier data article specified in the statement of work. The number of PMP types shall be minimized consistent with good design practice. The PMPSL shall be maintained and updated during the program to reflect actual usage as opposed to proposed usage. The PMPSL shall be approved by the PMPCB.

3.3 Parts, Materials and Processes (PMP) Selection

Parts, materials, and processes shall conform to the applicable documents listed in MIL-E-8189H and shall be selected in the order of precedence specified in MIL-STD-143. PMP selection shall give consideration to current ALERTS.

3.3.1 Program Standard Parts

Parts that meet the following criteria shall be considered Program Standard Parts:

a. Established reliability resistors, capacitors and relays in accordance with MIL-STD-199B, MIL-STD-198C and MIL-R-39016B respectively.
(B) b. JANTXV semiconductors.
c. Monolithic, multichip and hybrid microcircuits meeting the requirements of MIL-M-38510C, Class B as a minimum.

All other parts are considered non-standard.

3.3.1.1 Use of Program Standard Parts

A maximum effort shall be made to use standard parts when available. When other than standard parts must be used in new design circuitry, selection shall give consideration to the future substitution of standard parts for non-standard parts. For circuitry of existing design, standard parts shall be substituted for non-standard where physically and functionally equivalent standard parts are available.

3.3.1.2 Non-Standard Part Approval

The PMPSL shall be reviewed for approval/disapproval. The PMPCB retains the authority to request specific supporting data on any non-standard part of concern.

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3.3.2 Parts Selection

3.3.2.1 Microelectronics

(C) Priority of selection of microelectronic devices, shall be Class "S" (MIL-M-0038510), Class "A" (MIL-M-38510), and Class "B" (MIL-M-38510) as a goal. Hybrid devices shall meet the requirements of MIL-M-38510, Class "B" as a minimum unless deviations are specifically approved. All microelectronic devices shall receive the 100% screening tests per Table I as a minimum.

3.3.2.2 Discrete Semiconductor Devices

Discrete semiconductor devices shall be selected from JANTXV devices qualified and procured to MIL-S-19500 as a goal. First order of selection should be of the types listed in SAMSO-STD 73-4A. Second order shall be from MIL-STD-701. All discrete semiconductor devices shall be 100% screened per Tables II (transistors) and III (diodes) as a minimum.

3.3.2.3 Capacitors

Capacitors shall be selected from MIL-STD-198C as a goal. Failure rate "R" or better shall be used. Capacitors shall receive the 100% screening tests per Table IV as a minimum.

3.3.2.4 Resistors

Resistors shall be selected from MIL-STD-199B as a goal. Failure rate "R" or better shall be used. Resistors shall receive the 100% screening tests per Table V as a minimum.

3.3.2.5 Magnetic Devices

(C) Transformers and inductors shall be selected and tested as Grade 4 or 5, Class S, minimum, operating temperature per MIL-T-27. Other electromagnetic devices shall be designed and tested to equivalent grade and class device. Magnetic devices shall receive the 100% screening tests per Table VI as a minimum.

3.3.2.6 Relays

Electromechanical relays shall be selected in accordance with MIL-R-39016B.

3.3.3 PMP Design Considerations

(C) Deviations require MDAC/PMPCB approval.

3.3.3.1 Microcircuits

a. Plastic Sealing Material - Microcircuits which are sealed or encapsulated with plastic shall not be used.

b. Chip Attachment - The silicon chip shall be attached to the case by means of a eutectic alloy; epoxy or ceramic (pyroceram) cements shall not be used for this purpose.

c. Glassivation - First priority shall be given to microcircuits which utilize glass passivation of their internal elements.

3.3.3.2 Discrete Semiconductor Devices

a. Plastic Sealing Material - Semiconductors which are sealed or encapsulated with plastic shall not be used.

b. Chip Mount - Devices which have the chip mounted away from the header shall not be used.

c. Mesa Construction - Mesa type construction for transistors shall not be used.

d. Alloy Type Construction - Alloy type construction for transistors shall not be used.

e. Germanium Transistors - Germanium transistors shall not be used.

f. Voidless, Metallurgically Bonded Double Heat Sink Diodes - Voidless, metallurgically bonded double heat sink diodes shall be used whenever possible.

g. Semiconductors in Hot-Weld Metal Cases - Semiconductors in Hot-Weld Cap-To-Header, Hermetically Sealed Metal Cases (Hot-Weld To Can) particularly power transistors of the studmount case styles such as TO-3, TO-59, TO-61, TO-111, etc. shall not be used unless the following requirements are met:

1. The device shall include an effective weld-splash barrier ring. Additionally, it is recommended that a protective coating of internal elements be used, provided adequate thermo-mechanical evaluation and qualification testing at the part level is performed to assure that no potential failure mechanisms of a more undesirable type have been introduced into the device for that application.

2. Subject parts to all of the screening tests of Table II.

3. Perform 100% mechanical shock test (such as MIL-STD-202, Method 213A, Condition F) of each lot followed by Acoustic Loose Particle Detection (ALPD) screening.

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4. Conduct Radiographic (X-Ray or Vidicon) inspection of each part after completion of screening requirements.

h. Glassivation - First priority shall be given to those diodes and transistors which utilize glass passivation of their internal elements.

3.3.3.3 Capacitors

a. Metallized Film - Capacitors employing metallized film construction shall not be used.

b. Wet Slug Electrolytic - Wet slug, electrolytic capacitors shall not be used.

3.3.3.4 Resistors

a. Talon Leads - Talon lead construction shall not be used.

b. Palladium-Silver - Palladium-silver resistor elements shall not be used.

c. Variable Resistors - Variable resistors and trimmer potentiometers shall not be used.

3.3.3.5 Magnetic Devices

a. Potting and Impregnation - Parts shall be vacuum-impregnated and potted or metal-encased. Pre-baking and cure-baking procedures shall be used. Thermally-setting adhesive tapes and compounds shall be cured as specified by the manufacturer of the tapes or compounds.

b. Open-Type Construction - The use of impregnated open-type construction shall not be used.

(B) c. Magnetic Wire - The use of wire sizes smaller than 40 AWG is not recommended. Wire shall be procured to JW 1177 as either Class S or Class V as applicable per MIL-T-27. The Class will be dependent on the maximum hot spot temperature of the electromagnetic device in the environment specified. All magnet wire windings shall be wound in the same direction.

d. Lead Wire - Whenever the winding wire is smaller than 26 AWG, lead wire 26 AWG or larger shall be used and shall be secured by tape and/or lacing cord. On toroidal devices, leads shall be wrapped and tied prior to bringing them out of the windings.

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e. Insulation System - The use of a dual insulation system is discouraged. When an impregnant does not permeate an insulator, the result is a dual insulation system. In some cases, the dielectric strength (test voltage) of a combination of dielectrics is less than the strength of each dielectric when tested separately. The thickness of insulation shall be governed by the maximum instantaneous working voltage across the insulation of the device.

f. Cores - Powder cores to be used outside environmentally controlled areas should be stabilized from -55 to +125°C. Tapewound cores should be encased in aluminum boxes with a glass epoxy insert and dampened with an inert silicone cushoning compound. Tapewound, bobbin and powder cores should have a protective finish which will seal the core and shall withstand a 1,000 volt test. All cores should have a Curie temperature greater than +170°C.

3.3.3 6 Relays

a. Relays which utilize cadmium or zinc internally or externally shall not be used.

b. Relay cans shall be of welded construction - not soldered. Relays with molybdenum contact material shall not be used.

c. Relays shall be designed so that cutting of insulation cannot occur during the canning operation.

d. Relay backfill gas shall be monitored (per detail specification requirements) for oxygen and moisture content.

e. Whenever the possibility exists that contact erosion may be deposited on the terminal glass beads, a protective device (splatter shield) shall be used.

3.3.4 Materials and Processes Selection and Control

3.3.4.1 Materials and Processes Selection and Approval

The PMPCB shall review and approve the supplier's materials and processes selections, substantiating test data, and supporting technical analyses. The supplier shall prepare and maintain a detailed description of the production processes, steps, and controls applied to the fabrication of parts which are not Program Standard Parts and for the fabrication of the supplier's hardware. (B) [This shall include documentation which sets forth the materials, procedures, calibrations, techniques, measurements, tests, inspections, equipment and apparatus with necessary tolerances used for production and quality assurance of each basic process step.] Rework and repair procedures shall also be documented. The supplier shall establish and maintain an effective method of identification, control, inspection and test of critical materials and critical processes. Critical items and critical processes are those which require special attention because of complexity, application of state-of-the-art techniques, and the impact of potential failure or anticipated reliability problems.

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3.3.4.2 Materials and Processes Control

3.3.4.2.1 Processes Control Documentation

The supplier shall identify the critical processes and critical control points in the production processes which will affect the quality or reliability of the part or assembly. Suitable control records shall be maintained and corrective actions taken when these records indicate that the process is not in control.

3.3.4.2.2 Cleanliness

The supplier shall have available standards which define the processes and criteria required for the control of contamination. The Quality Program shall include surveillance during fabrication, packing, storage, and unpacking of hardware to assure that required contamination standards are met and that conditions adverse to maintaining contaminant free hardware are discovered and eliminated.

3.3.4.2.3 Materials and Processes Inspection

Materials shall be adequately controlled and inspected prior to fabrication to ensure reliability of the electronic equipment. During fabrication the tools and processes, as well as materials, shall be adequately controlled and inspected. The configuration and workmanship of the completed hardware shall be verified by inspection.

3.3.4.3 Materials Control

3.3.4.3.1 Conforming Materials

The supplier shall maintain a positive system of identifying the inspection status by means of stamps, tags, routing cards, or other control devices. In controlling the status of materials, the supplier shall establish suitable controls to assure that identification of status is applied under the jurisdiction of authorized inspection personnel.

3.3.4.3.2 Nonconforming Materials

Nonconforming materials shall be controlled by a positive system of identification to prevent their inadvertent use or intermingling with conforming materials.

3.3.4.4 Prohibited Materials

Corrosive (acetic acid evolving) silicone sealants, adhesives and coatings are prohibited from use on electronic or electrical equipment. Non-corrosive Room Temperature Vulcanizing (RTV) silicone rubber compounds may be used if they meet the requirements of MIL-A-46146.

3.3.4.5 Printed Wiring

Printed wiring boards shall conform to the requirements of MIL-STD 275C and MIL-STD-1495.

3.4 Parts Derating

The MDAC Derating Guide Category 1, MDC G0155, shall be used (with modifications defined in paragraphs 3.4.1 thru 3.4.4) by designers on the AMaRV Program. Power derating will be at least 50 percent. Other derating parameters will be similarly conservative. Methods for checking the derating factors utilized in design shall be submitted for approval. The derating data shall be reviewed by MDAC Reliability Engineering and the PMPCB.

3.4.1 Capacitor Derating

The stress/temperature tables of MIL-HDBK-217B shall be used as the basis for capacitor derating. The following failure rates and tables shall be used:

FAILURE RATES $(X10^{-9})$

DESCRIPTION	TYPE	QUALITY LEVEL	MIL-HDBK-217B PAGE	MIL-HDBK-217B TABLE	MAX. ALLOW BASE FAIL. RATE (λ_b)
Capacitors	Ceramic	Level R	2.6.4-4	2.6.4-5	12
	Solid Tant.	Level R	2.6.5-2	2.6.5-4	28
	Non-S. Tant	Level R	2.6.5-4	2.6.5-7	35
	Mylar & Plastics	Level R	2.6.1-4	2.6.1-6	0.5

Stress due to steady applied voltage shall not exceed 50% or the value from the appropriate table for the specified failure rate and temperature, whichever is lower. Stress due to transient voltage shall not exceed 90% of rated voltage. Any capacitor utilized at a temperature in excess of 100°C must be documented as an exception to the AMaRV Derating Policy.

3.4.2 Microelectronic Monolithic Devices

For microelectronic monolithic devices the maximum allowable junction temperature is 125°C. For SSI/MSI MOS, linear MOS and LSI MOS devices, derating the junction temperature to 100°C is a goal. However, a junction temperature of 125°C is allowable if packaging and circuit design considerations necessitate.

3.4.3 Microelectronic Hybrids

The maximum temperature allowed at the case of a hybrid is to be limited to 100°C. If, however, the internal temperature of any internal component exceeds the requirements of the derating policy specified in the remainder of this document, it shall be treated as an exception to the policy.

3.4.4 General

This derating policy is based on specified ground and flight operations. Derating for qualification testing or failure conditions is not required. However, in no case will parts be utilized such that they exceed maximum vendor ratings. For example, derating will be based on a maximum operating voltage of 30.5 volts, not on the fault condition requirements of 36 volts for 5 minutes and 41 volts for .5 seconds. To assure compliance with the above derating policy, the supplier shall perform the necessary coordination and analysis.

3.5 PMP Qualification

3.5.1 Parts Qualification

Program Standard Parts as defined in 3.3.1 are considered qualified. Non-standard parts of commonly used configuration, materials and processes can be qualified by analysis or similarity, and do not require qualification test. [Non-standard parts of uncommon packaging design, materials or processes may be required by the PMPCB to be subjected to a customized qualification test.]

Qualification of a subject part by similarity may be justified by submittal of: (a) existing acceptable test data at the part level, or evidence of successful use in a similar application(s), or evidence of QPL listing on a device type(s) in the same family from the same supplier as the subject part; (b) documentation (e.g., construction analysis) which establishes design similarity in configuration, processes and materials between the subject part and another device type(s) qualified as in (a) above except that data need not be from the same supplier as required in (a) above. The following data should be provided to justify qualification by similarity:

a. Identification of similar part(s).
b. Description of similarity of processes, facilities, parts, etc.
c. Qualification levels to which similar part(s) is qualified.

Qualification testing, if required, will be specified on a part by part basis. When required, qualification testing will be limited to tests specifically applicable to AMaRV environments and applications. The total sample size for qualification shall not exceed twelve (12) (with the exception of pyrotechnic devices) and the following tests comprise the maximum that may be required.

a. Lead bond integrity
b. Seal, fine and gross
c. Thermal shock
d. Temperature cycling
e. Visual examination
f. Mechanical shock
g. Vibration, variable frequency
h. Constant acceleration
i. Life test
j. End point electrical parameters

3.5.2 Materials and Processes Qualification

Critical materials and processes shall be qualified for use on AMaRV by combining one or more of the following procedures.

a. Selection of applicable military-specified materials and processes.

b. Selection of materials previously qualified for use on Air Force space and missile programs in similar environments and applications as required by the AMaRV Program.

c. Satisfactory completion of tests on engineering and qualification hardware when the supplier is using new processes, new or exotic materials, or new and unique applications of materials or processes.

Process specifications and procedures shall have been successfully demonstrated prior to usage on flight hardware. Supplier audit and certification shall be required. Any critical process required to accomplish rework or retrofit shall be qualified and certified in the same manner.

3.6 Parts Screening

100% of the electronic parts are to receive all applicable tests per Tables I through XI. The supplier shall submit a screening matrix and shall indicate for each part type on the PMPSL the applicable screening tests shown in the matrix, The order shown in Tables Tables I-XI does not require a specific test sequence but does identify an acceptable test sequence. Differing test sequences require MDAC/PMPCB approval.

3.6.1 Screening Percent Defective

The percent defective allowed (PDA) during burn-in shall not exceed 10 percent, including post burn-in interim electrical and Delta failures (where applicable). If the PDA limits are exceeded, MDAC/PMPCB shall be notified promptly and prior to lot disposition. MDAC/PMPCB shall also be notified promptly, for information purposes, if radiographic rejections exceed 10 percent, or if loose particle detection test rejects exceed 20 percent, or if over five test runs are required to meet STC0016.

3.6.2 Screening Summary Data

Summary reports on lot screening shall be submitted to the PMPCB and shall include: a) part number, b) part type, c) manufacturer, d) lot number, e) certification of conformance to screening tests, f) list of tests performed, g) number of parts tested in each screen, h) number of parts failing each screen, i) total number of defective parts.

3.7 Parts Rescreening

All parts that do not receive a close contractor/supplier surveillance of the part vendor's fabrication and screening tests of the parts shall be rescreened to the requirements of Tables I-XI. This applies only to parts for which Pre-Cap

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Visual is not required except that JANTXV and ER parts may be rescreened as defined in paragraph 3.7.1. Class "S" devices per MIL-M-0038510 may be used without rescreening; however, DPA per paragraph 3.12 will be required.

3.7.1 Rescreening Options - Standard Discrete Semiconductors and ER Parts Only

Transistors, diodes, and passive parts (resistors and capacitors) are to receive 100% screening test by one of the two following options:

Option I - Preferred - Procurred to all the requirements of this document with monitored processes and screening tests to Table II, III, IV or V as applicable by the vendor in compliance with paragraph 3.6.

Option II - Acceptable Where Option I Is Not Practical

a. JANTXV parts procurred off the shelf directly from vendors or franchised distributors shall be rescreened to the requirements of Table II or III as applicable, with the exception of pre-cap internal visual inspection during rescreening, by a facility other than that of the parts manufacturer. Rescreening tests are to be sample monitored by the contractor/supplier. Prior to re-screening, JANTXV transistors shall receive and pass a 7% LTPD lead bond pull test, maximum acceptance no. +1. The bond pull sample parts shall also receive and pass an internal visual inspection per the requirements of the applicable method of MIL-STD-750.

b. Resistors and capacitors procurred off the shelf directly from vendors or franchised distributors as ER parts shall be rescreened to the requirements of Table IV or V as applicable, with the exception of internal pre-cap visual examination, by a facility other than that of the parts manufacturer.

c. Following rescreening, JANTXV and ER parts shall receive destructive physical analysis (DPA - reference paragraph 3.12) and JANTXV parts shall also receive loose particle detection (LPD) per paregraph 3.13).

3.7.2 Rescreening Laboratory Selection/Approval

The laboratory to be used for rescreening must be identified to the PMPCB. If requested by the PMPCB, the supplier shall submit evidence to justify that the laboratory meets the program needs. This evidence shall be comprised of:

a. Acceptable QC survey
b. Status of required test setups for applicable parts
c. Status of required software for applicable parts
d. Test history on other similar programs

3.8 Pre-Cap Visual Examination

Parts shall receive pre-cap visual inspection to the following procedures and methods as applicable:

	Part Type	Document	Method	Condition
a.	Hybrid	MIL-STD-883A	2017	-
b.	Integrated Circuit	MIL-STD-883A	2010.2	B
c.	Transistor	MIL-STD-750B	2072	-
d.	Diode	MIL-STD-750B	2073 & 2074	-

e. Capacitors - All ceramic capacitors shall be given an internal visual inspection prior to encapsulation. The inspection shall be conducted using suitable magnification and lighting. Any of the following defects shall be cause for rejection: cracks, chips, inadequate solder filet, inadequate solder wetting or solder voids.

f. Resistors - Power Wire Wound - All power wire wound resistors shall be given an internal visual examination prior to sealing or encapsulation. The inspection shall be conducted using suitable magnification and lighting. Any of the following defects shall be cause for rejection:

1. Weld anomalies, resistance wire to end can: cracking, deformation, pitting, excessive surface melting, blow holes, or off center, and lead attachment.
2. Weld anomalies, lead to end cap such as: cracking, deformation, pitting, blow holes, or off center.
3. Wire anomalies such as: nicks, cuts, kinks, corrosion, breaks, loops/sag, crossover or uneven spacing.

g. Resistors, Wire Wound Precision - All precision wire wound resistors shall be given an internal visual examination prior to sealing or encapsulation. The inspection shall be conducted using suitable magnification and lighting. Any of the following defects shall be cause for rejection:

1. Weld anomalies, resistance wire to end cap such as: cracking, deformed, pitted, blow hole, excessive surface melting or off center.
2. Improper number of Pi sections.
3. (A) Uneven distribution of resistance wire on each Pi section.

h. Filters - All filters shall be given an internal visual examination prior to sealing or encapsulation. The inspection shall be conducted using suitable magnification and lighting. Examination shall be made for cracks or position of ceramic chips or parts, isolation of feed-through from case, inadequate soldering and contamination.

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i. Magnetic Devices - All magnetic devices shall be given an internal visual examination prior to sealing or encapsulation. The inspection shall be conducted using suitable magnification and lighting. Examination shall be made of core, neatness of winding, insulation system, solder terminations and lead placement workmanship.

j. Relays - An internal inspection shall be conducted to verify that the internal design, construction, and workmanship are in accordance with requirements. Relays shall be examined for such defects as foreign particles, weld splatter and loose or improper placement of lead wires. The inspection shall be conducted using suitable magnification and lighting.

3.9 Quality Conformance Testing

Each lot of parts shall receive quality conformance inspection and test following screening consisting of electrical and operating life testing on a sample basis in accordance with the applicable part category military specification or standard. Lot sample size for operating life test shall be 5. For high cost parts the sample size may be smaller as approved by the PMPCB. Data from the above tests shall be submitted to PMPCB for review. This data shall include pre and post life test electrical data for all parts in the sample. These tests need not be repeated on standard parts which have up to date Quality Conformance tests.

For Established Reliability (ER) parts, original life test data (usually a subgroup of Group C data) performed in accordance with the applicable MIL-SPEC, may be substituted for the quality conformance tests.

For JANTXV parts, original life test data (usually a subgroup of Group C data) performed in accordance with the applicable MIL-SPEC may be substituted for the quality conformance tests if such data is less than two years old on the purchase order placement date.

