VOL. I.

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UNCLASSIFIED

REPORT OF THE AIR-TO-AIR MISSILE SYSTEM CAPABILITY REVIEW (U)

JULY – NOVEMBER 1968

APPENDICES

1 JANUARY 1969

NAVAL AIR SYSTEMS COMMAND

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REPORT

OF THE

AIR-TO-AIR MISSILE SYSTEM

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PROPOSED ACTION MATRIX

This section contains a proposed action matrix wherein proposed action assignments for commands and activities concerned are keyed to each of the specific recommendations appearing in Appendices I through VI.

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APPENDIX	D. PROPOSED ACTION / RECOMMENDATION NUMBER	CNO	FLEET CDR's	TYCOM's	CVA's	CVW's	RCVW's	CNM	NAVAIR	NAVORD	BUPERS	CNA TECHTRA	OPTEVFOR	NWC CHINA LAKE	NAVMISCEN PT. MUGU	NADC	NATC	NATSF	NWEF	NARF's	NWS's	FMSAEG	SPCC	NAVMAG SUBIC	NAV AV SAF CEN	INDUSTRY
I	I								X																	
	II								X																	X
	III								X																	
	IV								X																	X
	V								X																	X
	VI								X					X	X											X
	VII								X					X	X											X
	VIII	X						X	X																	
	IX								X					X	X	X	X	X	X	X						X
II	II B.1.								X	X											X					
	II B.2.								X																	
	II B.3.								X																	
	II C.1.								X	X											X					
	II C.2.								X	X																
	II C.3.								X																	X
	II C.4.								X												X					
	II D.1.								X																	
	II D.2.								X														X			
	II D.3.								X	X																
	II D.4.								X												X		X			
	II D.5.								X												X					
	II D.6.				X				X													X			X	
	II D.7.								X																	
	II E.1.								X																	
	II E.2.								X	X																
	II E.3.								X	X												X				
	II E.4.								X																	
	II F.1.								X							X					X					
	II F.2.								X																	
	II F.3.			X	X	X	X		X	X											X	X				
	II F.4.								X																	
	II F.5.								X	X												X				
	II F.6.			X					X	X															X	
	II G.1.								X																	
	II G.2.			X					X																	
	II G.3.								X																	
	II G.4.								X																	
	II G.5.								X																	
	II G.6.								X																	
III	I A.	X	X	X	X						X															
	I B.	X	X	X	X	X					X															
	I C.1.	X							X			X														
	I C.2.								X			X														
	I C.3.								X			X														
	I D.1.	X							X																	X

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	D. PROPOSED ACTION	CNO	FLEET CDR's	TYCOM's	CVA's	CVW's	RCVW's	CNM	NAVAIR	NAVORD	BUPERS	CNA TECHTRA	OPTEVFOR	NWC CHINA LAKE	NMC PT. MUGU	NADC	NATC	NATSF	NWEF	NARF's	NWS's	FMSAEG	SPCC	NAVMAG SUBIC	NAV AV SAF CEN	INDUSTRY
III	I D.2.	X							X					X	X											X
	I E.	X											X													
	I F.	X							X																X	X
	I G.	X							X			X														X
	I H.			X								X														
	I I.1.			X	X	X	X																			
	I I.2.			X																						
	I I.3.						X						X		X											
	I I.4.			X			X																			
	I I.5.			X		X																				
	I J.1.			X								X			X											
	I J.2.			X																						
	I K.1.	X									X	X														
	I K.2.											X														
	I K.3.			X							X															
	I K.4.	X										X														
	I K.5.	X										X														
	I K.6.	X										X														
	I K.7.	X										X														
	I K.8.			X			X																			
	II A.1.			X		X			X																	X
	II A.2.								X									X								
	II A.3.								X																	
	II B.1.								X																	
	II B.2.						X		X				X													
	II B.3.								X									X								X
	II C.7.a.(a)								X						X		X		X							
	II C.7.a.(b)								X					X	X		X		X							X
	II C.7.a.(c)													X	X				X							X
	II C.7.b.(2)	X	X	X															X							
	II C.7.c.(2)							X																		
	II C.7.d.(2)								X																	
	II C.8.								X					X	X		X									
	II D.1.								X																	
	II D.2.								X						X							X				
	II D.3.							X	X	X				X	X										X	
	II E.1.								X									X								X
	II E.2.								X																	X
	II E.3.								X									X								X
	II E.4.								X									X								X
	III A.1.	X		X	X	X																				
	III A.2.			X	X	X																				
	III B.								X																	
	III C.1.	X		X					X						X											
	III C.2.	X	X	X				X	X	X																
	IV A.	X		X	X						X															
	IV B.								X																	
	IV C.								X																	
	IV D.1.			X					X																	
	IV D.2.			X	X				X	X											X					
	IV D.3.								X																	X
	IV D.4.								X																	X
	IV E.								X																	X
	V A.1.a.								X										X							
	V A.1.b.								X																	
	V A.1.c.								X																	