3.10 Supplier Responsibility

All vendor manufacturing processes shall be reviewed by the supplier prior to production of the item. The supplier shall monitor critical processes and screening tests at the vendor facility and shall be responsible for authorizing shipment of devices from the vendor. Pre-cap visual must be witnessed on a 100% AMaRV part basis. Witnessing of pre-cap visuals shall be interpreted that the supplier must visually inspect the parts per the appropriate specification after the vendor's inspection. Other critical processes which are required to be monitored may be monitored on a sample basis whereby it is assured that the vendor is equipped and trained adequately and that proper procedures, etc., are applied to the AMaRV parts build.

3.10.1 Lot Data Requirements

The following defines the lot data requirements for parts for the AMaRV Program.

a. Original Screening Summary Data and Rescreening Summary Data for rescreened parts are required as defined in Paragraph 3.6.2. If original screening for rescreened parts is unavailable, the PMPCB is to be notified.

b. Quality Conformance data is required for the quality conformance testing done per Paragraph 3.9. This data shall include pre and post life test electrical data for all parts in the sample.

c. Summary Groups A, B, and C Data are required for all JANTXV and ER parts where it is available. If it is not available, it is not required. The existence of the data is not a condition for use of a part.

Summary Groups A, B, and C Data consist of:

- Number of parts entering Group A testing
- Number of parts failing Group A testing
- Number of parts entering Group B testing
- Number of parts failing Group B testing
- Number of parts entering Group C testing
- Number of parts failing Group C testing

d. For Established Reliability (ER) parts, original life test data (usually a subgroup of Group C data) performed in accordance with the applicable MIL-SPEC may be substituted for the quality conformance tests required by paragraph 3.9. Summary data does not suffice for these data.

e. For JANTXV parts, original life test data (usually a subgroup of Group C data) performed in accordance with the applicable MIL-SPEC may be substituted for the quality conformance test requirements of paragraph 3.9 if such data is less than two years old on the purchase order placement date. Summary data does not suffice for these data.

3.11 Incoming Inspection Requirements

Parts shall receive incoming inspection and testing to applicable part specifications and lot acceptance criteria. As a minimum requirement, this shall consist of inspections and tests as follows:

a. 100 percent external inspection at 10x magnification (minimum) for permanent and legible marking, body finish, lead finish, insulation, lead straightness, pinholes, excessive material, misalignment, and any other visual or mechanical defects.

b. 100 percent electrical testing at +25 ±5 degrees C.

c. Sample electrical tests at the temperature extremes that are specified for thermal cycling.

Incoming inspection may be waived for parts provided to the supplier as pooled parts. Full incoming inspection will be accomplished by the purchaser of the parts.

Incoming inspection may be accomplished in part or in full at a facility other than the supplier's (either an independent laboratory or the vendor) provided the supplier is on-site during the receiving inspection and witnesses (or, for a. above, participates in) 100% of the Incoming Inspections.

3.11.1 Incoming Inspection Requirements for MDAC ST/STD Termination Hardware

Hardware shall receive incoming inspection per existing inspection criteria.

a. Magnification shall be used when inspection requirements dictate and shall be of a power compatable with the task at hand.

b. Electrical tests shall be per existing inspection requirements.

c. Sample electricals at temperature extremes are not required.

3.12 Destructive Physical Analysis (DPA)

A Destructive Physical Analysis shall be performed on a sample basis by the supplier on each lot date code of hybrids, integrated circuits, discrete semiconductor devices, filters, magnetic components, tantalum, ceramic, and mica capacitors, relays and crystals. The supplier shall prepare and implement DPA procedures to define the methods and lot accept/reject criteria for inspecting the internal materials, design, construction and workmanship of the part. DPA procedures shall be submitted for MDAC/PMPCB approval. DPA as a minimum shall include:

a. Review of vendor lot data per 3.10.1.

b. Review acoustic loose particle detection data.

c. X-Ray, or review existing X-Ray on DPA sample.

d. Seal leakage tests as applicable.

e. External terminal strength tests.

f. Dissection and visual examination and analysis of part construction.

g. Internal lead bond pull tests on all transistor and microelectronic devices per MIL-STD-883, Method 2011, Condition D.

h. SEM inspection of integrated circuits and semiconductor devices which have expanded contact metalization in accordance to MIL-STD-883, Method 2018.

3.12.1 DPA Sample Size

The sample size shall be 2 percent or three units, whichever is larger, of all screening lots except crystals where 1 percent or two devices, whichever is larger, will be analyzed. For high cost parts the sample size may be smaller as approved by the PMPCB. Parts used for Quality Conformance Testing per paragraph 3.9 may be used for DPA. DPA samples and documentation shall be retrievable to MDAC for the duration of the contract. DPA data shall be used to verify similarity of any subsequent lot procurement. Lots not meeting acceptance criteria shall not be used in qualification or flight hardware.

3.13 Loose Particle Detection

All semiconductor type devices except those of solid voidless construction shall be subjected to loose particle detection (LPD) in accordance with MDAC Standard STC0016. LPD shall be performed during screening as noted in the screening tables or as part of receiving inspection.

It is the program policy to have as few companies conduct STC0016 testing as practical. Operator qualification and facility/procedure approval are required prior to testing. Requests for approval of an STC0016 operator/facility/procedure must be submitted to MDAC.

3.14 Failures

3.14.1 Failure Analysis and Reporting

All parts failures subsequent to screening shall be reported to the PMPCB. (In this context, LPD testing per STC0016 will be considered as a screening test.) Failure analyses are to be conducted only in the event of specific request by MDAC. When requested, failure analysis shall be conducted and results reported to MDAC. When warranted, parts failures shall be reported to industry through the GIDEP Alert System. Where the supplier is not a participant in GIDEP, MDAC may issue an Alert.

3.14.2 Disposition of Failed Parts

Procedures shall be established to assure that all failed parts are segregated from acceptable parts.

3.15 Traceability and Lot Control

d. Seal leakage tests as applicable.

e. External terminal strength tests.

f. Dissection and visual examination and analysis of part construction.

g. Internal lead bond pull tests on all transistor and microelectronic devices per MIL-STD-883, Method 2011, Condition D.

h. SEM inspection of integrated circuits and semiconductor devices which have expanded contact metalization in accordance to MIL-STD-883, Method 2018.

3.12.1 DPA Sample Size

The sample size shall be 2 percent or three units, whichever is larger, of all screening lots except crystals where 1 percent or two devices, whichever is larger, will be analyzed. For high cost parts the sample size may be smaller as approved by the PMPCB. Parts used for Quality Conformance Testing per paragraph 3.9 may be used for DPA. DPA samples and documentation shall be retrievable to MDAC for the duration of the contract. DPA data shall be used to verify similarity of any subsequent lot procurement. Lots not meeting acceptance criteria shall not be used in qualification or flight hardware.

3.13 Loose Particle Detection

All semiconductor type devices except those of solid voidless construction shall be subjected to loose particle detection (LPD) in accordance with MDAC Standard STC0016. LPD shall be performed during screening as noted in the screening tables or as part of receiving inspection.

It is the program policy to have as few companies conduct STC0016 testing as practical. Operator qualification and facility/procedure approval are required prior to testing. Requests for approval of an STC0016 operator/facility/procedure must be submitted to MDAC.

3.14 Failures

3.14.1 Failure Analysis and Reporting

All parts failures subsequent to screening shall be reported to the PMPCB. (In this context, LPD testing per STC0016 will be considered as a screening test.) Failure analyses are to be conducted only in the event of specific request by MDAC. When requested, failure analysis shall be conducted and results reported to MDAC. When warranted, parts failures shall be reported to industry through the GIDEP Alert System. Where the supplier is not a participant in GIDEP, MDAC may issue an Alert.

3.14.2 Disposition of Failed Parts

Procedures shall be established to assure that all failed parts are segregated from acceptable parts.

3.15 Traceability and Lot Control

3.15.1 Shelf Life Control

Parts must be installed in the next assembly within two years of screening, or re-screening to the requirements of Tables I-XI (except pre-cap visual) will be required.

3.15.2 Traceability

The supplier shall establish a traceability system that allows determination of individual parts (by lot) installed in each unit.

3.16 Preservation and Packaging

Preservation, packaging and packing shall be in accordance with MIL-STD-794. The following guidance supplements the MIL-STD-794 paragraph on electronic parts susceptible to damage by excessive electrostatic forces:

a. Many electronic devices such as thin or thick film resistors, semi-conductors (MOS devices), field effect transistors or circuitry containing any of these can be degraded by static-electricity.

   The supplier shall assure that design engineering identifies such items and communicates the essential precautions to all in-plant handling and packaging personnel.

b. All items which are subject to degradation by electrostatic discharge and which are to be packed in bags or wraps manufactured from MIL-F-22191, MIL-B-121, MIL-B-131, or other static-generating materials shall be wrapped individually and properly in anti-static material meeting the requirements of MIL-B-81705, Type II. Anti-static packaging materials shall in all cases be intimate to the item.

c. A label, advising that the contents can be destroyed by static electricity and should be handled only by personnel instructed in the necessary precautions, shall be affixed to each unit package.

3.17 Handling and Storage

3.17.1 Use of Special Handling and Storage Procedures

To prevent part/material degradation special handling and storage procedures shall be formulated by components, quality and materials handling specialists. These procedures shall apply until the parts/materials lose their individuality when assembled into modules, boards, or higher indentured items. The identified handling shall be retained through inspection, kitting, and assembly on "build to" documentation.

3.17.2 Criteria for Establishing Procedures

The following criteria shall be used when establishing handling and storage procedures for parts/materials:

a. Control of environment, such as temperature, humidity, contamination, and pressure.

b. Measures and facilities to segregate and protect parts/materials routed to the materials review crib or to a laboratory for inspection, or returned to the vendor from unacceptable shipments.

c. Housekeeping practices, including provisions for the routine disposal of used packaging materials.

d. Control measures to limit personnel access to parts/materials during the receiving inspection and storage cycle.

e. Facilities for the interim storage of parts/materials including shelving with protective cushioning if required.

f. Use of an integrated system of containers to separate and protect individual parts/materials.

g. Special handling of all parts/materials, individually or in quantity, when required.

h. The minimizing of mechanical shock or vibration as items are transported from place to place.

i. Careful handling of package or items on shelves or benches.

j. Protective features of transportation equipment designed to ensure that packages will not be accidentally dropped or dislodged in transit.

k. Cushioning of bench surfaces on which parts/materials are handled during operations such as test, assembly, and inspection.

3.18 Deviations

Deviations to the requirements herein require PMPCB approval prior to incorporation into design. A request for deviation with justification and supporting documentation shall be submitted to MDAC for approval.

3.19 Change of Parts, Materials or Processes

All changes in parts, materials or processes shall be processed in accordance with the approved change control procedures for all affected documents and require PMPCB approval.

3.20 Definitions

Supplier - The producer of equipment items.

Vendor - The manufacturer of parts or materials.

Ⓐ EDITORIALLY UPDATED

TABLE I
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - MICROCIRCUITS AND HYBRIDS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
	INTERNAL VISUAL	MIL-STD-883	2010,2017	B	
	STABILIZATION BAKE	MIL-STD-883	1008	C, 24 HRS MIN	
	TEMPERATURE CYCLING	MIL-STD-883	1010	C	
3/	THERMAL SHOCK	MIL-STD-883	1011.1	A	
	CONSTANT ACCELERATION	MIL-STD-883	2001	E, Y_1 MIN	
	HERMETIC SEAL	MIL-STD-883	1014	A or B & C2	
1/	HIGH TEMPERATURE REVERSE BIAS	MIL-STD-883	1015.1	A or C	
	INTERIM ELECTRICALS	2/			
4/	BURN IN	MIL-STD-883	1015	160 HRS @ 125°C MIN	
	INTERIM ELECTRICALS	2/			
4/	RADIOGRAPHIC	MIL-STD-883	2012.1		
	EXTERNAL VISUAL	MIL-STD-883	2009		
(A) 4/	LOOSE PARTICLE DETECTION	STC0016-1			

1/ TO BE SPECIFIED FOR APPLICABLE DEVICE TYPES

2/ PER DETAIL SPECIFICATION

3/ APPLICABLE TO ALL GLASS/CERAMIC PACKAGES

4/ PER PARAGRAPH 3.6.1 (A)

(A) EDITORIALLY UPDATED

TABLE II
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - TRANSISTORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
	INTERNAL VISUAL	MIL-STD-750	2072		
	STABILIZATION BAKE			24 HRS, 200°C	
	TEMPERATURE CYCLING	MIL-STD-202	107D	C, 10 CYCLES	
3/	THERMAL SHOCK	MIL-STD-750	1056.1	A	
	CONSTANT ACCELERATION	MIL-STD-750	2006	30,000, X_1, Y_1 AXES	
	HERMETIC SEAL	MIL-STD-750 MIL-STD-883	1071.1 1014	G or H, & C2 A or B & C2	
1/	HIGH TEMPERATURE REVERSE BIAS	MIL-STD-750	1039	A	
	INTERIM ELECTRICALS	2/			
4/	BURN IN	MIL-STD-750	1039	B	
	INTERIM ELECTRICALS	2/			
4/	RADIOGRAPHIC	MSFC-STD-355	APPEND A		
	EXTERNAL VISUAL	MIL-STD-750	2071		
(A) 4/	LOOSE PARTICLE DETECTION	STC0016-1			

1/ TO BE SPECIFIED FOR APPLICABLE DEVICE TYPES

2/ PER DETAIL SPECIFICATION

3/ APPLICABLE TO ALL GLASS/CERAMIC PACKAGES

4/ PER PARAGRAPH 3.6.1

(A)

(A) EDITORIALLY UPDATED

TABLE III
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - DIODES

(A)

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
	INTERNAL VISUAL	MIL-STD-750	2073, 2074		
	STABILIZATION BAKE			24 HRS, 200°C	
	TEMPERATURE CYCLING	MIL-STD-202	107D	C, 10 CYCLES	
3/	THERMAL SHOCK	MIL-STD-750	1056.1	A	
	CONSTANT ACCELERATION	MIL-STD-750	2006	30,000, X_1, Y_1 AXES	
	HERMETIC SEAL	MIL-STD-750 MIL-STD-883	1071.1 1014	G or H, & C2 A or B & C2	
1/	HIGH TEMPERATURE REVERSE BIAS	MIL-STD-750	1038	A	
	INTERIM ELECTRICALS	2/			
4/	BURN IN	MIL-STD-750	1038	B	
	INTERIM ELECTRICALS	2/			
4/	RADIOGRAPHIC	MSFC-STD-355	APPEND C		
	EXTERNAL VISUAL	MIL-STD-750	2071		
(A) 4/	LOOSE PARTICLE DETECTION	STC0016-1			

1/ TO BE SPECIFIED FOR APPLICABLE DEVICE TYPES
2/ PER DETAIL SPECIFICATION
3/ APPLICABLE TO ALL GLASS/CERAMIC PACKAGES
4/ PER PARAGRAPH 3.6.1

(A)

(A) EDITORIALLY UPDATED

TABLE IV
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - CAPACITORS

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PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
CERAMIC 1/	INTERNAL VISUAL	-	-	-	
	CAPACITANCE	MIL-STD-202	305	-	
	INSULATION RESISTANCE	MIL-STD-202	302	RATED DC VOLTAGE	
	TEMPERATURE CYCLING	MIL-STD-202	107	A	
	DISSIPATION FACTOR	MIL-C-39014	4.7.4	-	
	POWER VOLTAGE CONDITIONING	MIL-C-39014	4.7.2.2	2X RATED VOLTAGE	
	RADIOGRAPHIC INSPECTION	MIL-C-39014	4.7.22		
	EXTERNAL VISUAL EXAMINATION	MIL-D-39014	4.7.1	-	
	PDA < 10%				
GLASS	CAPACITANCE	MIL-STD-202	305	-	
	INSULATION RESISTANCE	MIL-STD-202	302	RATED DCV	
	DISSIPATION FACTOR	MIL-C-23269	4.7.7		
	POWER VOLTAGE CONDITIONING	MIL-C_23269	4.7.3	5X RATED VOLTAGE 300V 4X RATED VOLTAGE <300V	
	HERMETIC SEAL	MIL-C-23269	4.7.2.1		
	EXTERNAL VISUAL EXAMINATION ODA <10%	MIL-C-23269	4.7.1		

Ⓐ EDITORIALLY UPDATED

TABLE IV (CONTD)
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - CAPACITORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH Ⓐ	TEST CONDITION Ⓐ	REJECTION CRITERIA
MICA	CAPACITANCE	MIL-STD-202	305	-	
	INSULATION RESISTANCE	MIL-STD-202	302	RATED DC VOLTAGE	
	DIELECTRIC WITHSTANDING VOLTAGE	MIL-STD-202	301	200% RATED DCV	
	TEMPERATURE CYCLING	MIL-STD-202	107	A	
	DISSIPATION FACTOR	MIL-C-39001	4.7.6		
	POWER VOLTAGE CONDITIONING	MIL-C-39001	4.7.7	2X RATED VOLTAGE, AT 125°C, 48 HRS MIN.	
	EXTERNAL VISUAL EXAMINATION	MIL-C-39001	4.7.1	-	
	1/ HERMETIC SEAL	-	-	-	
PAPER PLASTIC	CAPACITANCE	MIL-STD-202	305	-	
	DIELECTRIC WITHSTANDING VOLTAGE	↕	301		
	INSULATION RESISTANCE	↕	302	RATED DC VOLTAGE	
	TEMPERATURE CYCLE	MIL-STD-202	107	B	
	HERMETIC SEAL		112	A	
	DISSIPATION FACTOR	MIL-C-14157	4.6.8	-	
	EXTERNAL VISUAL EXAMINATION	MIL-C-14157	4.6.1	-	
	1/ POWER VOLTAGE CONDITIONING	-	-	RATED VOLTAGE, 100 HRS MIN., 85°C	
	1/ RADIOGRAPHIC	MSFC-STD-355	10	APPENDIX E	
POLY-CARBONATE	CAPACITANCE	MIL-STD-202	305	-	
	INSULATION RESISTANCE	↕	302	RATED VOLTAGE	
	THERMAL SHOCK	↕	107	B	
	HERMETIC SEAL	↕	112	A	
	1/ RADIOGRAPHIC	MIL-STD-202	209	-	

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TABLE IV (CONTD)
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - CAPACITORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH (A)	TEST CONDITION (A)	REJECTION CRITERIA
POLY-CARBONATE (CONT)	DISSIPATION FACTOR	MIL-C-83421	4.7.9	-	
	TEMPERATURE COEFFICIENT	↕	4.7.2.2	-	
	POWER VOLTAGE CONDITIONING	↕	4.7.2.4	140% RATED VOLTAGE AND 125°C TEMP	
	EXTERNAL VISUAL EXAMINATION	MIL-C-83421	4.7.1	-	
TANTALUM NON-SOLID	CAPACITANCE	MIL-STD-202	305	-	
	TEMPERATURE CYCLE	MIL-STD-202	107	A	
	DC LEAKAGE	MIL-C-39006	4.7.3	RATED VOLTAGE	
	HIGH TEMPERATURE SURGE		4.7.13		
	DISSIPATION FACTOR		4.7.5	-	
	POWER VOLTAGE CONDITIONING	MIL-C-39006	4.7.2	RATED VOLTAGE AND TEMP	
	HERMETIC SEAL	MIL-STD-202	112	A	
	EXTERNAL VISUAL EXAMINATION	MIL-C-39006	4.7.1	-	
	RADIOGRAPHIC	MSFC-STD-355	10	APPENDIX E	
TANTALUM FOIL	CAPACITANCE	MIL-STD-202	305	-	
	TEMPERATURE CYCLE	MIL-STD-202	107	A	
	DC LEAKAGE	MIL-C-39006	4.7.3	RATED VOLTAGE	
	DISSIPATION FACTOR	MIL-C-39006	4.7.5	-	
	POWER VOLTAGE CONDITIONING	MIL-C-39006	4.7.2	RATED VOLTAGE AND TEMP	
	HERMETIC SEAL	MIL-STD-202	305	-	
	EXTERNAL VISUAL EXAMINATION	MIL-C-39006	4.7.1	-	
	RADIOGRAPHIC	MSFC-STD-355	10	APPENDIX E	

(A) EDITORIALLY UPDATED

TABLE IV (CONTD)
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - CAPACITORS

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PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
TANTALUM SOLID	CAPACITANCE	MIL-STD-202	305	-	
	TEMPERATURE CYCLE	MIL-STD-202	107	B	
	DC LEAKAGE	MIL-C-39003	4.7.5	RATED VOLTAGE	
	DISSIPATION FACTOR	MIL-C-39003	4.7.7	-	
	POWER VOLTAGE CONDITIONING	MIL-C-39003	4.7.2	RATED VOLTAGE AND TEMP	
	HERMETIC SEAL	MIL-STD-202	112		
	EXTERNAL VISUAL EXAMINATION	MIL-C-39003	4.7.1		
	RADIOGRAPHIC INSP.	MSFC-STD-355	10	APPENDIX E	
VARIABLE	CAPACITANCE	MIL-STD-202	305		
	DIELECTRIC WITHSTANDING VOLTAGE		301	2 x RATED VOLTAGE	
	INSULATION RESISTANCE		302	RATED VOLTAGE	
	1/ ACCELERATION		217		
	TEMPERATURE CYCLE		107		
	1/ VIBRATION		201		
	HERMETIC SEAL	MIL-STD-202	112	A	
	EXTERNAL VISUAL EXAMINATION	MIL-C-14409	4.6.1	-	
	QUALITY FACTOR	MIL-C-14409	4.6.5	-	
	POWER VOLTAGE CONDITIONING	-	-	RATED VOLTAGE AND TEMP 50 HRS.	
	1/ MECHANICAL PERFORMANCE	-	-	-	
	1/ RADIOGRAPHIC	MIL-STD-202	209		

1/ THE REQUIREMENT/OR TESTS SHALL BE ADDED TO THE PROCURING AGENCY SPECIFICATION.