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	D. PROPOSED ACTION	CNO	FLEET CDR's	TYCOM's	CVA's	CVW's	RCVW's	CNM	NAVAIR	NAVORD	BUPERS	CNA TECHTRA	OPTEVFOR	NWC CHINA LAKE	NMC PT. MUGU	NADC	NATC	NATSF	NWEF	NARF's	NWS's	FMSAEG	SPCC	NAVMAG SUBIC	NAV AV SAF CEN	INDUSTRY
III	V A.1.d.	X																								
	V A.2.a.								X																	
	V A.2.b.								X																	
	V A.2.c.								X																	
	VI A.1.			X	X				X																	
	VI A.2.			X					X	X											X					
	VI A.3.								X	X											X					
	VI A.4.								X	X											X					
	VI B.1.	X							X																	
	VI B.2.	X		X			X		X		X	X														
	VII A.1.								X																	
	VII A.2.								X																	
	VII B.			X					X																	
	VII C.			X																X						
	VII D.1.								X											X						
	VII D.2.								X											X						
	VII D.3.								X																	
	VII D.4.								X																	X
	VII D.5.			X					X											X						
	VII E.1.								X																	
	VII E.2.								X																	
	VII E.3.								X																	
	VII E.4.								X																	X
	VII E.5.			X		X			X																	
	VII F.								X																	X
	VII G.1.a.			X																						
	VII G.1.b.														X											
	VII G.1.c.														X											
	VII G.1.d.								X																	
	VII G.2.a.								X																	
	VII G.2.b.								X						X											
	VII G.2.c.														X											
	VII G.2.d.														X											
	VII G.2.e.																						X			
	VII G.2.f.			X																						
	VII G.2.g.								X									X								
	VIII A.	X																								
	VIII B.1.								X																	
	VIII B.2.							X	X																	
	VIII B.3.							X	X																	
	VIII B.4.	X						X	X																	
	VIII C.	X	X	X																						
IV	I A.	X	X																							
	I B.1.	X	X	X																		X				
	I B.2.		X	X																						
	I B.3.		X	X																						
	I B.4.		X	X																						
	I B.5.		X	X																						
	I B.6.		X	X																						
	I B.7.																					X				
	I C.1.	X	X	X		X																				
	I C.2.	X	X	X		X																				
	I C.3.	X		X				X	X																	
	I D.	X		X				X	X																	
	I E.	X	X	X			X																			

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D. PROPOSED ACTION	CNO	FLEET CDR's	TYCOM's	CVA's	CVW's	RCVW's	CNM	NAVAIR	NAVORD	BUPERS	CNA TECHTRA	OPTEVFOR	NWC CHINA LAKE	NMC PT. MUGU	NADC	NATC	NATSF	NWEF	NARF's	NWS's	FMSAEG	SPCC	NAVMAG SUBIC	NAV AV SAF CEN	INDUSTRY
IV I F.	X	X	X				X	X																	
I G.			X																						
II A.								X																	X
II B.								X					X												
III A.								X																	
III B.	X						X	X																	
III C.	X						X	X																	
III D.	X							X																	X
III E.	X							X																	X
III F.								X						X	X										X
IV A.								X				X													X
IV B.								X				X													X
IV C.			X					X																	X
V A.	X							X													X				
VI A.1.a.(1)								X																	X
VI A.1.a.(2)								X																	X
VI A.1.b.								X																	X
VI A.2.a.(1)			X		X			X																	
VI A.2.a.(2)								X																	
VI A.2.a.(3)			X					X																	
VI A.2.a.(4)								X																	X
VI A.2.a.(5)								X																	X
VI A.2.a.(6)								X									X								X
VI A.2.b.								X																	
VI A.3.a.								X																	
VI A.3.b.								X																	X
VI A.3.c.(1)								X																	X
VI A.3.c.(2)																									X
VI A.3.d.(1)								X																	X
VI A.3.d.(2)								X																	X
VI A.3.d.(3)	X							X																	X
VI A.3.e.								X						X											
VI A.4.a.(1)								X																	
VI A.4.a.(2)	X						X	X																	
VI A.4.a.(3)	X						X	X																	
VI A.4.a.(4)								X																	
VI A.4.a.(5)								X											X						
VI A.4.b.(1)								X																	
VI A.4.b.(2)	X						X	X																	
VI A.4.b.(3)	X						X	X																	
VI A.5.	X							X				X													
VI B.1.a.(1)								X						X											X
VI B.1.a.(2)								X																	
VI B.1.a.(3)								X																	
VI B.1.b.								X																	X
VI B.1.c.(1)								X																	
VI B.1.c.(2)								X																	X
VI B.1.d.								X														X			
VI B.1.e.(1)								X																	
VI B.1.e.(2)								X																	X
VI B.1.f.								X																	
VI B.1.g.								X						X					X						X
VI B.1.h.							X	X						X											
VI B.1.i.(1)																									X
VI B.1.i.(2)								X																	X
VI B.1.i.(3)								X																	X

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	D. PROPOSED ACTION	CNO	FLEET CDR's	TYCOM's	CVA's	CVW's	RCVW's	CNM	NAVAIR	NAVORD	BUPERS	CNA TECHTRA	OPTEVFOR	NWC CHINA LAKE	NMC PT. MUGU	NADC	NATC	NATSF	NWEF	NARF's	NWS's	FMSAEG	SPCC	NAVMAG SUBIC	NAV AV SAF CEN	INDUSTRY
IV	VI B.1.j.(1)								X																	X
	VI B.1.j.(2)								X						X					X						
	VI B.1.j.(3)								X																	
	VI B.2.a.	X							X																	
	VI B.2.b.	X							X						X											
	VI B.2.c.	X							X																	
	VI B.3.a.			X					X					X												
	VI B.3.b.	X		X				X	X																	
	VI B.3.c.	X						X	X																	
	VI B.3.d.	X																								
	VI B.3.e.								X																	
	VI B.4.a.(1)								X																	
	VI B.4.a.(2)								X											X						
	VI B.4.a.(3)								X											X	X	X				
	VI B.4.b.(1)								X						X											
	VI B.4.b.(2)								X																	
	VI B.5.a.(1)								X																	
	VI B.5.a.(2)								X											X						
	VI B.5.a.(3)								X						X					X						X
	VI B.5.a.(4)	X																								
	VI B.5.a.(5)	X																								
	VI B.5.b.(1)								X																	
	VI B.5.b.(2)	X						X	X																	
	VI B.5.c.(1)								X																	
	VI B.5.c.(2)	X						X	X																	
	VI B.5.c.(3)	X						X	X																	
	VI C.1.a.								X																	
	VI C.1.b.								X																	
	VI C.1.c.								X																	
	VI C.2.								X																	
	VI C.3.								X					X												
	VI C.4.								X																	X
V	I A.								X																	
	I B.							X	X																	
	I C.								X																	
	I D.								X	X					X					X	X	X				X
	I E.																			X						
	I F.								X																	
	II A.								X											X						X
	II B.								X											X						X
	II C.	X						X	X											X						
	II D.								X																	X
	II E.(a)								X											X						
	II E.(b)								X																	
	II E.(c)								X											X			X			
	II E.(d)								X											X			X			
	II E.(e)			X																						
	II F.																			X						
	II G.								X											X						
	II H.								X											X						X
	II I.								X						X					X	X	X				
	II J.								X											X						X
	II K.								X											X						X
	II L.								X																	
	III A.								X											X		X				

	D. PROPOSED ACTION	CNO	FLEET CDR's	TYCOM's	CVA's	CVW's	RCVW's	CNM	NAVAIR	NAVORD	BUPERS	CNA TECHTRA	OPTEVFOR	NWC CHINA LAKE	NMC PT. MUGU	NADC	NATC	NATSF	NWEF	NARF's	NWS's	FMSAEG	SPCC	NAVMAG SUBIC	NAV AV SAF CEN	INDUSTRY
V	IV A.								X											X	X					
	V A.								X																	
	V B.								X																	
	VI A.								X									X								X
VI	3 A.								X					X	X						X	X				
	3 B.								X					X	X							X				
	3 C.	X						X	X																	
	3 D.	X	X	X				X	X													X				
	3 E.			X		X																				
	3 F.	X						X	X																	
	3 G.	X						X	X																	

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JULY—NOVEMBER 1968

APPENDIX 1

NAVAL AIR SYSTEMS COMMAND

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APPENDIX I

REPORT OF TASK TEAM ONE

Chairman: Mr. B. W. Hays, Naval Weapons Center, China Lake

"Is Industry delivering to the Navy a high quality product, designed and built to specifications?"

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INTRODUCTION

A. The mission of Task Team One was to determine, "Is industry delivering to the Navy a high quality product, designed and built to specifications?" and, if the answer to this question were negative, to ascertain the causes and determine possible corrective actions. In preparing to answer this question Task Team One, comprised of 30 representatives from the Navy and industry, met over a three-day period during the week of 19 August 1968 to discuss the problem. In addition, members of Team One visited Aerojet; Ling-Temco-Vought; McDonnell Douglas; Rocketdyne; Raytheon; Westinghouse; the Air Force Plant Representative at Aerojet; Defense Contracts Administration Service Office; Navy Plant Representative at Westinghouse; Chief of Naval Operations; Naval Air Systems Command, Naval Missile Center, Point Mugu and Naval Weapons Center, China Lake.

B. In the course of inquiry, it was pointed out repeatedly that the Navy does not actually define what is meant in air-to-air systems by a "high quality product" and relies on industry to determine how much quality is required in each part of the system. The individual contractor's integrity is jeopardized if he either underestimates the requirements or fails to meet his established criteria. Moreover, government contracts are written in a manner which discourages expenditures by industry on quality control beyond what industry feels are the bare minimum requirements. This results in pitting the contractors' profit incentives against maintaining a high integrity image.