Ⓐ EDITORIALLY UPDATED

TABLE V
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - RESISTORS

Ⓐ Ⓐ

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OF PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
COMPOSITION	DC RESISTANCE	MIL-STD-202	303	-	
	EXTERNAL VISUAL EXAMINATION	MIL-R-39008	4.7.1	-	
	POWER VOLTAGE CONDITIONING	-	-	RATED POWER, 70°C 100 HRS	
CARBON FILM	DC RESISTANCE	MIL-STD-202	303	-	
	HERMETIC SEAL	MIL-STD-202	112	C	
		MIL-STD-883	1014	D	
	TEMPERATURE CYCLE	MIL-STD-202	107	B	
	EXTERNAL VISUAL EXAMINATION	MIL-R-10509	4.6.1	-	
1/	OVERLOAD	-	-	3X POWER, 5 SECONDS	
1/	POWER VOLTAGE CONDITIONING	-	-	RATED POWER AND TEMP, 100 HOURS	
	RADIOGRAPHIC INSPECTION	MSFC-STD-355	20	APPENDIX D	
METAL	DC RESISTANCE	MIL-STD-202	303	-	
	TEMPERATURE CYCLE	MIL-STD-202	107	150°C "B"	
	OVERLOAD	MIL-R-55182	4.7.3	-	
FILM	HERMETIC SEAL	MIL-STD-202	112		
		MIL-STD-883	1014	D	
	EXTERNAL VISUAL	MIL-R-55182	4.7.1	-	
1/	POWER VOLTAGE CONDITIONING	-	-	RATED POWER AND TEMP, 100 HOURS	
	RADIGRAPHIC INSPECTION	MSFC-STD-355	20	APPENDIX D	

Ⓐ EDITORIALLY UPDATED

TABLE V (CONTD)

ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - RESISTORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	(A) METHOD OR PARAGRAPH	(A) TEST CONDITION	REJECTION CRITERIA
W.W. POWER 1/	INTERNAL (PRECAP) VISUAL EXAM.	-	-	-	
	DC RESISTANCE	MIL-STD-202	303	-	
	RESISTANCE TEMPERATURE CHARAC.	MIL-STD-202	304	-65°C to 125°C	
	THERMAL SHOCK	MIL-STD-202	107	B	
	POWER VOLTAGE CONDITIONING	MIL-R-39007	4.7.2	RATED WATTAGE AT 25°C, 100 HOURS	
	EXTERNAL VISUAL EXAMINATION	MIL-R-39007	4.7.1		
W.W. ACCURATE 1/	INTERNAL (PRECAP) VISUAL EXAM	-	-	-	
	DC RESISTANCE	MIL-STD-202	303		
	TEMPERATURE CYCLE	MIL-STD-202	107	B	
	POWER VOLTAGE CONDITIONING	MIL-R-39005	4.7.2	RATED WATTAGE AND TEMP FOR 100 HOURS	
	EXTERNAL VISUAL EXAM.	MIL-R-39005	4.7.1		
1/	OVERLOAD	-	-	1.5X, 5 SECONDS	
VARIABLE W.W. 1/	INTERNAL (PRECAP) VISUAL EXAM.	-	-	-	
	DC RESISTANCE	MIL-STD-202	303		
	THERMAL SHOCK	MIL-STD-202	107	B	
	VIBRATION	MIL-STD-202	201		
	HERMETIC SEAL	MIL-STD-202	112	A	
	EXTERNAL VISUAL EXAMINATION	MIL-R-39015	4.7.1	-	
	PEAK NOISE	MIL-R-39015	4.7.3		
1/	POWER VOLTAGE CONDITIONING	-	-	RATED POWER AND TEMP, 100 HOURS	
	RADIOGRAPHIC	MIL-STD-202	209	-	

(A) EDITORIALLY UPDATED

TABLE V (CONTD)

ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - RESISTORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
VARIABLE 1/ W.W. (CONT)	MECHANICAL PERFORMANCE	-	-	-	
		-	-	-	

1/ THE REQUIREMENT/OR TESTS SHALL BE ADDED TO THE PROCURING AGENCY SPECIFICATION.

Ⓐ EDITORIALLY UPDATED

TABLE VI
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - MAGNETICS

PART TYPE	TEST OR INSPECTION	Ⓐ APPLICABLE DOCUMENT	Ⓐ METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
FILTERS	1/ INTERNAL VISUAL	-	-	-	
	INSERTION LOSSES	MIL-F-15733	4.6.9	-	
	DC RESISTANCE	MIL-STD-202	303	-	
	DIELECTRIC WITHSTANDING	MIL-F-15733	4.6.5	-	
	1/ POWER BURN-IN/STAB	-	-	-	
	TEMP CYCLE/THERM SHOCK	MIL-STD-202	107	B	
	1/ VIBRATION	-	-	-	
	HERMETIC SEAL	MIL-STD-202	112	A	
	1/ RADIOGRAPHIC	-	-	-	
	EXTERNAL VISUAL	MIL-F-15733	4.6.1	-	
INDUCTORS	1/ INTERNAL VISUAL	-	-	-	
	INDUCTANCE	MIL-T-27	4.8.11.4		
	DIELECTRIC WITHSTANDING	MIL-T-27	4.8.8.1	-	
	INSULATION RESISTANCE	MIL-T-27	4.8.10		
	1/ POWER BURN-IN/STAB				
	TEMP CYCLE/THERM SHOCK	MIL-T-27	4.8.4		
	HERMETIC SEAL	MIL-T-27	4.8.7		
	1/ NO LOAD BURN-IN				
	1/ RADIOGRAPHIC INSPECTION				
	EXTERNAL VISUAL	MIL-T-27	4.8.1.1		

Ⓐ EDITORIALLY UPDATED

TABLE VI (CONTD)
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - MAGNETICS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
COILS 1/	INTERNAL VISUAL				
	INDUCTANCE	MIL-C-39010	4.7.3		
	DIELECTRIC WITHSTANDING	"	4.7.4		
	INSULATION RESISTANCE	"	4.7.6		
	TEMP CYCLE/THERM SHOCK	"	4.7.2		
1/	NO LOAD BURN-IN				
	EXTERNAL VISUAL	MIL-C-39010	4.7.1		
TRANSFORMERS					
1/	INTERNAL VISUAL				
	ELECTRICALS	MIL-T-27	4.8.11		
	DIELECTRIC WITHSTANDING	MIL-T-27	4.8.8.1		
	INSULATION RESISTANCE	"	4.8.10		
1/	POWER BURN-IN/STAB		-		
	TEMP CYCLE/BURN IN	MIL-T-27	4.8.4		
	HERMETIC SEAL	"	4.8.7		
1/	NO LOAD BURN-IN/STAB		-		
	EXTERNAL VISUAL	MIL-T-27	4.8.1.1		

1/ THE REQUIREMENT/OR TESTS SHALL BE ADDED TO THE PROCURING AGENCY SPECIFICATION.

TABLE VII
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - RELAYS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
	INTERNAL VISUAL EXAM	(1) PER COMPONENT SPEC.			
	CONTACT RESISTANCE	(1) PER COMPONENT SPEC.			
	DC RESISTANCE (COIL)	MIL-STD-202	303		
	DIELECTRIC WITHSTAND VOLTAGE	MIL-STD-202	301		
	INSULATION RESISTANCE	MIL-STD-202	302	B	
	OPERATE AND RELEASE TIME	(1) PER COMPONENT SPEC.			
	PICK UP AND DROP OUT VOLTAGE	(1) PER COMPONENT SPEC.			
	SIM. RUN IN/TEMP CYCLE	2 MIL-R-39016	4.8.2.2		
	VIBRATION	1 PER COMPONENT SPEC.			
	HERMETIC SEAL	MIL-STD-202	112	C, PROC. III	
	PARTICLE DETECTION	1 PER COMPONENT SPEC.			
	EXTERNAL VISUAL EXAM.	1 PER COMPONENT SPEC.			

(1) THE VARIABLES OF THE TEST METHOD ARE DEPENDENT UPON THE SPECIFIC COMPONENT BEING EXAMINED, SO THE APPLICABLE COMPONENT CONTROLLING DOCUMENT MUST BE USED TO DEFINE THE TEST PARAMETERS.

(2) EXCEPT USE RELAYS TEMP. RATING AS HIGH TEMP. AND LOW TEMP.

TABLE VIII
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - CONNECTORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
	DIELECTRIC WITHSTANDING VOLTAGE	MIL-STD-202	301	TEST VOLTAGE AS SPECIFIED BY PART SPECIFICATION	
	INSULATION RESISTANCE	MIL-STD-202	302	B (500VDC) OR AS SPECIFIED BY PART SPECIFICATION	

TABLE IX
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - CRYSTALS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OF PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
	INTERNAL (PRECAP) VISUAL	MIL-C-3098	PARA 4.8.2.2		
	PARAMETER (ACTIVE)	(1)			
	INSULATION RESISTANCE	(1)			
	ACCELERATION	MIL-STD-883	2001.1	A	
	SIMULTANEOUS RUN-IN/ TEMP CYCLE	(1)	(1)		
	TEMP CYCLE/THERMAL SHOCK	MIL-STD-202	107	B	
	VIBRATION	(1)			
	HERMETIC SEAL	MIL-STD-202		C	
	AGING	MIL-C-3098	PARA 4.8.16		
	RADIOGRAPHIC INSPEC.	MSFC-STD-355C	APPENDIX M		
	EXTERNAL VISUAL	MIL-C-3098	PARA 4.8.2.1		

(1) PER DETAILED PART SPECIFICATION

TABLE X
ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - MICROSWITCHES

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OF PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
	INTERNAL VISUAL EXAM	(1) PER COMPONENT SPEC.			
	CONTACT RESISTANCE	(1) "	" "		
	DIELECTRIC WITHSTAND VOLTAGE	MIL-STD-202	301		
	INSULATION RESISTANCE	MIL-STD-202	302	B	
	TEMP CYCLE/THERMAL SHOCK	1 PER COMPONENT SPEC.			
	VIBRATION	1 "	" "		
	HERMETIC SEAL	MIL-STD-202	112	C, PROC. III	
	MECHANICAL PERFORMANCE	1 PER COMPONENT SPEC.			
	RADIOGRAPHIC INSPECTION	1 "	" "		
	EXTERNAL VISUAL EXAM	1 "	" "		

(1) THE VARIABLES OF THE TEST METHOD ARE DEPENDENT UPON THE SPECIFIC COMPONENT BEING EXAMINED, SO THE APPLICABLE COMPONENT CONTROLLING DOCUMENT MUST BE USED TO DEFINE THE TEST PARAMETERS.

TABLE XI

ENVIRONMENTAL CONDITIONING AND SCREENING TESTS - THERMISTORS

PART TYPE	TEST OR INSPECTION	APPLICABLE DOCUMENT	METHOD OR PARAGRAPH	TEST CONDITION	REJECTION CRITERIA
	D.C. RESISTANCE	MIL-T-23648	4.6.2		±10% FROM SPECIFIED NOMINAL
	THERMAL SHOCK	MIL-T-23648	4.6.14		"C" 125°C ΔR ±2% MAX.
	DISSIPATION CONSTANT	MIL-T-23648	4.6.10		SPECIFICATION
	CONDITIONING	SPECIFICATION	-	MAX RATED AMBIENT TEMP. 100 HOURS MIN. @1.5 HOURS ON MAX. RATED POWER AND .5 HOURS NO POWER. (75% DUTY CYCLE) (50 CYCLES MIN.)	
	VISUAL AND MECHANICAL INSPECTION	MIL-T-23648	4.6.1		VERIFY DESIGN, WORKMANSHIP, PHYSICAL DIMENSIONS AND MARKINGS.

CONTRACT DATA REQUIREMENTS LIST

PAGE 35 OF 66

2. EXHIBIT A 3A. PIIN F04701-76-C-0100 3B. SPIIN CLIN IDENT EXHIBIT 0002

5. CATEGORY E 6. MCS 7. SYSTEM/ITEM 627A

8. ITEM NO.	9. QTY	10. PUR U	11. UNIT PRICE	12. TOTAL PRICE	13. PRICE	14. AUTHORITY (Date Item No.)
A021	6/0	CY	$ N	$ N	X	DI-E-30128

15. SITE CODES	16. ACRN	17. TECH OFC	18. DEL SCH DATES	19. ENDING DATE	20. FREQUENCY	21. AS OF DATE	22. SHIP TO
D D D	AA	MNRSM	ASREQ		ASREQ		FY1146

23. TITLE	25. CONTRACT REFERENCE	26. APP CODES	27. NO. OF PAGES
PARTS, MATERIALS, AND PROCESSES (PMP) SELECTED FOR DESIGN	W. S. Para 3.1.8	AN	4,000

24. SUBTITLE

28. REMARKS

Block 18:

Request for approval to use non-standard parts shall be prepared in accordance with Step 1 of MIL-STD-749, 60 days prior to the need to order such parts. Interim Air Force approval/disapproval will be within 15 days of receipt of Step I data. Step II data to be submitted for Air Force review and approval within 15 days of contractor's receipt of interim Air Force approval of Step I data. Final Air Force approval of Step II data within 15 days of receipt.

Data shall be delivered by a letter of transmittal and a DD 250 will be prepared in accordance with J31 of Special Provisions.

29. DISTRIBUTION AND ADDRESSEES

a. ADDRESSEES	b. COPIES REG/REPRO
~~DYMM~~	~~1/0~~
~~AFSC~~	~~2/0~~
~~DESC~~	~~1/0~~
~~DYI~~	~~1/0~~
~~ACO~~	~~1/0~~
~~PMTR-2 (TLO)~~	
~~AWSR~~	~~1/0~~
MNRSM	1/0
TRW	2/0
DESC	1/0
MNBR	1/0
ACO	1/0
MNCR (TLO)	

30. PREPARED BY 31. DATE 32. APPROVED BY AND DATE

AFSC FORM NOV 75 709

CONTRACT DATA REQUIREMENTS LIST | PAGE 36 OF 66

2. EXHIBIT A 3A. PIIN F04701-76-C-0100 3B. SPIIN 4. CLIN/ELEMENT EXHIBIT 0002

5. CATEGORY E 6. MCS 7. SYSTEM/ITEM 627A

8. ITEM NO	9. QTY	10. PUR U	11. UNIT PRICE	12. TOTAL PRICE	13. PRICE	14. AUTHORITY (Data item no.)
AC22	5/0	CY	$ N	$ N	X	DI-E-30129/M

15. SITE CODES	16. ACRN	17. TECH OFC	18. DEL SCH DATES	19. ENDING DATE	20. FREQUENCY	21. AS OF DATE	22. SHIP TO
D D D	AA	MNRSM	ASREQ		ONE/R		FY1146

23. TITLE	25. CONTRACT REFERENCE	26. APP CODES	27. NO. OF PAGES
PROGRAM PARTS, MATERIALS AND PROCESSES LIST (PPMPL).	W. S. Para 3.1.8	AN	50

24. SUBTITLE

28. REMARKS

Block 18: Preliminary 15 days prior to PDR. Final 15 days prior to CDR. Air Force approval/disapproval will be within 15 days after each design review. PPMPL shall be within 15 days after Air Force approval of CDR package. Above data is acceptable in the contractor's format. (U) E-693-1-SAMSO, para 10.3.k, change "supplier" to "manufacturer".

Data shall be delivered by a letter of transmittal and a DD 250 will be prepared in accordance with J31 of Special Provisions.

29. DISTRIBUTION AND ADDRESSEES

a. ADDRESSEES	b. COPIES REG/REPRO
~~RYMM~~	~~1/0~~
~~DYI~~	~~1/0~~
~~AERO~~	~~2/0~~
~~AWSR~~	~~1/0~~
~~ACO~~	~~1/0~~
~~PMTR-2 (TLO)~~	
~~AERO/GIDEP~~	~~1/0~~
MNRSM	1/0
MNBR	1/0
TRW	2/0
ACO	1/0
MNCR (TLO)	

30. PREPARED BY | 31. DATE | 32. APPROVED BY AND DATE

AFSC FORM NOV 75 709

APPENDIX B
PIECE PART SCREENING SUMMARY DATA

B-1 SCREENING SUMMARY DATA

Tables B-1 through B-21 provide a summary of the AMaRV Piece Part Screen/Rescreen data. Data is shown for the following part types:

Capacitors	Magnetics
Diodes	Resistors
Hybrids	Transistors
Integrated Circuits	

The tables show, for each manufacturer, the quantity received into screening, quantity rejected, percent rejected and quantity rejected at each applicable screening test point. Figures B-1 through B-21 provide a pictorial representation of total rejects for each test.

This data is presented only as a summary. To obtain the full explanation of rejects it is necessary to review the individual screening data sheets for each part number. There has been no effort to specifically identify or provide explanation for parts that fell out of the screening sequence due to damage or loss.

The tables summarize the data recorded on the individual data sheets from the testing laboratory without adjustment. For instance, rejects are shown in the burn-in column for which there is no criteria for reject. Rejects normally occur at post burn-in electricals. Rejects appearing in the burn-in column represent parts which did not complete burn-in due to mis-test or mishandling. Screening test data is on file at MDAC-HB.

TABLE B-1. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Capacitors - Ceramic, CKR, M39014

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test									
				Incom Inspec	Cap	Diss Fact	Ins Res	Temp Cycle	Pwr Volt Cond	Cap	X-Ray	Final	Visual & Mech
AVX	21695	1749	8.1	103	104	2	16	0	26	172	600	401	325
San Fernando	380	47	12.4	10	0	0	1	0	1	2	33	0	0
Kemet	4403	227	5.2	1	109	0	2	0	10	39	58	6	2
Republic Elec	154	1	.6	0	0	0	1	0	0	0	0	0	0
JFD	1103	24	2.2	14	0	0	0	0	1	0	0	0	9
Spectrum Control	336	5	1.5	0	0	0	0	0	2	3	0	0	0
Union Carbide	167	48	28.7	0	1	0	0	0	0	1	0	46	0
Totals	28238	2101	7.4	128	214	2	20	0	40	217	691	453	336

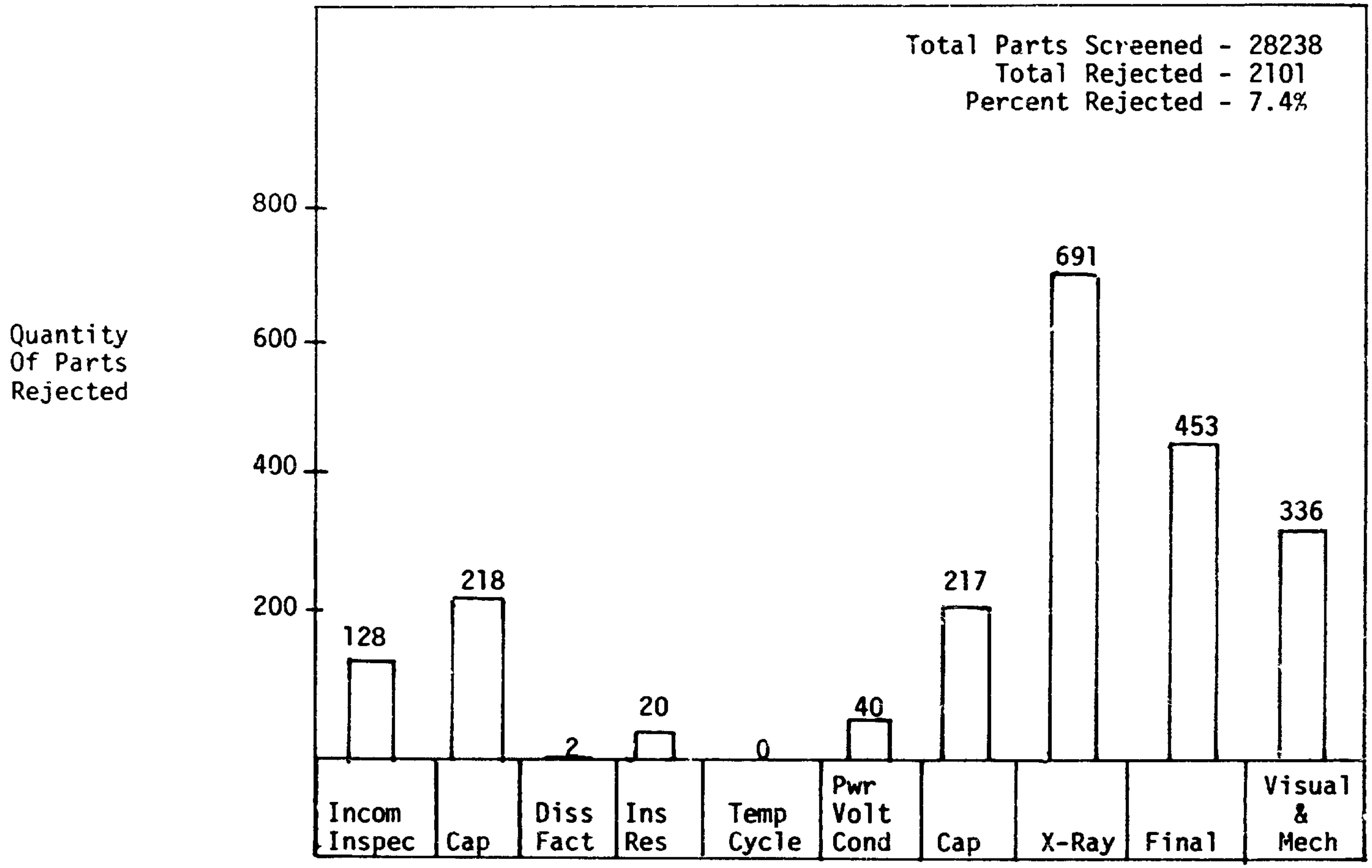

Figure B-1 - Capacitors - Ceramic, CKR, M39014 Screening Summary

Quantity Rejected At Each Screening Test

TABLE B-2. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Capacitor, Mica, CMR04, M-39001/05