C. Task Team One feels that industry has not been delivering an air-to-air system product of sufficiently high quality to satisfy the Navy requirements. It is felt, however, that industry can deliver as high a "high quality" product as is requested of them. It is incumbent upon the Navy to define more adequately its systems quality requirements, and to state in contracts its quality requirements instead of quality goals. Further, when quality becomes a stated requirement, it should be funded by the Navy in the same manner as any other contractual end item.

INDEX

I. NAVAIR AIR-TO-AIR SYSTEM PROGRAM MANAGEMENT

Conclusion

Questions concerning the effectiveness of the current NAVAIR Management of Air-to-Air Missile Systems were raised by several of the groups consulted in both industry and the Navy. There was general concurrence that better quality products could be procured if better program direction were accorded to all elements of the missile systems.

A detailed study of the NAVAIR Management System reveals it to be conceptually sound and functionally similar to management schemes successfully employed elsewhere in the military and in industry. NAVAIR Instructions 5400 series establish sufficient authority to make the program organization effective. However, the study revealed that both the SIDEWINDER and SPARROW III program management organizations are extremely understaffed. It is estimated that the SPARROW III Program Manager should have six to seven people (vice the current one) and the SIDEWINDER Project Coordinator should have five people (vice the current one). Discussions with both the Project Management Office, PMO, and the NAVAIR functional groups revealed that heavy workloads for understaffed functional groups are also prevalent. The PMO's devote the majority of their efforts to fulfilling their responsibilities to their immediate line supervisors, Air 01 and PMA, for program coordination, budgetary submissions, and program procurement actions. Since the PMO's do not have the staff to direct the functional groups in accordance with NAVAIRINST's 5400 series, they have delegated such authority to the functional groups. Unfortunately, since basic missile system sub-groups such as the rocket motor, warhead, guidance, launcher, etc., are handled by different functional divisions, delegation of program coordination functions, by exception or otherwise, results in coordination between Division level personnel rather than at the Branch level. Further with the functional tasks elevated to the Division level, it becomes difficult for the PMO, a Commander in each instance, to assert authority over a senior officer, even though his authority is provided by NAVAIRINST's. This results in uncoordinated efforts between the functional groups as well as ineffective utilization of the currently available personnel. Based on detailed study, it is concluded that while the basic management scheme is sound, it can definitely be improved to provide greater program direction and coordination of the functional personnel. This, in turn, will improve program direction of industry efforts and greatly assist in meeting the Government quality needs.

Recommendation

It is recommended that the NAVAIR Program Management and functional organizations be consolidated by realignment of personnel currently assigned so as to maximize their effectiveness without significantly increasing the number of personnel required. Realignment to provide better lines of authority and physical colocation of many of the functional personnel and PMO's would significantly improve communications and program coordination and direction. Detailed comments on the internal organizational actions recommended have been submitted directly to the Commander, Naval Air Systems Command, by the Review Director.

II. QUALITY CONTROL AT THE CONTRACTOR'S FACILITY

Conclusion

Team One's findings indicate that the Navy specifies quality goals to industry to a greater extent than it specifies specific quality requirements. The most explicit contractual coverage of Quality Control (QC) is the application of MIL-Q-9858A, Quality Program Requirements. However, this document states the QC requirements in broad and general terms so the document is applicable over wide spectrum of government representatives' interpretation and application of MIL-Q-9858A. The net result is a considerable variation in QC standards between contractors and even between contractors producing the identical product. Team One concludes that an interpretation of MIL-Q-9858A should be made by the Purchasing Activity in all SPARROW and SIDEWINDER system component contracts.

Recommendations

Tab A has been prepared to state the Navy's interpretation of many of the generalized requirements of MIL-Q-9858A without adding requirements to, or removing requirements from, this basic document. Tab A has been written so that it can be included directly in NAVAIR contracts as part of the supplies or services section.

It is strongly recommended that Tab A be included in all future SPARROW or SIDEWINDER System component contracts. This will greatly increase the standard of Quality Control in some contractor facilities and will bring a degree of standardization in QC between contractors.

III. LOCAL CONTRACTOR GOVERNMENT REPRESENTATIVE ACTIONS

Conclusion

From the contacts made by Team One, it is obvious that the amount of Government representation in the monitoring of the quality control exercised by the contractor is considerably different at various facilities. For instance, at one facility there was one government representative at an average GS-11/12 level for every 50 contractor employees on this contract while at another contractor's plant producing the same item there was one government representative at an average GS-7/9 level for every 160 contractor employees. This wide range of control not only allows uncoordinated quality control requirements, but places contractors in different competitive positions. It was apparent that the quality of the two products was directly proportional to the degree of government monitoring.

DCASO representatives stated during the Air-to-Air Symposium that if the monitoring requirements are completely and specifically stated, the DCAS organization can provide the personnel to do the monitoring. Based on the desirability of adequate and consistent government control it is concluded that the exact and specific Government inspection monitoring requirements should be defined and directed by NAVAIR to the local Government representatives.

Recommendations

Tab B is the specific inspection monitoring requirement for the SIDEWINDER AIM-9D missile. It is strongly recommended that these requirements be directed to the local Government representatives of SIDEWINDER contractors and that NAVAIR request increased DCAS personnel be provided to accomplish the required monitoring. It is estimated that three additional people at Raytheon, Lowell, Mass., on the guidance and control group contracts and one additional person at each of the other sub-groups contractors are required to meet the requirements of Tab B.

It is further recommended that NAVAIR task the Quality Assurance Office to provide the detailed inspection monitoring requirements on the SPARROW missile and that these be directed to the local Government representatives for the SPARROW contracts.

IV. QUALITY CONTROL SURVEY OF CONTRACTORS FACILITIES

Conclusion

Visits at the various contractors facilities for SPARROW III and SIDEWINDER AIM-9D production indicate that the Quality Control at Raytheon, Lowell, could be improved for the SPARROW III Guidance Control Group production. NAVAIR recently conducted a quality survey of this facility for the SIDEWINDER contracts which revealed several quality control concerns as reported in Naval Weapons Center letter Serial 3883 of 5 September 1968 to NAVAIR. During the recent Task Team One visit to Raytheon, Lowell, many of the same or similar quality discrepancies noted in the SIDEWINDER report were observed in the SPARROW III assembly areas.

Recommendations

It is recommended that a Quality Control Survey Team be established by NAVAIR. This Team should be directed to do a QC survey of Raytheon SPARROW III production facilities as was accomplished by the SIDEWINDER survey. This Team could be from Quality Assurance Office Washington, the Quality Assurance Office at Pomona, or one of the Navy field activities. The team would be directed to ascertain in detail the extent to which applicable documentation, the quality assurance plan, and quality control procedures are being followed. It would determine the acceptability and adequacy of the plant area, assembly and test equipment, inspection and acceptance equipment, personnel training, and general execution of the quality control plan. The recommendations of this Quality Control Survey Team should be carefully considered by the NAVAIR SPARROW III Program Manager and implemented as required.

V. RELIABILITY STUDIES

Conclusion

High failure rates of electronics equipments can be caused by one, or a combination of, many aspects, including marginal designs, use of unreliable components, quality control, and environment. Discussions with Raytheon and Westinghouse personnel indicate that the reliability and design margin studies which were originally planned for the SPARROW III and the AWG-10 were seriously curtailed by limited funding. The mean-time-between-failure (MTBF) of five to ten hours experienced by MACAIR for the AWG-10 is indicative of a design that requires additional attention on component selection, parts burn-in, and design margin studies.

The Hughes Surveyor Program has almost exactly the same complexity of design as the AWG-10, i.e., 29,000 active components and 110,000 total components and the Survey achieved an MTBF of 365 hours. This high MTBF was accomplished by a complete reliability program. Also, Hughes has proven that considerable dollar savings are realized when programs utilize effective component screening, parts burn-in, and design margin studies. These savings result from the greatly reduced time and expense wasted by equipment failures, down time, failure analysis, repair, rework, component replacement, spares inventory, retest time, and mission failures. Tab C is an Aerospace Technology Report which substantiates the above conclusions and provides dramatic proof of the increase in system MTBF and cost savings. Tab C shows how an expenditure of $305,000 for reliability on the Early Bird Program resulted in a savings of $1,016,000 in final systems tests costs. Similar improvements in reliability and costs will be achieved on the SPARROW III and AWG-10 if similar programs are initiated by NAVAIR.

Recommendations

It is strongly recommended that funding be provided for total reliability programs at both Raytheon and Westinghouse. These programs would select components, establish burn-in procedures, and recommend design changes based on design margin studies for the SPARROW and the AWG-10. Such a program should cost less than $3,000,000 for the AWG-10 and could result in a MTBF of approximately 100 hours. A detailed plan for such a program could be obtained from the Quality Assurance Office, one of several Naval activities, or contracted for from a reliability study corporation such as ARINC or Computer Applications. Raytheon and Westinghouse could respond also.

VI. PRODUCTION MONITORING TESTS, PMT

Conclusion

Many groups consulted expressed concern that Production Monitoring Tests (PMT) were not being applied to the entire missile system and that there were different requirements between programs. It was repeatedly suggested that considerable time, confusion, and costs could be saved if a standard PMT plan were authorized for all air launched guided weapons. This plan would include information, sample techniques, types of testing required, accept/reject criteria, system requirements, system reliability requirements, and government and contractor responsibilities. Further discussions indicate that NAVAIR should establish whether free flight test results are the basis for lot rejection.