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test							
				Incom Inspec	Cap	Diel With Volt	Temp Cycle	Diss Fact	Pwr Volt Cond	Cap	Final
Sangamo	296	2	.7	0	1	0	0	0	1	0	0

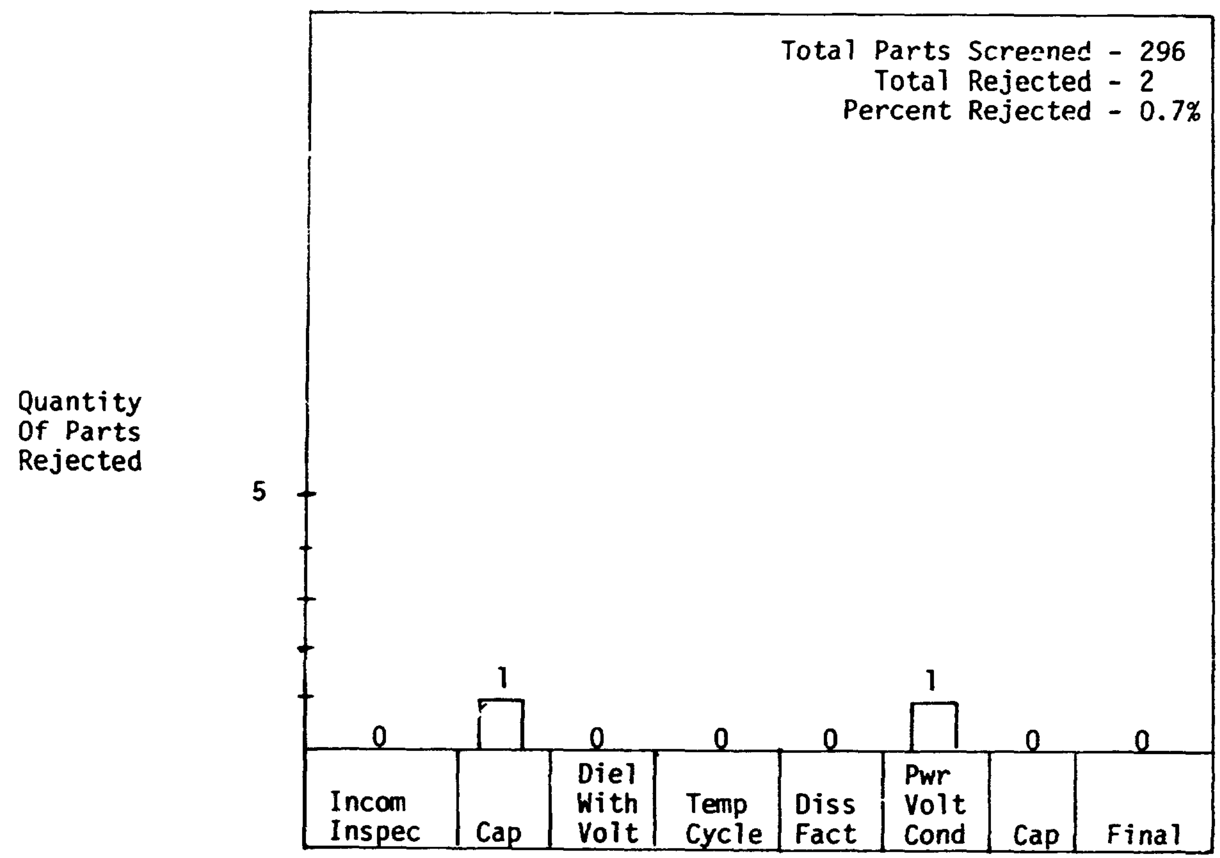

Figure B-2 - Capacitor, Mica, CMR04, M-39001/5
Quantity Rejected At Each Screening Test

TABLE B-3. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Capacitor, Plastic, CRH01/03

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test										
				Incom Inspec	Cap	Dial Witn Volt	Volt Cond	Cap	Dial With Volt	Seal	X-Ray	Final	Temp Coeff	I.R. Term/Term
Sprague	372	75	20.2	1	0	0	10	2	0	0	36	21	5	0
Union Carbide	25	5	20	0	2	0	0	1	0	0	0	2	0	0
Component Res	594	41	6.9	0	0	0	0	0	0	0	35	0	3	3
Totals	991	121	12.2	1	2	0	10	3	0	0	71	23	8	3

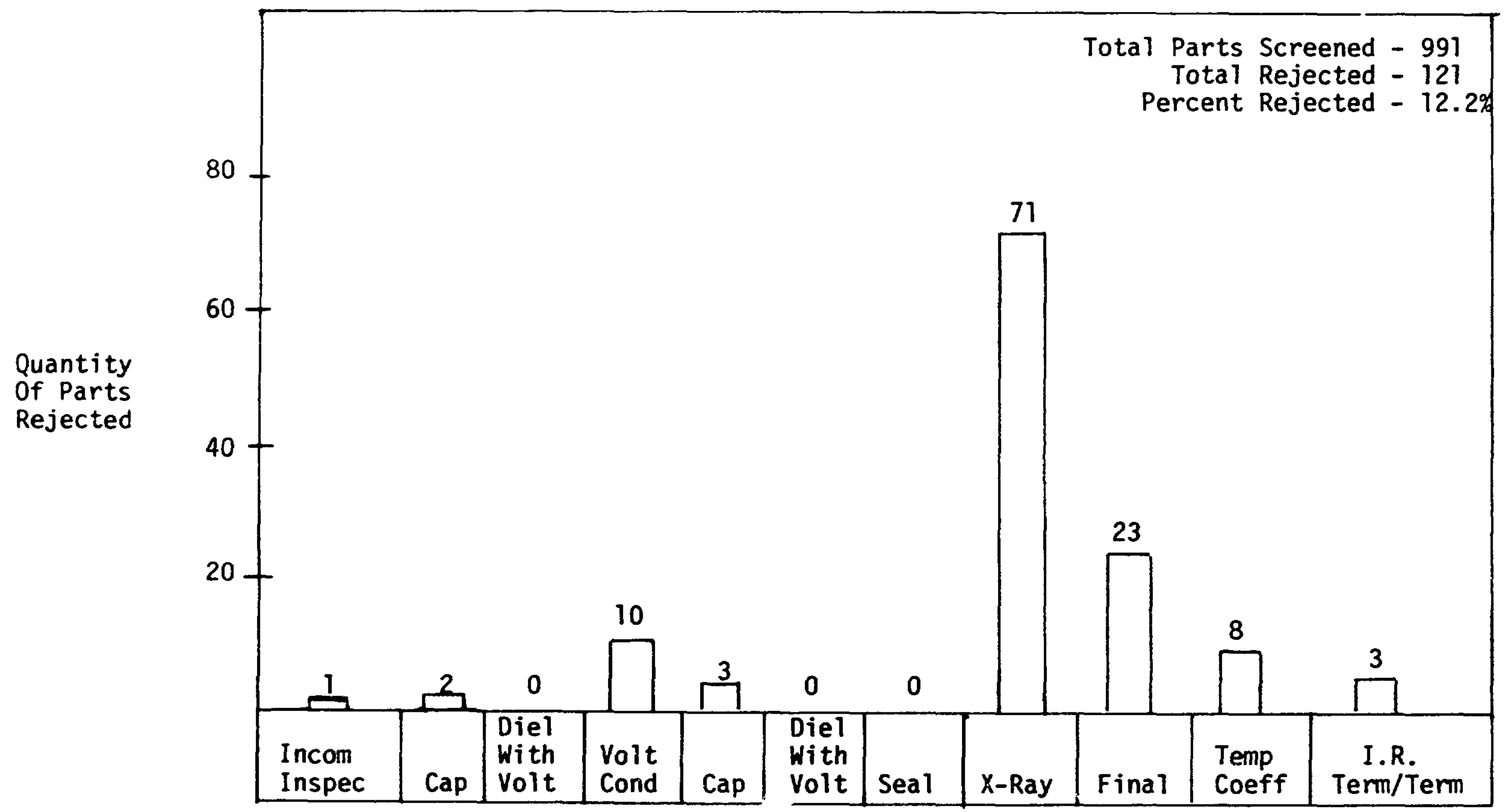

Figure B-3 - Capacitor, Plastic, CRH01/03 Screening Summary

Quantity Rejected At Each Screening Test

TABLE B-4. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Capacitor, Polycarbonate, M83421/1

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test								
				Incom Inspec	Cap	Ins Res	Therm Shock	Seal	Pwr Cond	Cap	X-Ray	Final
Component Res.	80	31	38.8	0	1	0	0	0	0	2	28	0

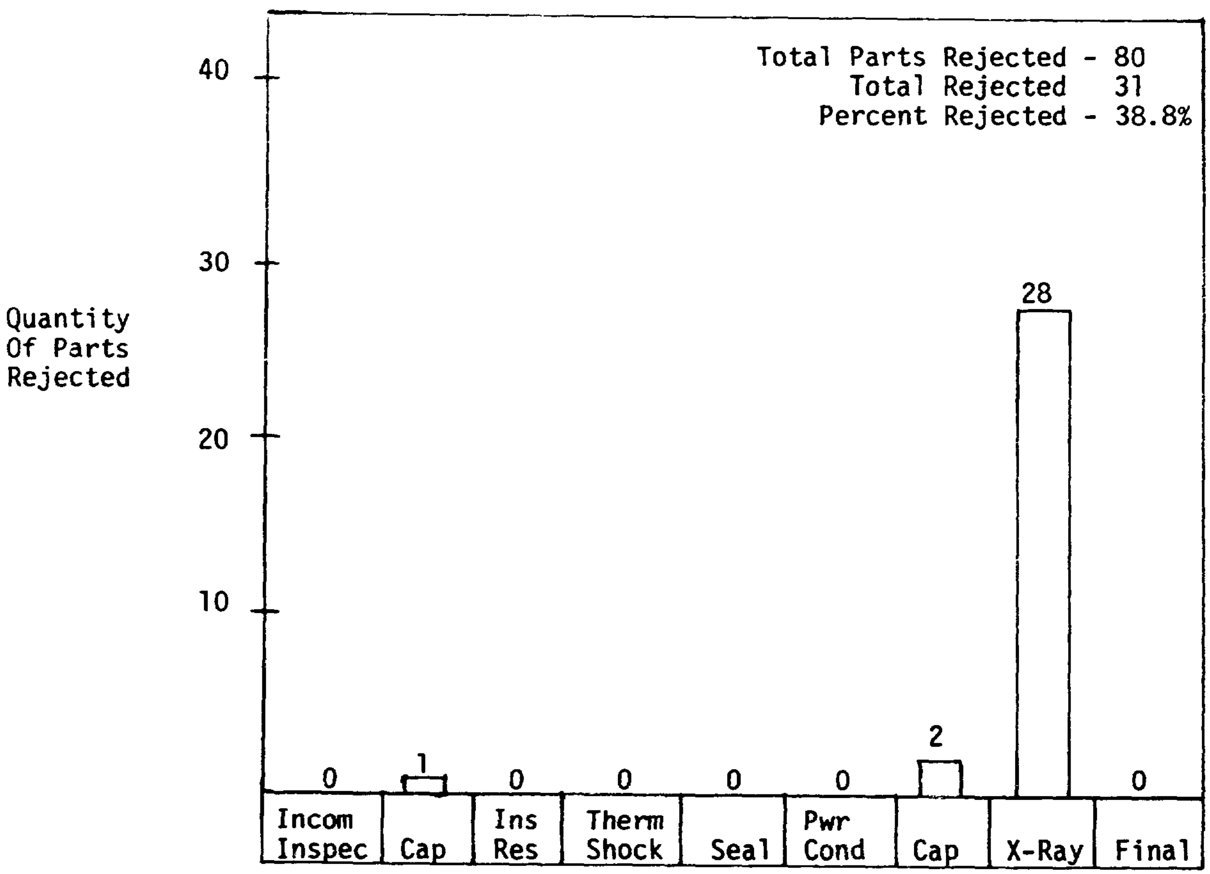

Figure B-4 - Capacitor, Polycarbonate, M83421/1 Screening Summary Quantity Rejected At Each Screening Test

TABLE B-5. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Capacitors, Tantalum, Solid, CSR 13, M39003/01

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test										
				Incom Inspec	Visual Inspec	Seal	Cap	Diss Fact	D.C. Leak	Therm Shock	Pwr Volt Cond	Cap	X-Ray	Final
Sprague	74	6	8.1	0	2	0	1	0	1	0	0	0	2	0
Kemet	1674	39	2.3	0	2	0	0	0	6	0	5	0	24	2
Union Carbide	792	128	16.2	0	0	0	2	0	0	0	4	16	76	30
Totals	2540	173	6.8	0	4	0	3	0	7	0	9	16	102	32

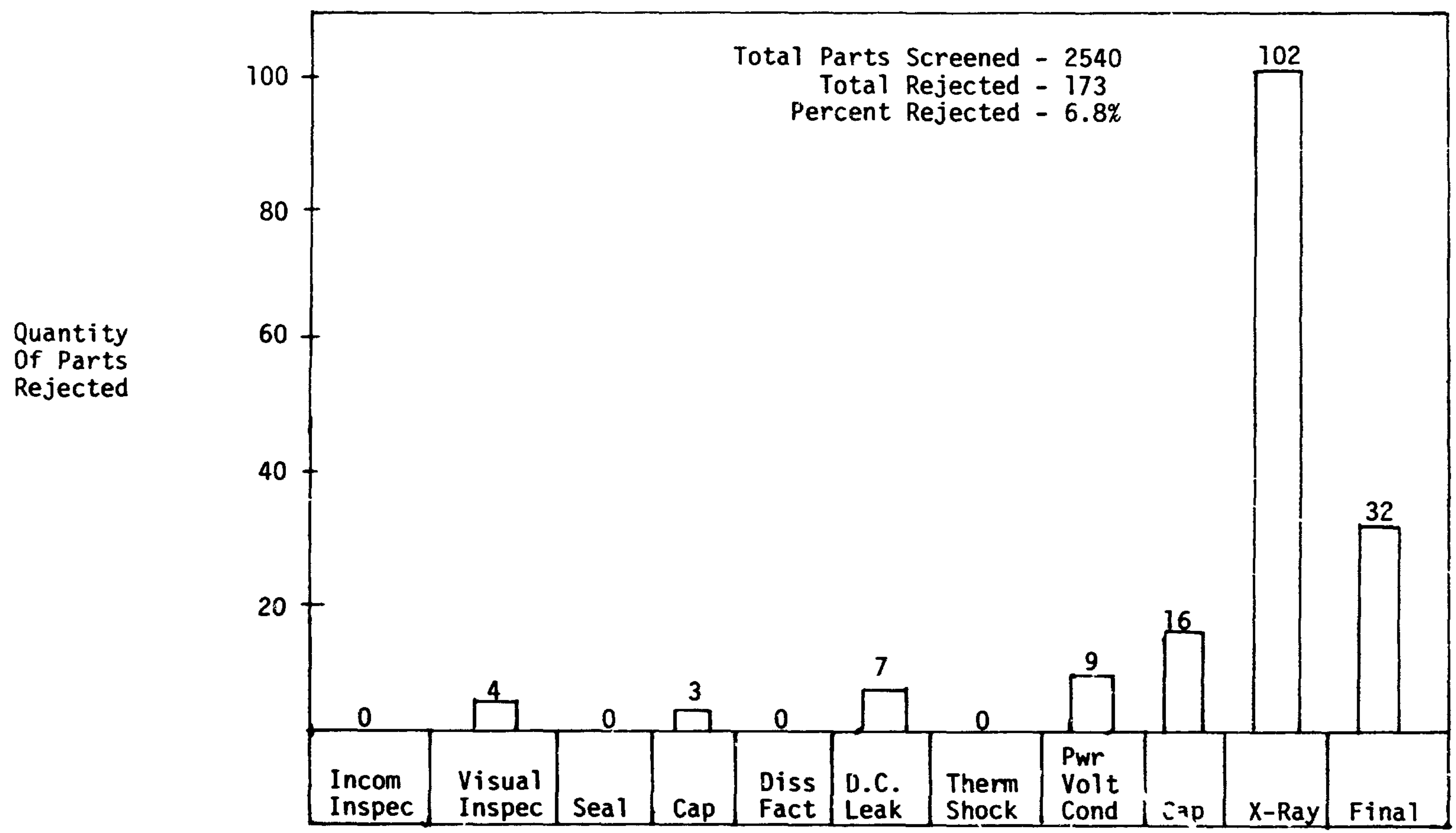

Figure B-5 - Capacitors, Tantalum, Solid, CSR 13, M39003/01 Screening Summary
Quantity Rejected At Each Screening Test

TABLE B-6. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Capacitors, Tantalum, CSR 13, M39006/22

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test										
				Incom Inspec	Visual Inspec	Seal	Cap	Diss Fact	D.C. Leak	Therm Shock	Pwr Volt Cond	Cap	X-Ray	Final
Sprague	200	0	0	0	0	0	0	0	0	0	0	0	0	0

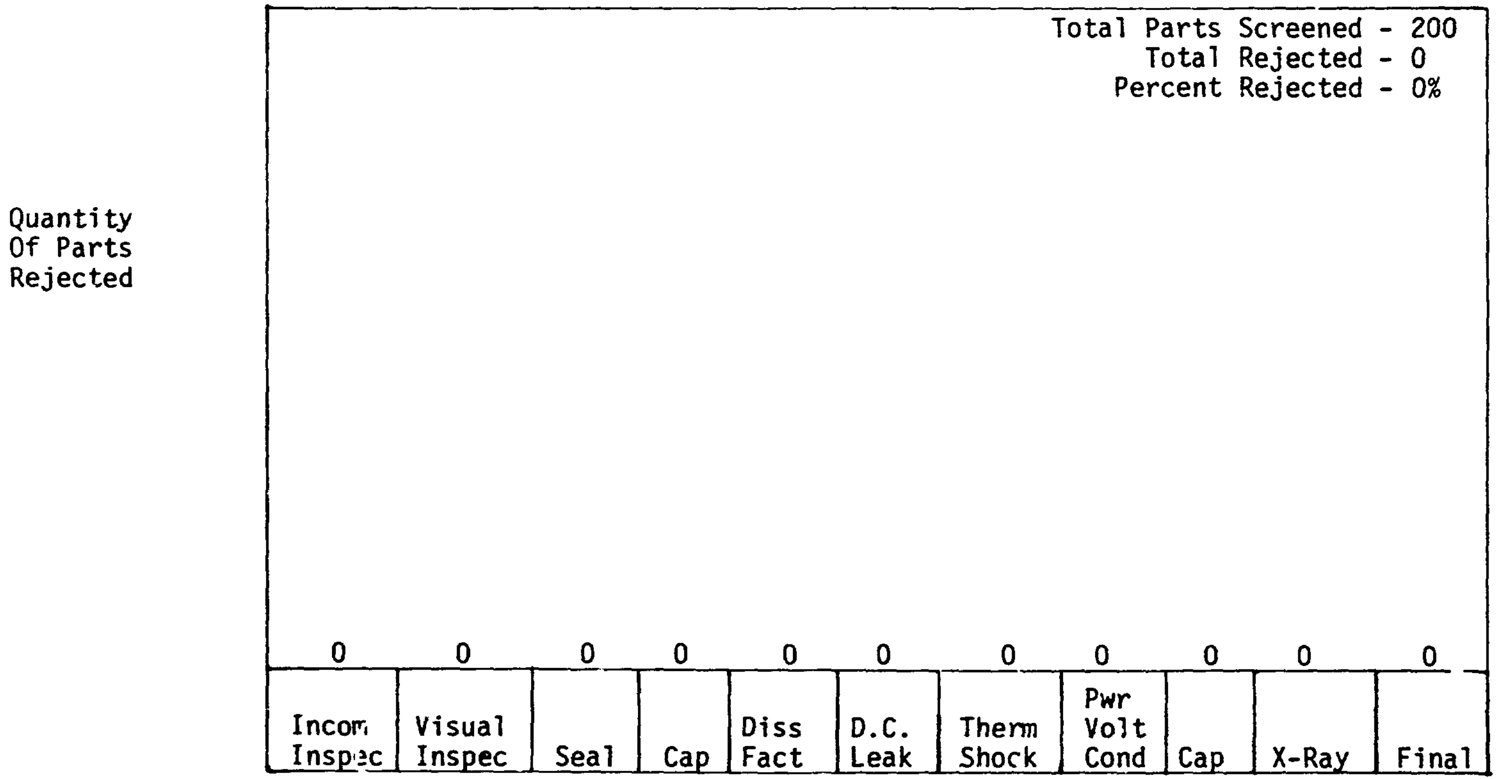

Figure B-6 - Capacitors, Tantalum, CSR 13, M39006/22 Screening Summary

Quantity Rejected At Each Screening Test

TABLE B-7. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Diodes

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test: Inc Insp	Int Vis	Stab Bake	Envir	Seal	Elect	Burn In	Elect	X-Ray	PIND	Final Elect	Final Vis
Siemens	750	241	32.1	33	1	1	5	20	26	6	48	22	51	28	
T.I.	2274	397	17.5	77	0	0	10	0	6	0	7	96	0	201	
Unitrode	2015	684*	33.9	55	1	0	18	24	22	11	412	12	31	37	
Micro Semi	244	51	20.9	0	0	0	24	0	16	0	3	1	0	7	
Motorola	234	36	15.4	0	1	0	0	0	0	0	0	11	13	9	
Hewlett Packard	100	64*	64	10	0	0	0	0	4	0	2	2	0	2	
Fairchild	405	66	16.3	0	7	0	0	0	5	0	2	43	9	0	
Semtech	120	1	.8	0	0	0	0	0	0	0	1	0	0	0	
Ampower	37	15	40.5	0	0	0	0	0	0	0	15	0	0	0	
Raytheon	15	7	47	1	0	0	0	0	0	0	0	0	6	0	
Aertech	120	24	20	1	0	0	4	1	1	0	0	4	8	1	4
TRW	306	248	81	0	56	0	0	0	174	1	0	0	7	10	
(Unknown)	72	1	1.4	0	0	0	0	0	0	0	0	0	1	0	
Codi	32	6	18.8	0	0	0	0	0	0	0	0	5	0	1	
(Unknown)	42	20	47.6	0	0	0	0	0	0	0	0	0	20	0	—
Totals	6766	1861	27.5	177	66	1	61	45	254	18	490	196	146	296	4

*Total rejections do not equal individual rejections due to instances of total lot rejections.