Recommendation

Tab D is written as a standard PMT plan. In response to the concerns expressed by many parties, it is recommended that such a plan be incorporated in all air-launched guided missile contract procurements.

This plan advocates the use of free flight tests for lot acceptance/rejection criteria rather than utilizing the free flight tests for information purposes, only. The reason for advocating this procedure is based on a review of the current PMT results for SHRIKE, an information purpose only plan, and SIDEWINDER, an accept/reject plan. This review indicates the following:

1. Difference in cost between the two concepts.

(a) Accept/Reject Plan expends approximately three missiles per lot if the quality of the hardware is high - i.e., 90% or better. These quantities are computed based on the plan of Tab D.

3 missiles @ $10,000 - $30,000

(b) Three air-firings test, i.e., Range Cost, Airplanes, Telemetry, Data Reduction, Reports, etc.

3 missiles @ $30,000 - $90,000

(c) Contractor statistical risk is that less than three lots per 100 lots will be rejected based on sampling probability if his product is at 90% or better reliability. Contractor initial effort on these returned units will be to retest. Approximately 50 missiles are retested to prove lot acceptance before the lot would be resubmitted for rerum of P.M.T.

$$50 \text{ missiles retest @ } \$5,000 \times \frac{3 \text{ lots}}{100 \text{ lots}} = \$7,500$$

$$3 \text{ missiles expended at } \$10,000 \times \frac{3}{100} = 900$$

$$3 \text{ tests @ } \$30,000 \times \frac{3}{100} = \underline{2,700}$$

$$\$11,100$$

(d) The cost that cannot be quoted is the charge to avoid this type of lot acceptance. However, it is reasonable to assume a contractor assignment of three full-time people to the P.M.T. facility at $30,000/yr a piece. On a one lot per month basis:

$$3 \times \$30,000 \times \frac{1}{12} = \$\ 7,500$$

The Total cost per lot = $138,600

or an increase in RFI missile cost of

$$\frac{138,600}{200} \quad \$\ 693 \quad \text{or } 7\%$$

The cost of air-firing for information only and will be the same for (a) and (b) above and zero for (c) and (d) above. The difference in cost for firing for score and for information then is:

Total cost difference 138,600 - 120,000 = $18,600

plus the intangible of (d) above.

Cost increases in RFI missile cost is:

$$\frac{\$18,600}{200} = \$93 \quad \text{or} \quad 1\%$$

The cost for either concept is high but the difference between the two methods is not.

2. Advantages of firing for lot acceptance/rejection criteria.

(a) The contractor is aware that he has to produce a high quality product, 90% or better, or he may expend considerable amounts of company monies for failure analysis, repair rework, and retest. He will consider quality control as a requirement rather than a goal.

(b) The testing agency will have to be expert and responsible because of the contractual pressures. Currently, programs which fire for information have low priority at the test facility and as a result, the tests tend to lag the production by three or more months and the reports are even later. This leaves some doubt as to their informational value. Firing for score, although painful until the test agency gets up to speed, does provide meaningful information in a timely fashion.

(c) The test plan is a strong incentive for the contractor to produce a high quality product so as to remain in the Stage III test conditions, because fewer total missiles will be required since unexpended rounds can be used for lot formation. Reliability and confidence information is acquired from the accumulative lot sample plans that is not received by firing an uncontrolled low number of missiles per lot for information purposes.

(d) By bringing the test agency into the program more significantly it will be better prepared to accept the technical field activity cognizance of the program at an earlier date.

(e) NAVAIR is in a stronger managerial position over the program. Without this, the accept/reject authority has been totally redelegated to local government factory representatives and to limited ground tests at a test agency.

3. Disadvantages of firing for score would be:

(a) Possible delay of lot shipment because of statistical lot rejection, about 3 lots per 100, or because of problems at the test activity. Of course, the government can waive these tests on an individual basis as the conditions dictate. These concerns should be carefully weighed against the possible alternatives.

(b) Test pilots will do the majority of the firings, rather than squadron pilots. This means a loss in possible training experience by squadron pilots. It must be remembered that these tests are for missile quality control and not pilot training. However, if this aspect is important, squadron pilots can be used with an anticipated higher number of "no test" missile expenditures.

Since the cost difference is low (approximately 1% of missile costs) and the advantages are significant, it is recommended that NAVAIR utilize the PMT free flight test results for product acceptance criteria in addition to other requirements.

VII. MISSILE SYSTEMS ENVIRONMENTAL TEST PLAN

Conclusion

One significant reason that the Navy does not more adequately describe the total systems quality requirements and relies on operational specifications is the lack of information concerning systems environmental conditions.

This is particularly appropriate on the SIDEWINDER AIM-9D and to a lesser extent on SPARROW III. Environmental tests are required to determine that adequate procedures are used for evaluation of the quality of hardware produced at the contractor's facility and the quality of reworked hardware at the NARF's.