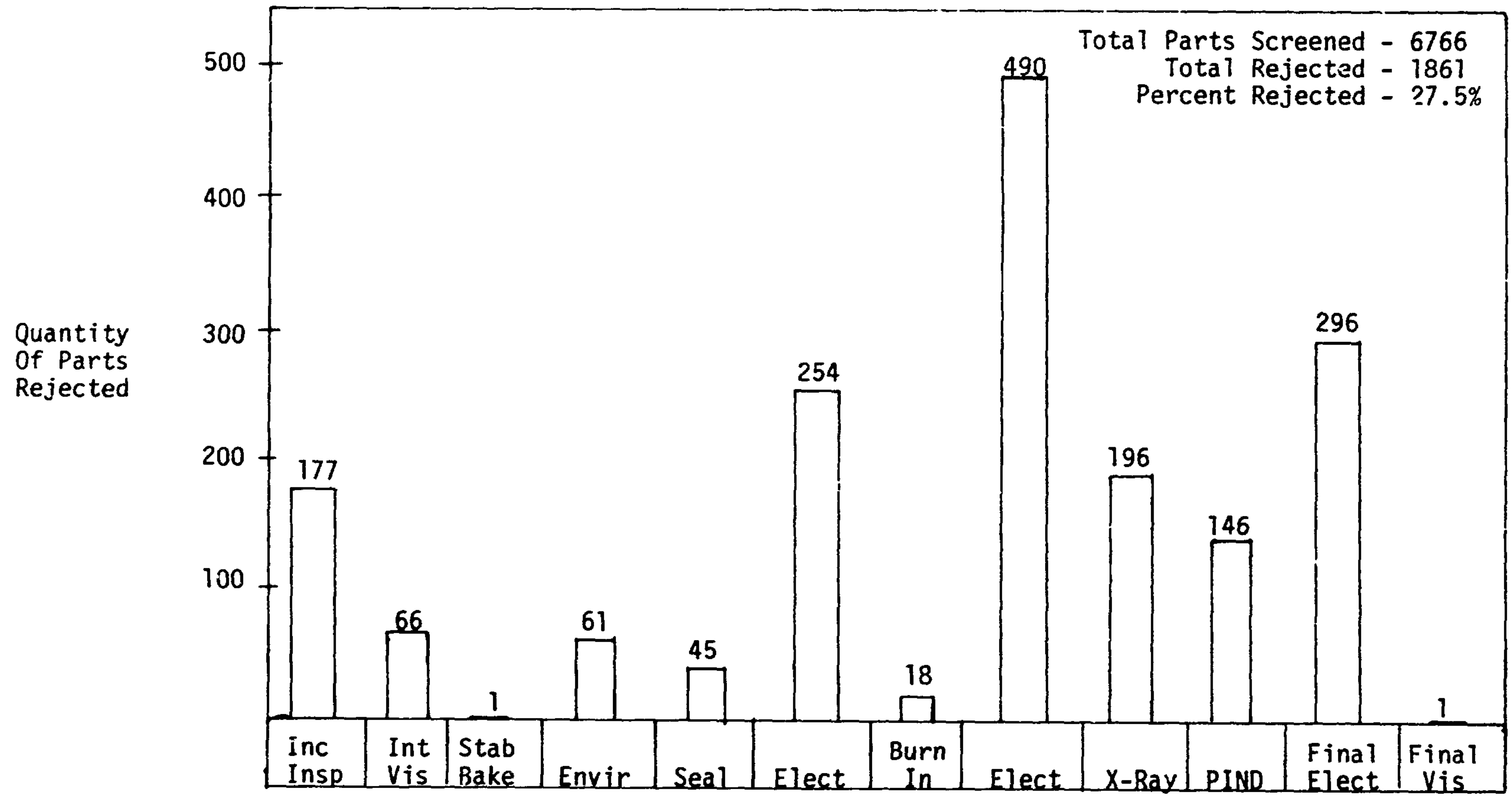

Figure B-7 - Diodes Screening Summary

Quantity Rejected At Each Screening Test

TABLE B-8. AMARV PIECE PART REPORT - SCREENING SUMMARY

HYBRIDS

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test										
				Incom Inspec	Int Visual	Stab Bake	Envir	Seal	HTRB	Elect	Burn In	Elect	X-Ray	PIND
Micronetworks	196	106	54%	12	11	0	0	0	0	51	0	29	0	3
Data Devices	23	23	100%	0	0	-	-	-	-	-	-	-	-	23
Aydin Vector	3	1	33%	0	0	0	0	0	0	0	0	0	0	1
Totals	222	130	59%	12	11	0	0	0	0	51	0	29	0	27

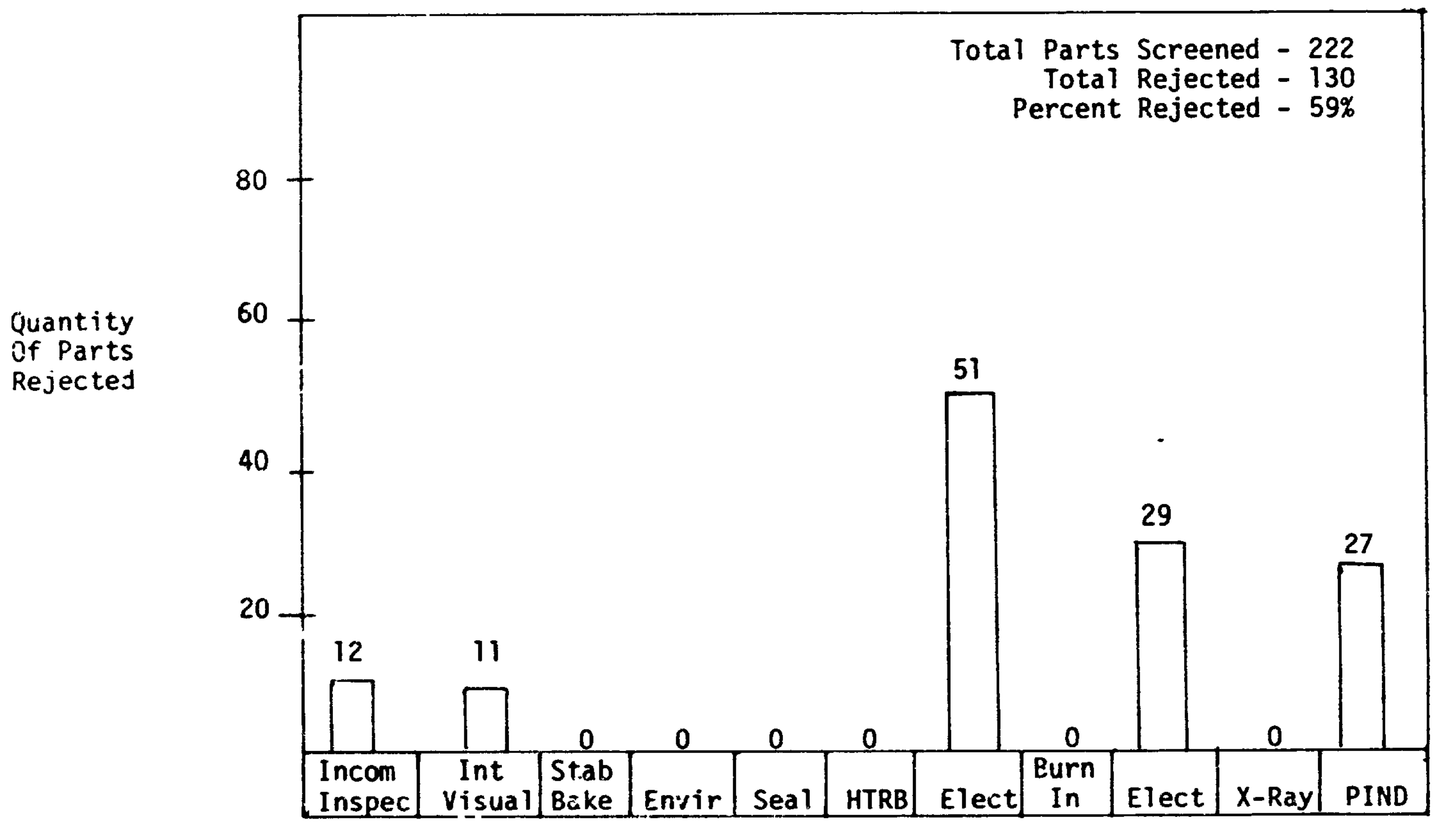

Figure B-8 - Hybrids Screening Summary
Quantity Rejected At Each Screening Test

TABLE B-9. AMARV PIECE PART REPORT - SCREENING SUMMARY

Integrated Circuits, Digital

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test											
				Incom Inspec	Int Visual	Stab Bake	Envir	Seal	HTRB	Elect	Burn In	Elect	X-Ray	PIND	Misc
TI (Sherman)	279?	861	30.78	0	542	0	0	7	0	94	0	8	166	43	1
TI (Dallas)	2001	869	43.42	0	389	0	0	30	0	266	0	18	136	30	0
National	4824	746	15.46	0	0	0	4	13	0	323	1	93	191	87	34
Signetics	4066	892	21.93	8	70	15	53	17	0	139	2	46	216	226	100
Fairchild	1818	1239	68.15	14	0	1	0	93	0	554	65	94	104	285	29
Intersil	1184	273	23.06	136	23	0	1	16	0	42	0	7	45	3	0
Silicon Gen	152	64	42.11	0	2	0	5	10	0	11	0	1	0	22	13
Motorola	58	5	8.62	2	0	0	0	0	0	0	0	1	0	2	0
Precision Monolithics	17	1	5.88	0	0	0	0	0	0	0	0	1	0	0	0
RCA	120	5	4.17	0	0	0	0	0	0	0	0	3	0	2	0
AMD	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	17,042	4955	29.08	160	1[illegible]	16	63	186	0	1429	68	272	858	700	177

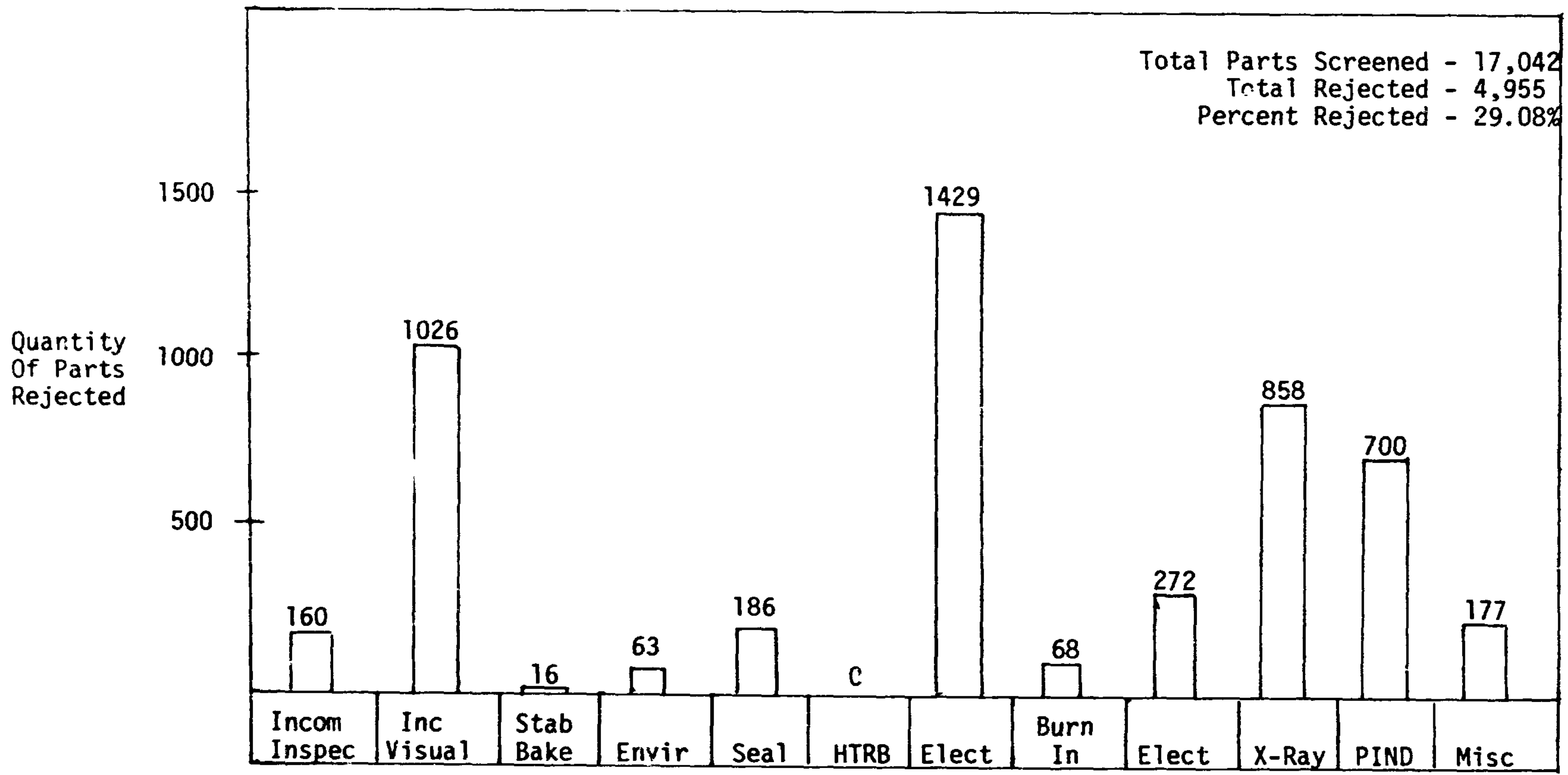

Figure B-9 - Integrated Circuits, Digital Screening Summary Quantity Rejected At Each Screening Test

TABLE B-10. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Integrated Circuits, Linear

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test											
				Incom Inspec	Int Visual	Stab Bake	Envir	Seal	HTRB	Elect	Burn In	Elect	X-Ray	PIND	Misc
National	164	14	8.54	0	0	0	0	0	0	8	0	0	1	4	1
Fairchild	5588	2168	38.80	19	0	2	2	4	0	1058	26	878	103	76	0
Intersil	323	154	47.68	0	118	0	0	4	0	6	0	12	8	6	0
Harris	89	13	14.61	0	0	0	0	0	0	2	0	9	2	0	0
Silicon Gen	150	111	74.00	0	0	0	0	24	0	73	0	7	0	7	0
Totals	6314	2460	38.96	19	118	2	2	32	0	1147	26	906	114	93	1

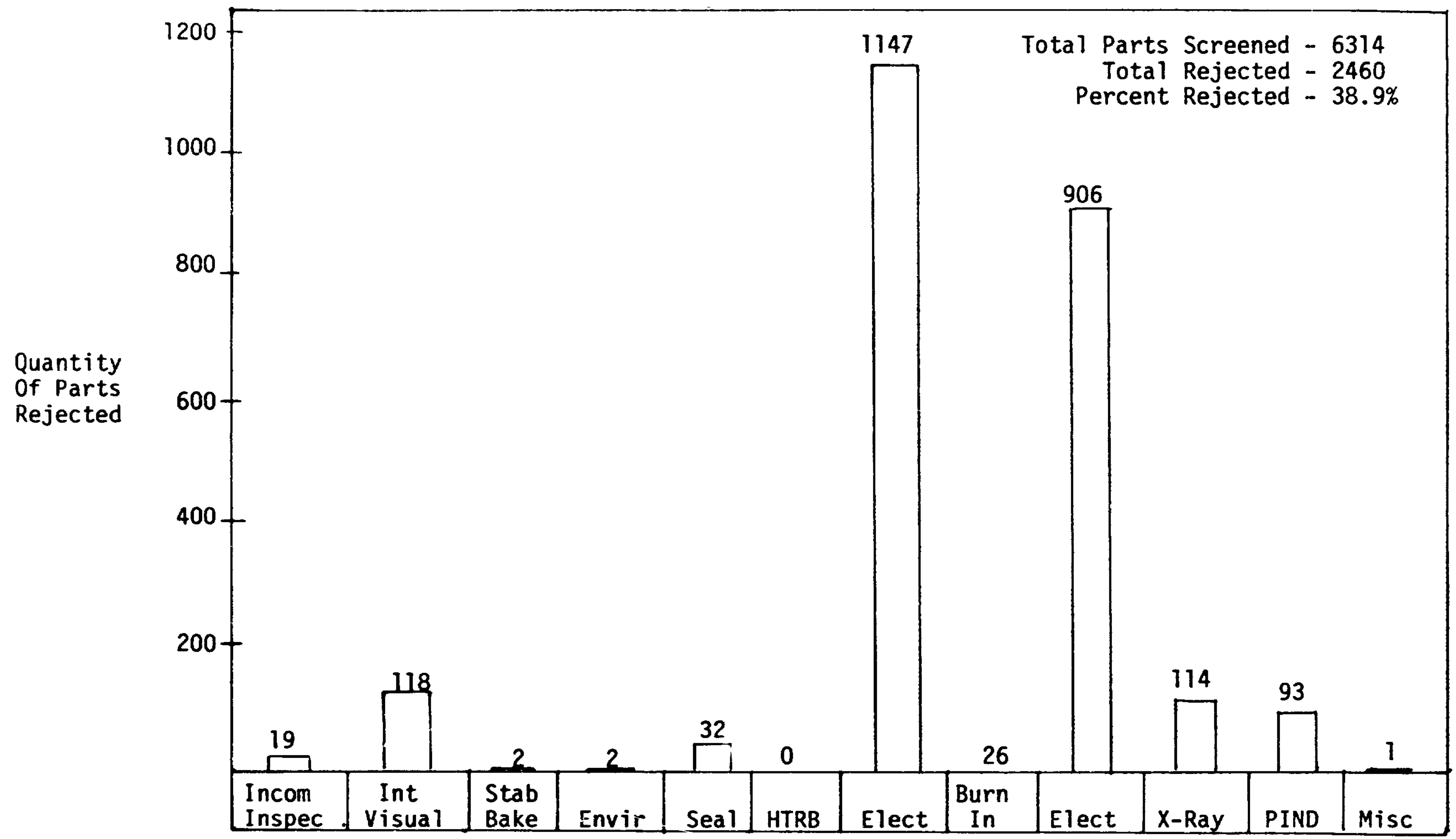

Figure B-10 - Integrated Circuits, Linear Screening Summary Quantity Rejected At Each Screening Test

TABLE B-11. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Magnetics, Filters

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test: Incom Inspc	Vis. Exam	Elec	Inser Loss	D.C. Res	Diel With Volt	Vibr	Burn In	Therm Shock	Seal	Elec	X-Ray	Ins Res
Erie	32	1	3.13	0	0	0	0	0	0	0	0	0	0	0	0	1
Spectrum	1403	38	2.7	0	4	0	0	0	21	0	2	2	0	8	0	1
Adams-Maxwell	25	1	4.	0	0	1	0	0	0	0	0	0	0	0	0	0
Sprague	21	2	9.52	0	0	0	0	0	0	0	0	0	0	0	2	0
Totals	1481	42	2.84	0	4	1	0	0	21	0	2	2	0	8	2	2