Recommendations

Tab E is an outline of a missile systems environmental test plan which would provide the data required on SIDEWINDER AIM-9D by stating requirements for evaluating the acceptability of missile systems components by non-destructive testing. Detailed environmental test plans are required for both the AIM-9D and the AIM-7, covering initial production at Raytheon as well as repair and rework at the NARF's.

VIII. SECOND SOURCE CONSIDERATIONS

Conclusion

Normally, the primary advantage of second source contracting is considered to be competitive pricing with a resultant lower product price. This consideration is valid and important as proven by the second source contracts on the AIM-9B with Philco and General Electric, MK-46 Torpedo with Aerojet and Honeywell, SHRIKE with Texas Instruments and Univac, and the WALLEYE with Hughes and Martin. However, a review of the above multiple source contracts indicates reduced price is not the only significant improvement second source contracts provide. This contracting method provides incentive for the contractors to be competitive in regard to quality control, reliability, maintainability, and in particular, in responsiveness to design changes required by the Navy. Historically, the second source concept encourages the contractor to be more aggressive in improving his performance since the Navy has a very powerful method of measuring his performance, i.e., the other contractor.

Second source contracts could overcome another present deficiency in that one or both of the contractors could provide a data package to be used by the NARF's for repair and rework efforts. Also, the Navy would be in a position of being able to determine the correctness and completeness of these documents through comparison. It should be observed that from the standpoint of national security considerations alone, the investment of the majority of the Navy's air-to-air missile capability in one prime contractor may well be sufficient justification for multiple sources.

All government contacts made by Team One were in favor of a second procurement source for SPARROW III as a means of increasing the quality of the product and obtaining a complete data package.

Recommendations

It is recommended that the AIM-7E and AIM-7F programs be multiple contractor programs. This recommendation is made not only because of improvement-of-the-product objectives, but to disperse the Navy's air-to-air missile production capability. SPARROW will be a major DOD procurement item for the next several years. Sufficient yearly quantities are planned so that the cost of initiating a second source can be amortized.

IX. CHANGE CONTROL ACTION, ECP

Conclusions

Several factions expressed concern over the time that it takes for the Navy to act on ECP's in the SPARROW and SIDEWINDER programs, and the failure to keep all interested parties informed with regard to pertinent changes for system interface control. In air-to-air missilery aircraft-fire control-missile interfaces are critical. Seldom can one be changed without affecting one or both of the others.

Recommendations

It is recommended that the NAVAIR Project Coordinator hold change control meetings at NAVAIR to discuss and take appropriate action prior to change action by the NAVAIR Change Control Board. This concept was previously established under the SIDEWINDER Guidance and Control Section Change Procedure, Bureau of Naval Weapons, FWAA-23:MJD; 2 June 1960, and was very successfully utilized for several years. The basic purpose of having all interested parties meet is to speed up the dissemination of information and to accommodate the vital interface considerations. The parties which should attend would be the PMO, AIR-05, AIR-04, AIR-02, all system contractors, local contractor Government Representatives, NARF's, and cognizant field activities. Meeting schedules would be dictated by the program needs.

TAB I-A

[redacted]

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Quality Program Provisions
for Inclusion in Supply Contracts
for Guided Missile Systems and Subsystems

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TAB I-A

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Quality Program Provisions
for Inclusion in Supply Contracts
for Guided Missile Systems and Subsystems

Section 1.0 Supplies or Services

1.x Quality Program

Section 2.0 Description and Specifications

2.x Quality Program. The contractor shall provide and maintain a quality program acceptable to the procuring activity for all supplies and services covered by this contract.

2.x.x The contractor shall require each of his subcontractors and suppliers to provide and maintain a quality program conforming to all of the requirements herein except as otherwise approved by the procuring activity. The contractor's quality program shall not be acceptable unless all suppliers of all products for eventual delivery under this contract have established a quality program acceptable to the procuring activity.

2.x.x The quality program shall be in accordance with MIL-Q-9858A and the provisions herein.

Section 4.0 Deliveries or Term of the Contract

4.x Item 1.x. Quality Program.

4.x.1 The contractor shall develop his quality program and procedures in sufficient time to permit evaluation and acceptance by the procuring activity within 90 days of award. The program shall not be acceptable until all requirements herein have been effectively implemented.

4.x.2 The contractor shall have developed and implemented his plan for the quality program requirements of suppliers and subcontractors, and shall have received approval of the procuring activity for the plan, prior to acceptance of any products from suppliers and subcontractors, or fabrication of any hardware intended for eventual delivery required by this contract.

4.x.3 The contractor shall have received approval of the procuring activity of his quality program before purchase of material and supplies or manufacture or assembly of any hardware for delivery under the terms of the contract. (If required, the contracting officer may direct here that pre-production or prototype hardware fabrication may commence upon award, when such hardware is required under the terms of the contract.)