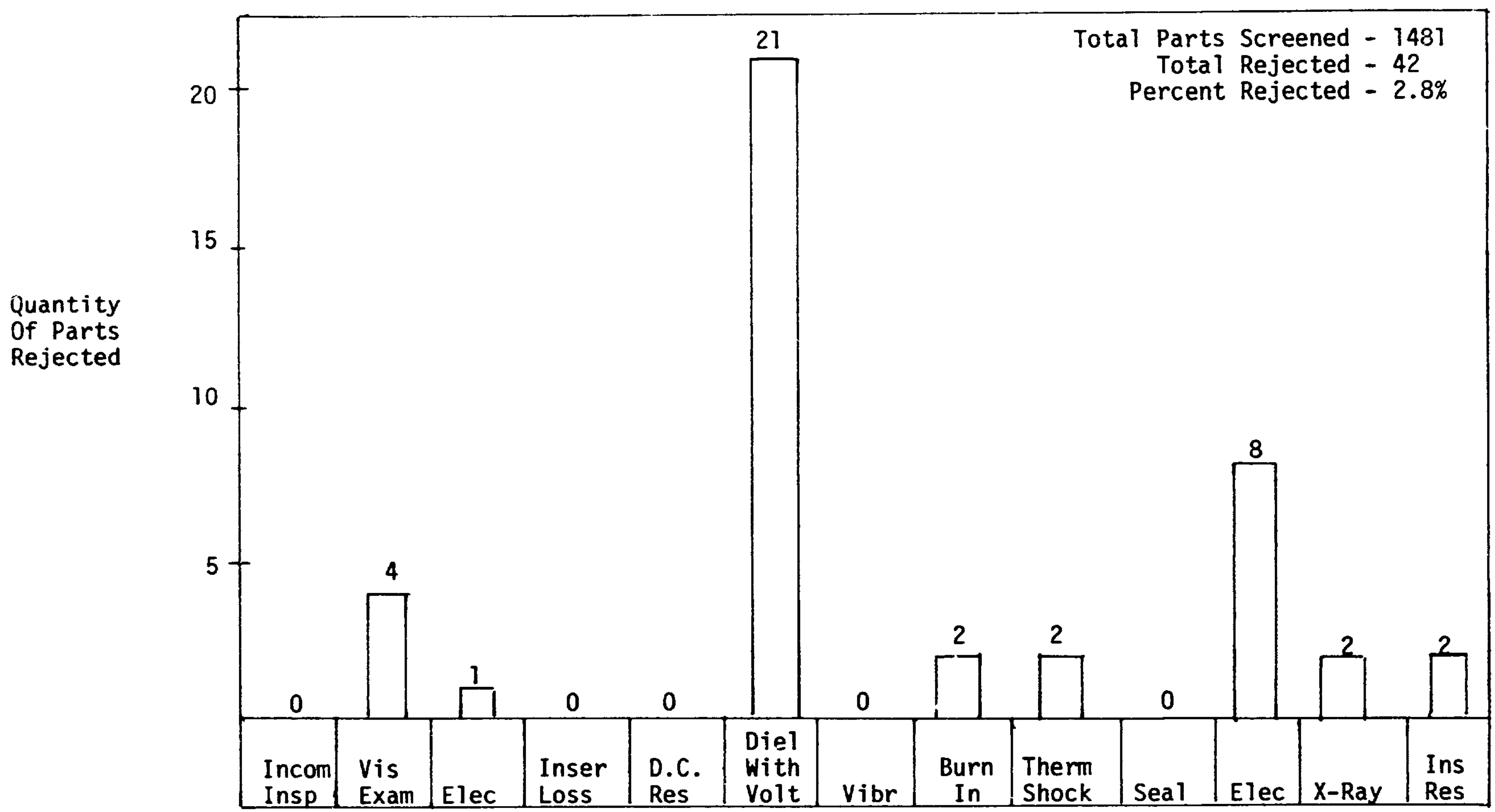

Figure B-11 - Magnetics, Filters Screening Summary
Quantity Rejected At Each Screening Test

TABLE B-12. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Magnetics Inductors

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test										
				Incom Inspec	Visual Exam	Ind	Diel With Volt	Insul Res	Burn In	Therm Shock	Seal	No Load Burn In	X-Ray	Visual Inspec
Hadley	120	2	1.66	0	0	0	0	0	0	0	0	0	2	0
Delevan	160	10	6.25	0	0	0	0	0	0	0	0	0	10	0
Nutronics	142	1	.7	0	0	0	0	0	0	0	0	0	0	1
Magnaspec	76	0	0	0	0	0	0	0	0	0	0	0	0	0
EWC	250	0	0	0	0	0	0	0	0	0	0	0	0	0
Microtran	16	0	0	0	0	0	0	0	0	0	0	0	0	0
Totals	764	13	1.70	0	0	0	0	0	0	0	0	0	12	1

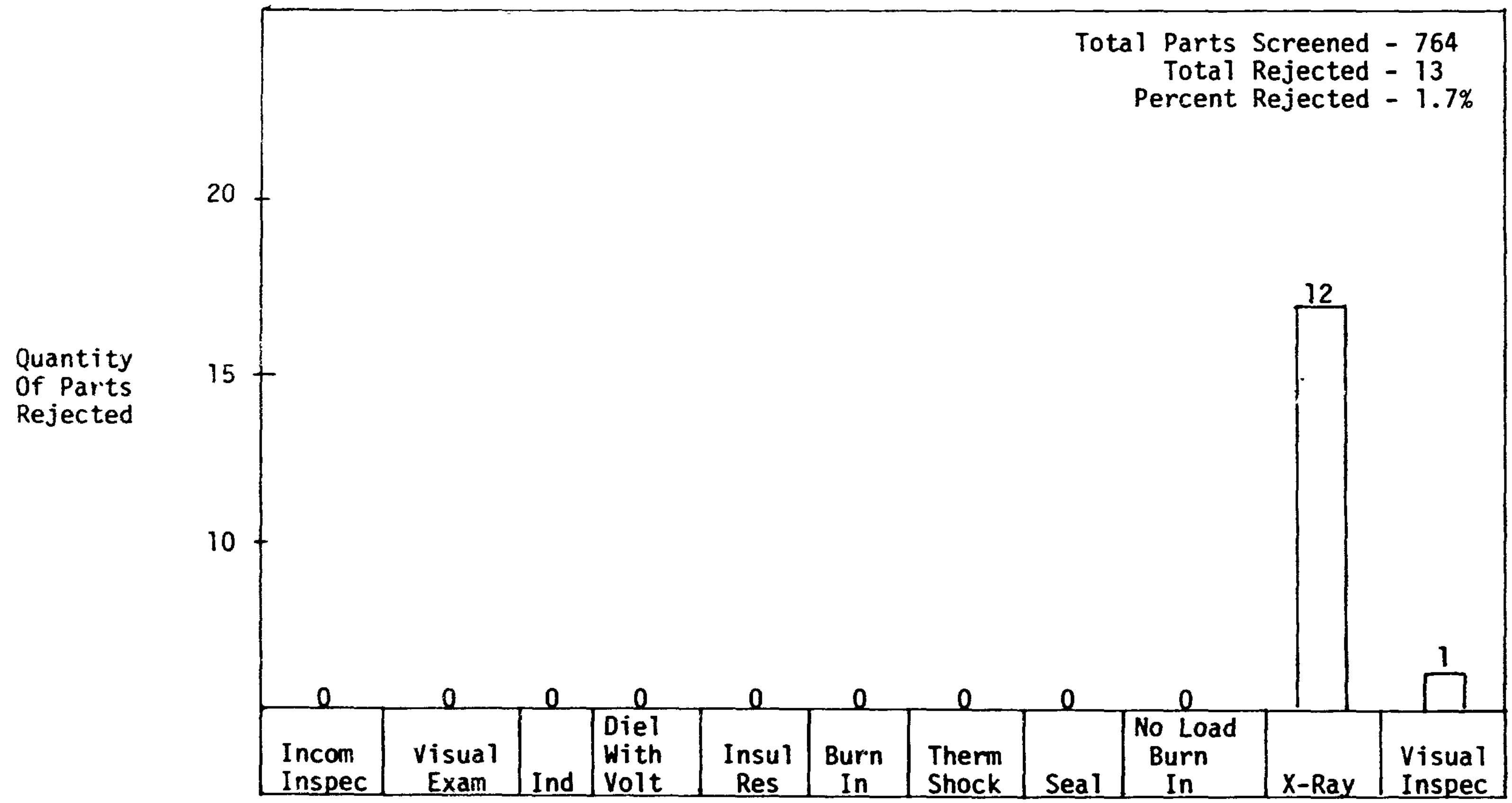

Figure B-12 - Magnetics, Inductors Screening Summary Quantity Rejected At Each Screening Test

TABLE B-13. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Magnetics, Transformer

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test: Incom Inspec	Visual Exam	Elect	Diel With Volt	Ins Res	Burn In	Temp Cycle	Seal	No Ld Burn In	X-Ray
Hadley	87	2	2.3	0	1	0	0	0	0	0	0	0	1
UTC	95	11	11.6	0	0	6	0	0	1	0	0	0	4
Tecnitrol	25	0	0	0	0	0	0	0	0	0	0	0	0
EWC	30	0	0	0	0	0	0	0	0	0	0	0	0
Totals	237	13	5.5	0	1	6	0	0	1	0	0	0	5

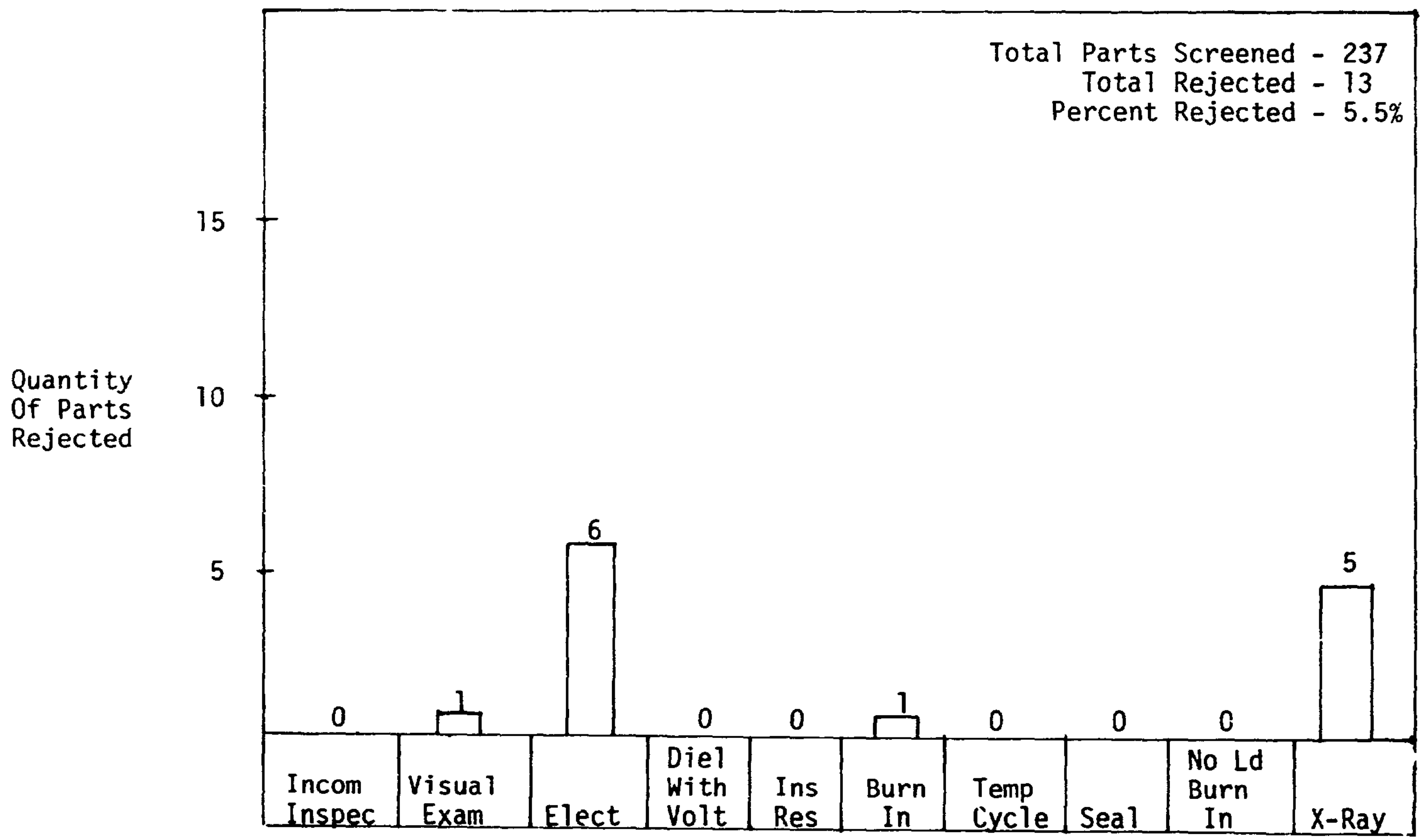

Figure B-13 - Magnetics, Transformer Screening Summary Quantity Rejected At Each Screening Test

TABLE B-14. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Resistors, Composition, Fixed, M39008

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test					
				Incom Inspec	Visual Exam	D.C. Resist	Power Volt Cond	D.C. Resist	Final
Allen Bradley	13062	427	3.3	1	0	377	1	43	5
Airco	1778	21	1.2	0	1	12	0	8	0
TRW	2398	106	4.4	0	0	62	0	44	0
Totals	17238	554	3.2	1	1	451	1	95	5

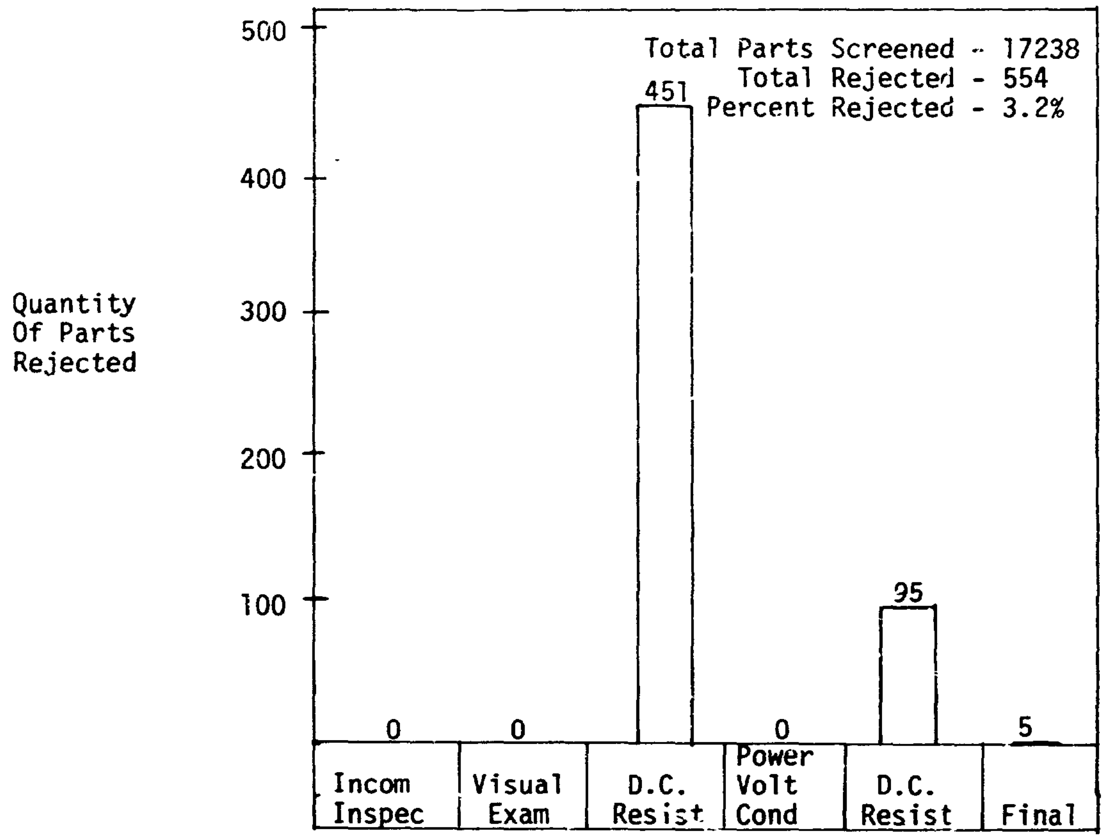

Figure B-14 - Resistors, Composition, Fixed, M39008 Screening Summary Quantity Rejected At Each Screening Test

TABLE B-15. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Resistors, Film, Fixed, M39017

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test									
				Incom Inspec	Visual Exam	D.C. Resist	Seal	Therm Shock	Over Load	Pwr Volt Cond	D.C. Resist	X-Ray	Final
Corning	8936	268	2.9	8	14	3	--	0	0	1	24	208	10
Mepco	430	51	11.9	1	0	0	0	0	1	0	0	47	2
Allen Bradley	600	18	3	0	0	0	0	0	0	0	5	13	0
Totals	9966	337	3.4	9	14	3	0	0	1	1	29	268	12

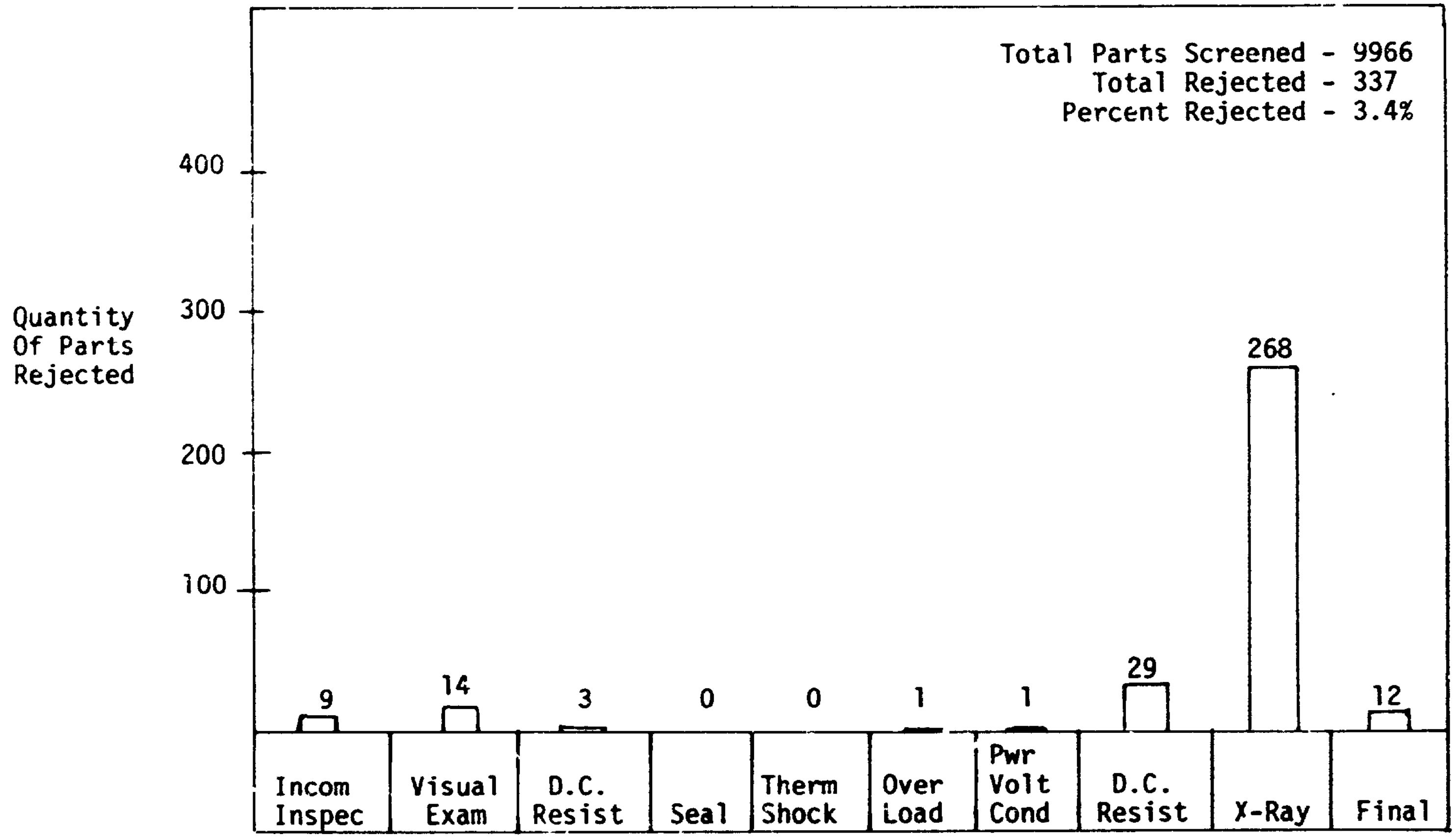

Figure B-15 - Resistors, Film, Fixed, M39017 Screening Summary

Quantity Rejected At Each Screening Test

TABLE B-16. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Resistors, Film, Fixed M55182

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test									
				Incom Inspec	Visual Exam	D.C. Resist	Seal	Therm Shock	Over Load	Pwr Volt Cond	D.C. Resist	X-Ray	Final
Dale	11607	1434	12.4	15	0	60	0	1	6	0	283	692	377
TRW	313	1	.3	0	0	0	0	0	0	0	0	1	0
Angstrom	145	1	.7	0	0	0	0	0	0	0	0	1	0
Mepco	11758	402	3.4	163	24	18	0	0	0	4	30	163	0
KDI	100	2	2	0	0	0	0	0	0	0	0	0	2
Vishay	973	420	43.2	0	9	2	0	0	0	29	5	375	0
Corning	13306	322	2.4	13	2	5	0	0	0	0	18	284	0
Totals	38202	2582	6.76	191	35	85	0	1	6	33	336	1516	379

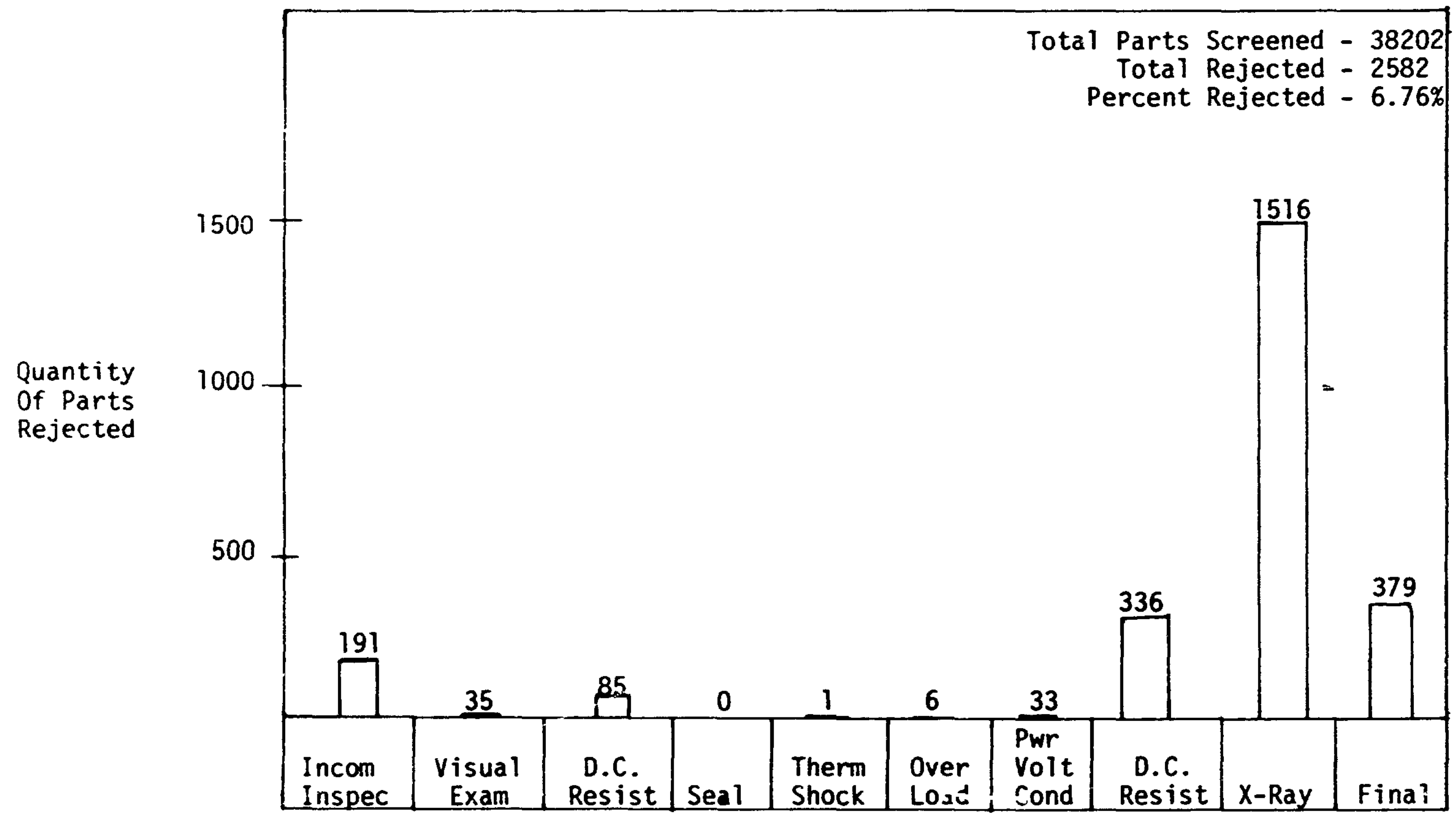

Figure B-15 - Resistors, Film, Fixed M55182 Screening Summary

Quantity Rejected At Each Screening Test

TABLE B-17. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Resistors, Film, Fixed, Network, M83401

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test									
				Incom Inspec	Visual Exam	D.C. Resist	Seal	Therm Shock	Over Load	Pwr Volt Cond	D.C. Resist	X-Ray	Final
Dale	101	11	10.9	5	0	0	0	0	0	0	0	6	0
Mepco	687	7	1	0	2	3	0	0	0	0	2	0	0
Totals	788	18	2.3	5	2	3	0	0	0	0	2	6	0

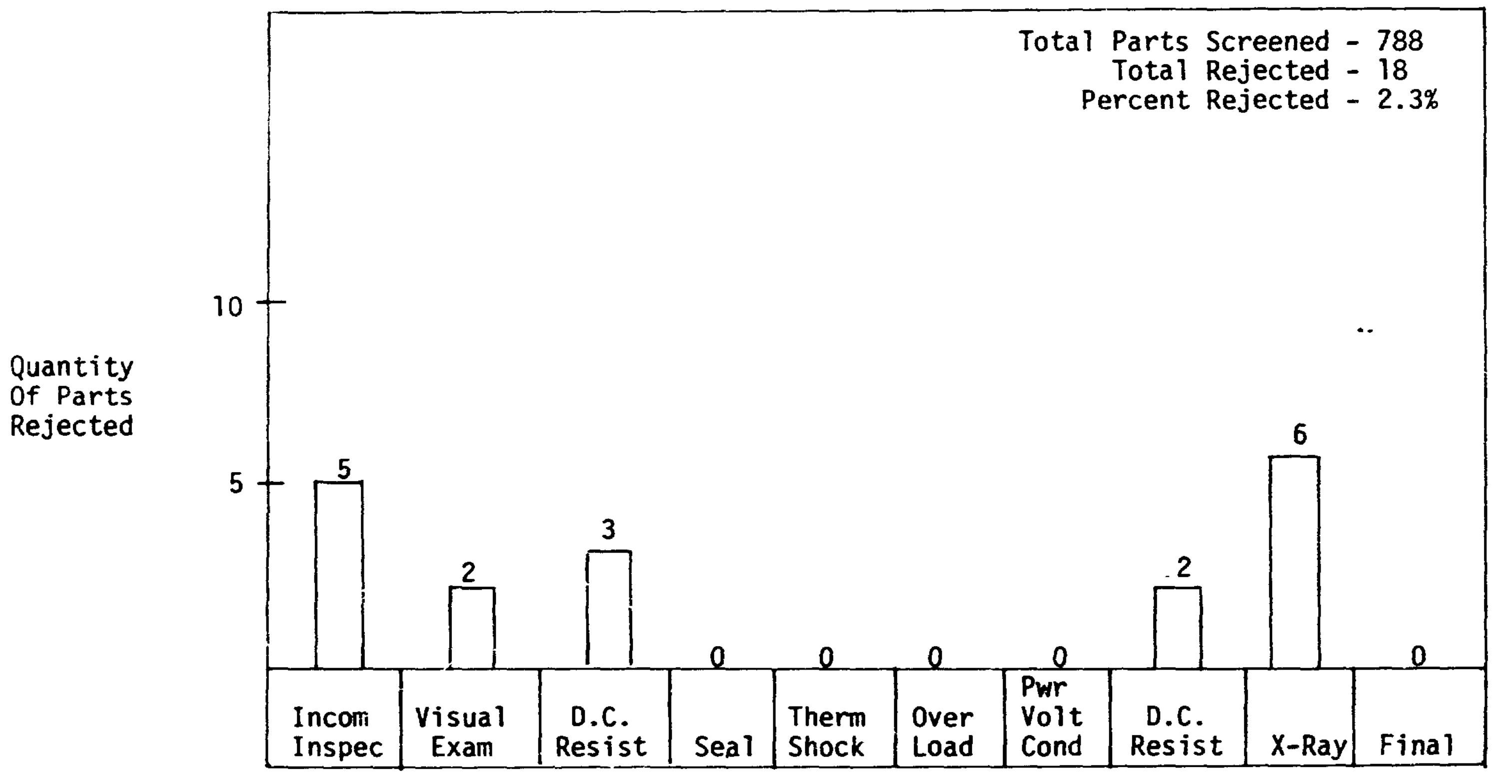

Figure B-17 - Resistors, Film, Fixed, Network, M83401 Screening Summary
Quantity Rejected At Each Screening Test

TABLE B-18. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test										
				Incom Inspec	Visual Exam	D.C. Resist	Res Temp Char	Therm Shock	D.C. Resist	Pwr Volt Cond	D.C. Resist	X-Ray	Ext. Visual	Final
Resistor, Wirewound, Power, M39007														
RCL	426	26	6.1	12	0	1	8	0	0	1	0	1	0	3
Dale	243	0	0	0	0	0	0	0	0	0	0	0	0	0
Mepco	100	1	1	0	1	0	0	0	0	0	0	0	0	0
UNK	63	0	0	0	0	0	0	0	0	0	0	0	0	0
Cal-R	145	2	1.4	0	0	1	0	0	0	0	0	0	1	0
Shallcross	129	5	3.9	0	0	1	0	0	0	0	3	1	0	0
Totals	1106	34	3	12	1	3	8	0	0	1	3	2	1	3
Resistor, Variable, Non-Wirewound, M39035														
Bourns	42	4	9.5	0	0	1	0	0	1	0	0	1	0	1

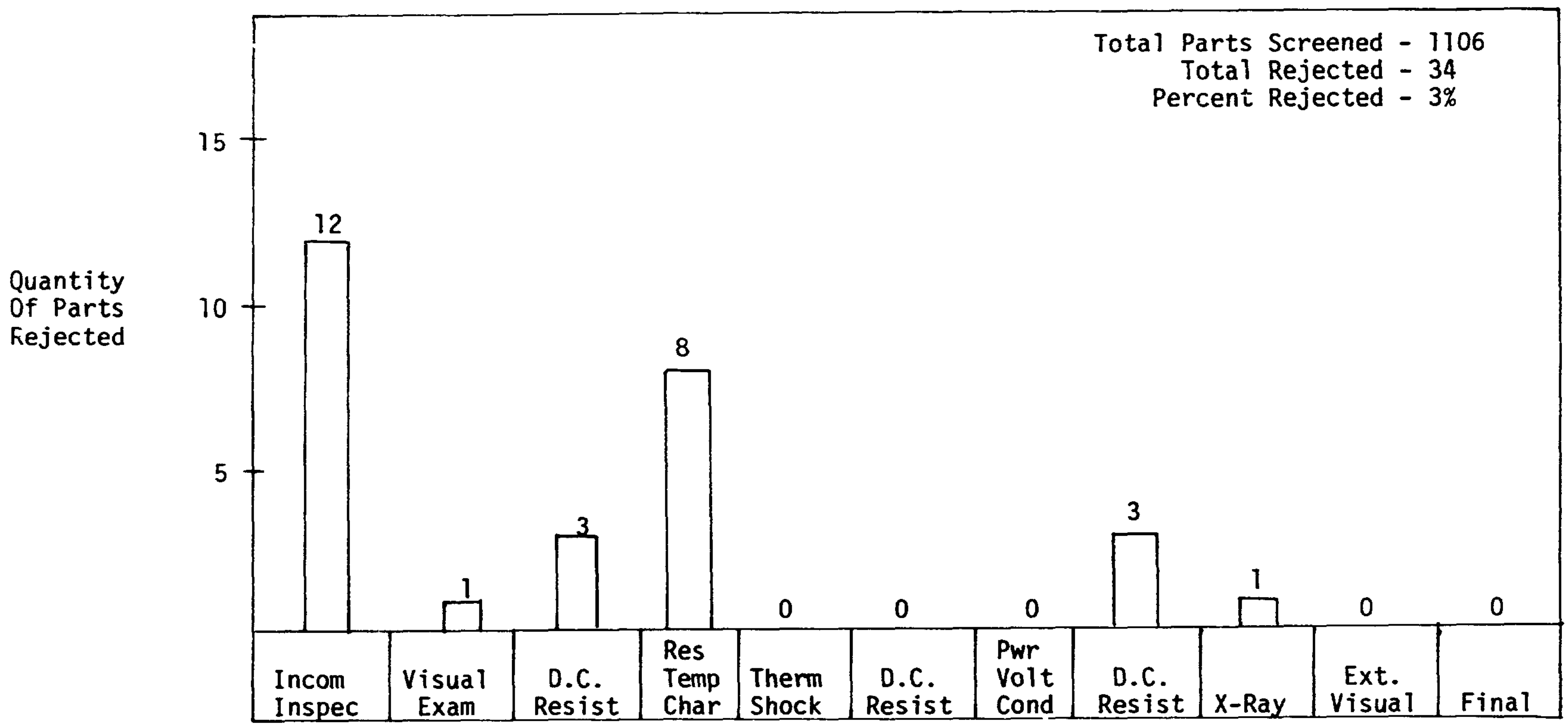

Figure B-18 - Resistor, Wirewound, Power, M39007 Screening Summary Quantity Rejected At Each Screening Test

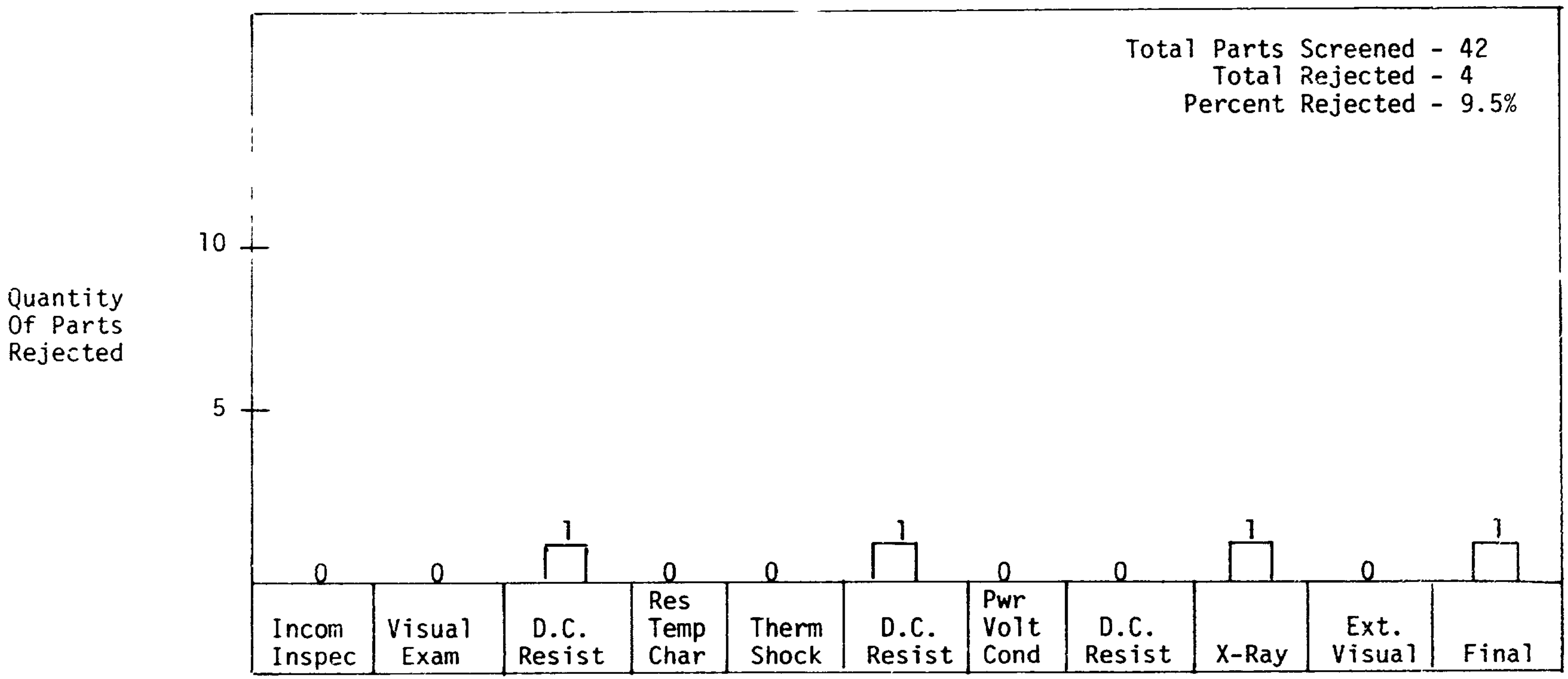

Figure B-18A - Resistor, Variable, Non-Wirewound, M39035 Screening Summary

Quantity Rejected At Each Screening Test

TABLE B-19. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Resistor, Wirewound, M39009

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test							
				Incom Inspec	Int. Visual	D.C. Resist	Temp. Shock	Pwr Volt Cond	D.C. Resist	Over Load	Ext. Visual
Dale	20	0	0	0	0	0	0	0	0	0	0
RCL	26	2	7.7	2	0	0	0	0	0	0	0
Totals	46	2	4.3	2	0	0	0	0	0	0	0

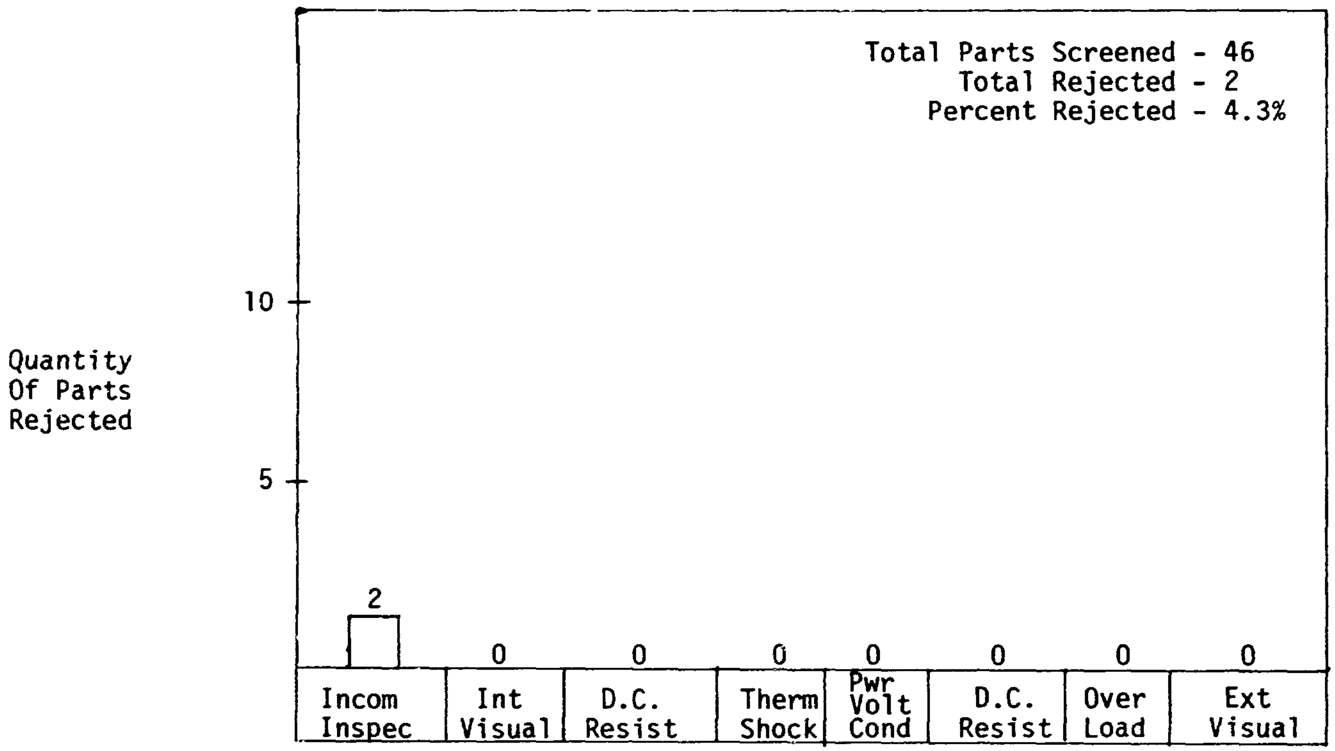

Figure B-19 - Resistor, Wirewound, M39009 Screening Summary
Quantity Rejected At Each Screening Test

TABLE B-20. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Thermistor, M-23648

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test							
				Incom Inspec	Visual Exam	D.C. Resis	Therm Shock	Diss Const	Pwr Cond	Final	R-T Charac-teristics
Keystone Carbon	111	40	36	0	0	0	0	15	6	0	19
Gulton	217	12	5.5	0	1	10	1	0	0	0	—
Totals	328	52	15.8	0	1	10	1	15	6	0	19

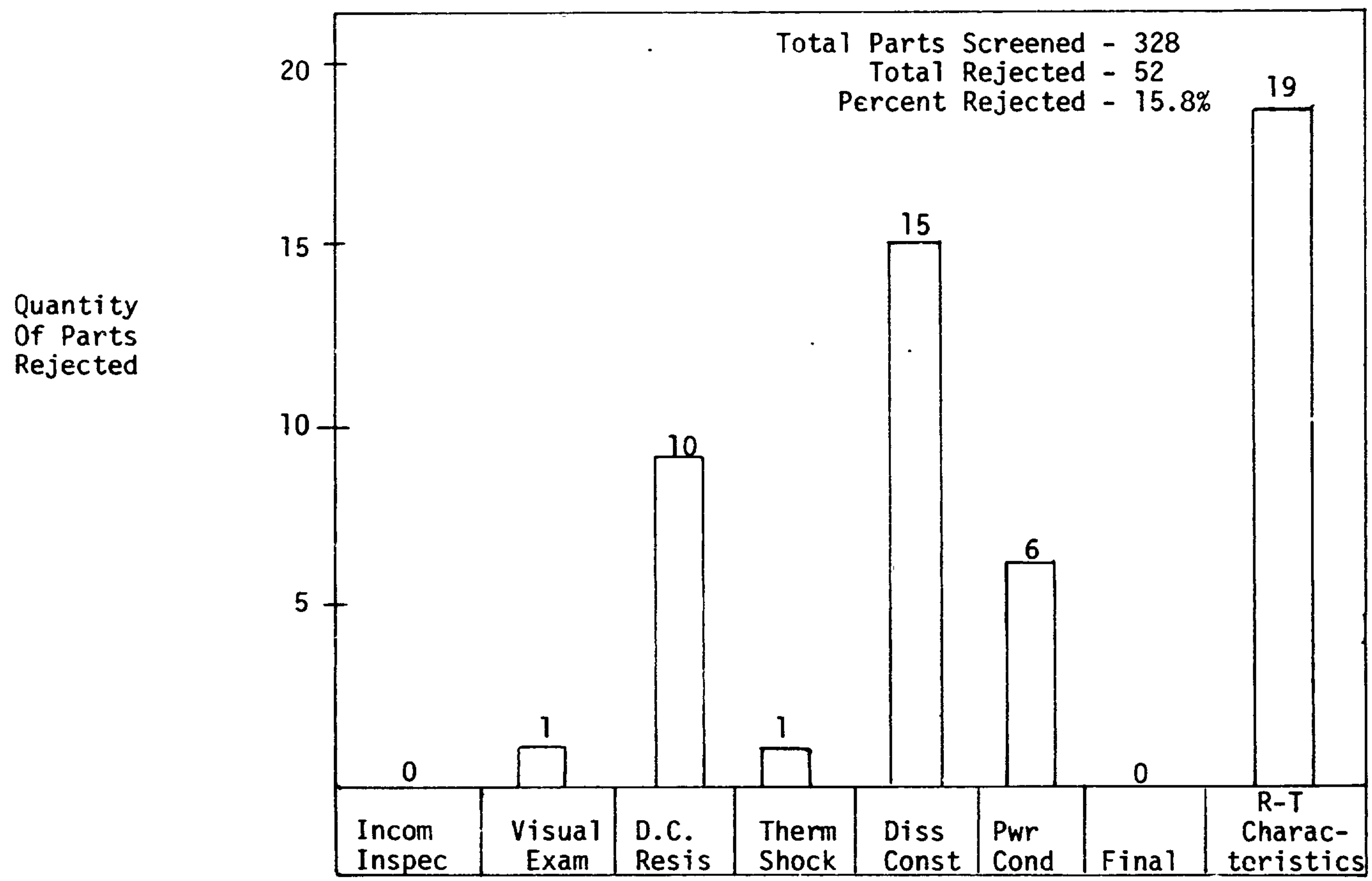

Figure B-20 - Thermistor, M-23648 Screening Summary
Quantity Rejected At Each Screening Summary

TABLE 3-21. AMaRV PIECE PART REPORT - SCREENING SUMMARY

Transistors

Part Manufacturer	Qty Rec'd	Qty Rej	% Rej	Quantity Rejected At Each Screening Test											
				Inc Insp	Int Vis	Stab Bake	Envir	Seal	HTRB	Elect	Burn In	Elect	X-Ray	PIND	Final Elect
Motorola	2632	*934	35.5	34	2	0	1	16	0	16	30	75	8	388	30
Transitron	100	29	29	6	0	0	0	15	0	0	0	0	0	5	3
Unitrode	164	100	60.9	53	0	0	0	0	0	3	0	1	18	25	0
Solitron	325	166	51	52	0	0	0	16	0	4	9	4	5	65	11
Teledyne	200	90	45	5	0	0	0	7	0	7	0	11	1	27	32
NSC	63	*63	100	6	-	-	-	-	0	-	-	-	-	-	-
Solid State	100	*100	100	10	-	-	-	-	0	-	-	-	-	-	-
Raytheon	150	*68	45.3	0	0	0	0	0	0	0	0	1	3	1	0
T.I.	531	150	28.2	8	0	0	0	5	1	7	27	4	22	59	17
G.E.	350	*213	60.8	1	0	0	0	0	0	3	0	2	13	43	1
Fairchild	355	17	4.8	0	0	0	1	2	0	5	0	0	4	5	0
TRW	80	3	3.75	0	0	0	0	0	0	0	0	0	1	2	0
National	255	108	42.3	0	0	0	0	0	0	0	0	8	8	88	4
Siliconix	32	4	12.5	0	0	0	0	0	0	4	0	0	0	0	0
Totals	5337	2045	38.3	322	2	0	2	61	1	49	66	106	83	708	98

*Total rejections are not equivalent to total individual rejections due to complete lot rejections.

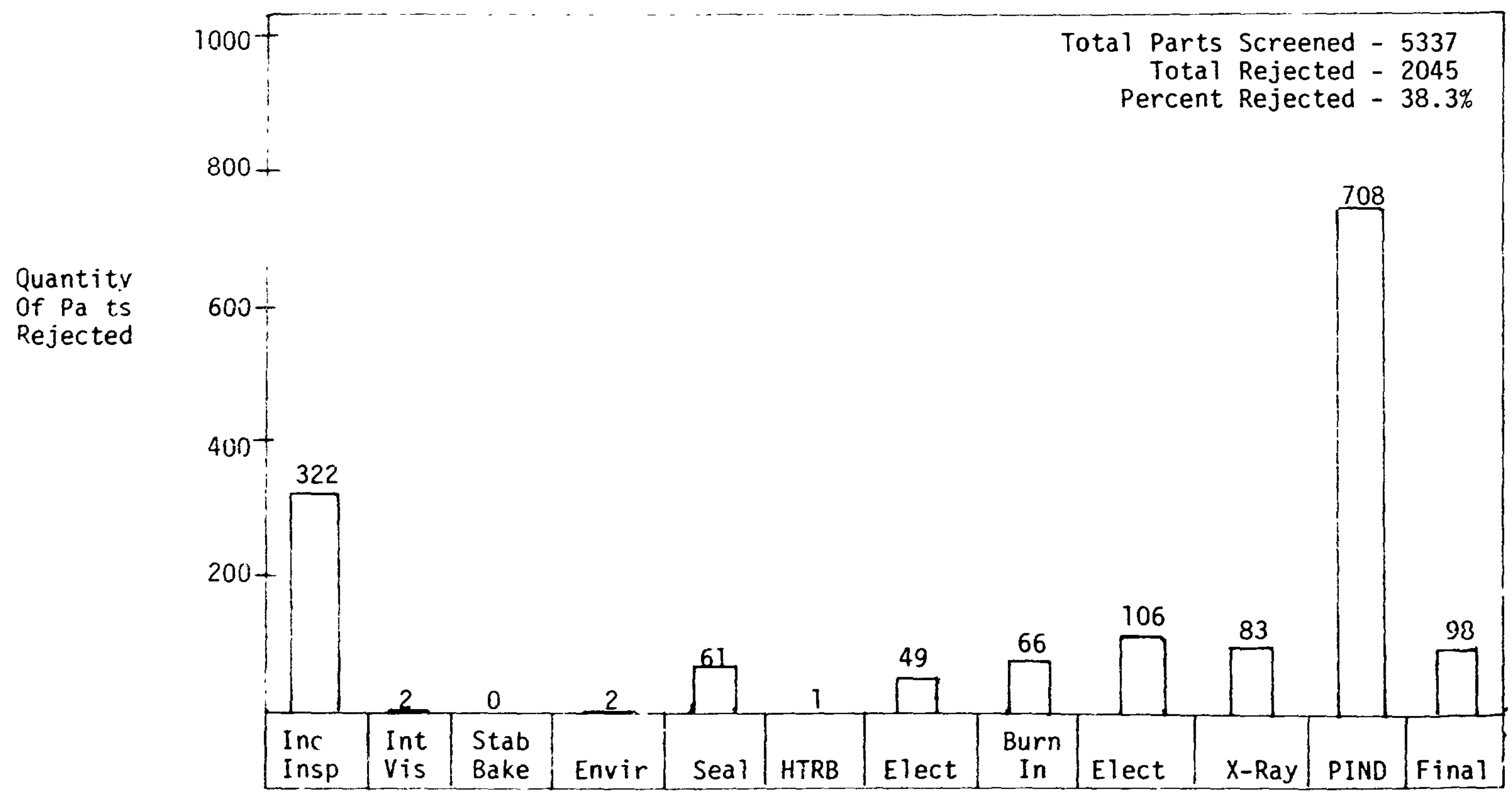

Figure B-21 - Transistors Screening Summary
Quantity Rejected At Each Screening Test

APPENDIX C

DESTRUCTIVE PHYSICAL ANALYSIS (DPA) SUMMARY

C-1 DESTRUCTIVE PHYSICAL ANALYSIS

A Destructive Physical Analysis (DPA) was performed on a sample from each lot of hybrids, integrated circuits, transistors, diodes, magnetic parts, tantalum, ceramic and mica capacitors, relays and crystals. Sample size per lot for DPA was 2% or 3, whichever was greater. Deviation was allowed on some parts for a smaller sample size due to cost complexity, and similarity. Examples are the hybrids, relays, and magnetic parts.

C-2 DPA SUMMARY

Table C-1 provides a summary of DPA activity on AMaRV. It may be noted that DPA failures did not always result in lot reject. The lot failure column reflects the number of DPA samples which failed due to some anomaly. The failures were reported to the PMPCB by non-conformance report (NCR) and a review performed of the DPA results and past history of the lot including screening data. When the review revealed a favorable history for the lot and investigation of the DPA anomaly showed the problem not to be lot related, the lot was accepted with DPA discrepancy. DPA lot rejects included [illegible]C-HB parts numbers ST401-05-1339 (CKR05) capacitor, 1D40514-501 (1N5071) diode, and 1B98774-1 (HI5051) integrated circuit.

TABLE C-1. AMaRV PIECE PART FINAL REPORT - DPA SUMMARY

PART TYPE	NO. OF LOTS	NO. OF DPA PERFORMED	NO. OF DPA FAILURES	PERCENT DPA FAILURES	LOTS REJECTED	PERCENT LOTS REJECTED
CAPACITORS	213	213	17	7.98	1	.5
DIODES	105	105	29	27.6	2	1.9
HYBRIDS	15	15	7	46.7	0	0
INTEGRATED CKTS	208	208	89	42.8	4	1.9
MAGNETICS	93	93	16	17.2	5	5.4
RESISTORS	32	32	9	28.1	0	0
TRANSISTORS	94	94	30	31.9	0	0
RELAYS	3	3	0	0	0	0
TOTALS	763	763	197	25.8	12	1.6

APPENDIX D

PROPOSED TAILORING TO MIL-STD-1546 AND MIL-STD-1547

D-I INTRODUCTION

MDAC-HB is a member of the Space Parts Working Group (SPWG), and has participated in the review and comment to the subject two military standards. Experience on AMaRV has shown that SAMSO-STD73-2C is an interpretive document requiring definition and tailoring for each program. Implementation of requirement has proven to have an impact on cost and schedule. Replacing it with the two subject standards containing more detail and specific requirements provides further control which may have impact on cost and schedule and require considerable tailoring for each application. The comments contained herein are essentially those submitted to the SPWG and were made to proposed MIL-STD-1546 issue dated 1 February 1979, and MIL-STD-1547, Revision 1, dated 8 November 1978. Considerable coordination has taken place on the standards since those dates.

D-2 COMMENTS TO MIL-STD-1546

The following comments are submitted for the noted paragraphs:

4.2 PMPCB

Comment: This paragraph should include management of engineering requirements to be consistent with the scope of this paragraph and the implied responsibility of paragraph 4.4, i.e., it should read: "...selection, standardization and engineering requirements..."

5.4.5.4 Destructive Physical Analysis

"The DPA sample size shall be two percent of five parts, whichever is larger, with a maximum of 30 parts."

D-2 COMMENTS TO MIL-STD-1546 (Cont'd)

5.4.5.4 Destructive Physical Analysis

Comment: The DPA 2% sample size is excessively large for the nature of the test and, being a variable quantity based on a percentage of the number procured, it can result in multiple jeopardy and costs on the same lot.

DPA is a relatively expensive inspection involving skilled man-hours and the destruction of relatively expensive production parts. The generally accepted purpose of DPA is to detect lot related problems, that cannot be detected earlier and/or more economically by other means. Lot related problems by definition are those which are characteristic of the lot, i.e., relatively large percentages of the parts exhibit the problem. On this basis a small fixed sample is sufficient and DPA then is economically justifiable by precluding the introduction of relatively large percentages of defective parts.

Very large sample sizes would be required to detect lots with a small percentage defectives. For example, a 130 piece sample from a lot of 200 pieces would be required for 90% confidence in detecting a lot with 1% defectives. As the cost of DPA becomes proportional to the sample size, as the sample size increases, attempts to detect low percentage defectives is extremely expensive.

D-2 COMMENTS TO MIL-STD-1546 (Cont'd)

5.4.5.4 Destructive Physical Analysis (Cont'd)

A three or five piece (constant size) single sample is recommended for DPA to detect lot related anomalies with reasonably high confidence (i.e., over 90% for lot related anomalies). Smaller sample sizes should be considered for high cost parts or extremely small lots. Three to five pieces would provide multiple units for the performance of mutually exclusive tests where required. The fixed sample size eliminates the multiple jeopardy exposure of the proposed 2% sample size. The receipt of parts from the same lot delivered to subsequent orders is not unusual in our experience. The 2% sample requirement would require an additional sample of parts to be subjected to another DPA, thus reopening the question of acceptability of previously received and accepted parts that may already be in systems. This belated jeopardy can be catastrophically expensive and must be avoided. The confidence in the test is not significantly influenced by the lot size and, therefore, a sample based on lot size is not warranted. For example, if a fixed five piece sample is acceptable for a lot of 250 pieces (which it is according to the 2% sample proposed) then it should be acceptable for larger lots, e.g., infinite size, and the risk gets even smaller for smaller size lots.

5.4.5.4.1 DPA Policy

Comment: The requirement to use "standardized ...report format..." here or elsewhere is an unnecessary expense and disruption of all contractors and suppliers existing business systems. The only purpose appears to be for the convenience of a few PMPCB members. The

5.4.5.4.1 DPA Policy (Cont'd)

content of the DPA reports is covered in the proposed standard and that would be sufficient. The standard format requirement should be deleted.

5.4.6 Incoming Inspection Requirements

"Lots not meeting acceptance criteria shall not be used...". Change to read "...shall be rejected...".

Comment: This implies that the quality assurance system of rejection and material review board (MRB) action is not allowed. This would obviously result in unwanted but serious cost and schedule impacts.

5.4.6 - b2

"Sample electrical test at specified temperature extremes".

Comment: This is not a clear definition of what is required, e.g.: What is specified temperature?, - High? Low? High and Low? Sample of what? e.g., a sample of the electrical performance requirements, a sample of the parts from a lot, or a sample lot from the lots, all or none of the above?

5.4.7 Failure Analysis

Comment: This paragraph requires extensive failure analysis on failed parts, and requires that such analysis requirements be contained in any military specifications selected for program use, or be added to these military specifications by the contractor (thru DESC). This virtually precludes the use of Mil Spec parts as they

D-2 COMMENTS TO MIL-STD-1546 (Cont'd)

5.4.7 Failure Analysis (Cont'd)

do not contain these requirements (including those on SAMSO PPL). It is unreasonable and unrealistic to expect the contractor to achieve the addition of these requirements to the mil specs when no government agency or parts group has been able to do so. The requirement should be deleted. If such requirements are left in, all mil spec parts and references should be deleted from the MIL-STD-1546/1547 documents as they create a serious mis-impression that they are usable, at least as a starting point, when in fact they are not.

Appendix D SAMSO Preferred Parts List substitute Class 'S' parts.

Comment: The use of substitute class 'S' parts is unacceptable. Efforts to use these parts (by direction) on a prior program were essentially unsuccessful from lack of a viable contractings mechanism, lack of data and surveillance evidence, unavailability of parts, and lack of support by the controlling agency. These should be either SAMSO furnished or SAMSO should take over the control, i.e., issue specs and provide the requisite quality surveillance, etc., similar to the JAN-S approach. If not, they should be eliminated from the PPL. Consideration should be given to the use of existing contractor controlled Hi-Rel parts which though apparently different may be equal, or superior to the subject parts, and offering considerable improvement in cost effectiveness.

D-3 COMMENTS TO MIL-STD-1547

The following comment is submitted on derating:

X.X.X Derating (Various Paragraphs)

Comment: The derating requirements in general are considered overly severe and inconsistent.

Excessive derating is counter-productive. Larger devices or higher power devices than necessary and then required to meet the arbitrary derating factor. These larger parts are most often inherently inferior. For example, when driven to high voltage capacitors a thicker dielectric is required. This necessitates a larger plate/dielectric area with higher defect probability, i.e., higher base failure rate, as the defects are proportional to the material area. The larger sizes are in less demand, built and used less often, and consequently have more variability and lower confidence, and poorer and fewer sources. The larger size may also be intolerable, forcing consideration of higher K dielectrics, even electrolytics, to maintain an acceptable size. The higher K dielectrics in general have inherently worst failure rates and may otherwise be poorer choices for the particular application. Multiple units or added stages with their attendant poorer reliability may also be required. Resistors, semiconductors and basically all parts suffer these same kinds of problems. To further illustrate, if driven from a carbon composition resistor to a wire wound power because of power derating coupled with size constraint, per MIL-HBK-217, the failure rate increases by 7.5 times (e.g., a 1/2 watt RCR compared to 3 watt RWR at .30 watt/60% stress for the RCR and 10% for the RWR results in a base failure rate of .0004 for the RCR and .003 for the

D-3 COMMENTS TO MIL-STD-1547 (Cont'd)

X.X.X Derating (Various Paragraphs) (Cont'd)

RWR at 25°C) The ratio of RCR failure rate at 60% to that at 50% is only 1.25 and the ratio for 70% to 50% is only 1.67 hence using the RCR at higher stress is preferable to using the RWR. If excessive power derating in semiconductors drives the designer to larger devices, e.g., to a TO-3 device from a TO-5 device we are subject to a wide range of new and increased problems. (Fewer sources, basically commercial product lines, poorer processes and controls, inferior technology, and infinitum).

Generalized derating factors geared to a particular failure rate value or constancy of value with temperature, as stated in MIL-STD-1547, is not productive. Derating to achieve a failure rate is an inseparable function of new application, i.e., the required system failure rate and the contribution of the subject part application to that requirement. Derating all resistors to the same percent of stress, for example, gives failure rates that vary among the resistor types by over an order of magnitude. One design may use ten times as many of the resistor type with the highest failure as the type with the lowest; in another design it may be the inverse; and in either case it may be adequate or not depending on the total contribution. Derating with temperature to maintain constant failure rate can also cause severe unwarranted penalties. Maximum temperatures are usually based on worst case conditions of design, tolerance, environment, etc. and worst deployment environment. These worst case factors usually have a very low probability of occurrance and the worst deployment environment may only be a small

D-3 COMMENTS TO MIL-STD-1547 (Cont'd)

X.X.X Derating (Various Paragraphs) (Cont'd)

percentage of the deployment lifetime. Hence, much higher failure rates are often acceptable at higher temperatures without affecting the mission reliability. General derating factors should not be linked to a particular failure rate value nor to a constant value with temperature or excessive derating, and its attendant woes will result; adequate failure rates likewise, will not be assured by such an approach.

Derating to provide a design or safety margin is desirable as a general policy (much as is employed in structural design). Derating should be relatively consistent. A 50% power stress for resistive devices ultimately implies a 70% voltage and current stress. Certain diodes and transistors are also derated at about 70% of voltage per MIL-STD-1547. The derating of capacitors per 1547, which have more attention in the design, construction and testing given to the insulation or dielectric material than many other parts, to 50% of voltage is unduly restrictive and inconsistent. Derating of fan out and similar characteristics is unwarranted. The output (fan out) of digital devices is based on the maximum input requirement of the respective loads. These are adequately guard banded by the maker and tested by the user (under 1546/1547 programs) to assure adequate margin i.e., derating. Frequency, gain and similar characteristics for semiconductors should not be "derated" as such as they are not a stress. They should rather be handled in the end of life design criteria in a similar manner to resistance and capacitance stability tolerances, etc. for resistors and capacitors application by application.

X.X.X. Derating (Various Paragraphs) (Cont'd)

Junction temperature of discrete semiconductors technically should not require greater derating than microcircuits or visa versa, i.e., 105°C for transistors and 125°C for monolithic microcircuits per MIL-STD-1547. Derating of 70% of maximum rated temperatures provides a guard band and allows variation in detail types absolute temperatures to correspond to their rating as established by design and materials considerations and supported by testing at that temperature. For example, a transistor with well matched die attach and all high temperature processes and materials, etc. with rated maximum temperature of 200°C and life tested at this temperature should not be penalized by a generalized derated temperature of 105°C as might be appropriate for a poorly designed transistor rated and tested only to 125°C or 150°C. Realizing also of course that properly designed semiconductors can survive temperatures much higher than the ratings.

Generalized derating factors are desirable but should allow as high a stress as prudent judgement allows. We believe these general factors should provide a reasonable guard band against absolute maximum stress limits for the devices to provide some protection in individual units against manufacturing flaws and variations, test tolerances and some material degradations. Additional specific derating determined by the application may then also be required in order to meet a failure rate requirement, or functional stability requirement. Derating to 50% of power (temperature rise), 70% of voltage and current, and 80% of maximum

D-3 COMMENTS TO MIL-STD-1547 (Cont'd)

X.X.X Derating (Various Paragraphs) (Cont'd)

temperature, as applicable to the part type, is recommended as a guide for generalized derating values that will not precipitate undue problems from over derating as described above.