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4.x.4 Failure of the contractor to gain approval of his quality program in sufficient time to permit hardware deliveries in accordance with the delivery schedule set forth herein shall not be considered cause for failure to meet such delivery schedules.

Section 7.0 Additional Provisions

The following interpretations of MIL-Q-9858A requirements shall apply:

7.x Quality Program Requirements

7.x.1 Section 1.2 of MIL-Q-9858A, Contractual Intent; Delete the last two sentences thereunder, and add:

"The quality program shall be judged acceptable by the procuring activity before fabrication or procurement of any product for eventual delivery to the procuring activity may begin. The quality program shall be subject to disapproval by the procuring activity whenever the contractor's procedures or processes do not accomplish their objectives. Approval of the contractor's quality program shall not in any way relieve the contractor of his responsibility for compliance with all contract requirements."

7.x.2 Section 1.3 of MIL-Q-9858A, Summary; add:

"The provisions of section 1.3 shall not be construed to alter or reduce the requirements set forth elsewhere in this specification, and are intended only to summarize those requirements."

7.x.4 Section 3.1 of MIL-Q-9858A, Organization; add:

"The authority and responsibility of personnel performing quality functions shall be stipulated in the company organization plan or other appropriate document duly approved by the head of the company. Personnel responsible for directing the quality program shall have direct unimpeded access to a management level above the production manager and shall report on the status and adequacy of the program at intervals of not more than 90 days. The report and the documented review thereof shall be made available to the procuring activity representative."

7.x.5 Section 3.2 of MIL-Q-9858A, Initial Quality Planning; add:

"3.2.1 Quality Program Plan. The contractor's quality program shall be documented in the form of a Quality Program Plan (QPP) which shall contain a description of the quality organization, including the responsibility and authority of each functional element, flow charts, work instructions, and other documentation prepared to implement the quality program. The plan shall identify all policies, existing instructions, and procedures which are necessary to comply with the provisions of this specification. The plan shall be made available for review by the procuring activity and must be judged acceptable before approval of the contractor's quality program.

"3.2.2 Flow Charts. Flow charts shall be prepared outlining each step in the fabrication, processing, inspection, and testing operations for each item of assembly. Flow charts shall include the identification number of all manufacturing or process sheets, process specifications, inspection and work instructions, and test procedures. Flow charts shall include a separate entry for each operation and include a unique symbol for each different type of operation."

"3.2.3 QPP Changes. Subsequent to approval of the QPP, the procuring activity shall be notified in writing within 24 hours of instituting any change to processes, assembly methods, inspection or test procedures, or to the quality organization together with justification for such changes. These changes shall be subject to disapproval by the procuring activity."

7.x.6 Section 3.3 of MIL-Q-9858A, Work Instructions, add:

"3.3.1 Documentation Control. All fabrication, assembly, inspection and test instructions shall be placed under the contractor's document control system."

"3.3.2 Instruction Content. Fabrication, assembly, inspection and test instructions shall define the work to be done, the step-by-step method for accomplishment, tooling and test or inspection equipment required, the criteria for acceptance, record keeping instructions, and disposition. Maximum use of multicolor or multishade graphics, diagrams, overlays and visual standards should be made."

"3.3.3 Instruction Format. All instructions shall be typewritten or printed, shall contain the date of issue, and revision level, and shall be authenticated by a member of the quality organization. No handwritten instructions or changes shall be permitted. The instructions shall be clearly legible, and shall be protected from damage by the use of clear plastic envelopes or other appropriate means. Faded, defaced, or otherwise damaged instructions shall be promptly replaced."

"3.3.4 Instruction Placement. All instructions shall be placed so as to permit unimpeded view by the operator at all times. Multi-sheet instructions shall be arranged in a manner to facilitate proceeding from sheet to sheet. No fabrication, assembly, inspection or test operation shall be performed without direct access to the appropriate instructions."

"3.3.5 Audit. The quality program shall contain, as a separate section of the QPP, provisions for auditing the preparation, maintenance, control, and use of the required instructions. The functions required by this specification shall be audited on a scheduled basis. The audit shall include evaluation of all quality operations and documentation, comparison with established requirements, notification of required corrective action, and follow-up to assess results of corrective action. The audit shall ascertain that the work is being performed as specified, and that compliance with the instructions does in fact produce the required quality output. Monthly audit reports shall be submitted to the head of the quality organization, and shall be made available to the procuring activity upon request."

7.x.7 Section 3.4 of MIL-Q-9858A, Records; add:

"The contractor shall maintain records of all inspections and tests performed throughout the entire procurement, fabrication and assembly cycle. The records shall provide evidence that required inspections and tests have been performed, and shall include part, component or system identification, inspection or test involved, number of conforming articles, number rejected, and causes for rejection. The records shall cover both conforming and nonconforming items. Where variables data are involved, the actual numerical results obtained shall be indicated, and where data or information are recorded, the film, tape, or other recording media shall be identified with the characteristic measured, the date and identification of the article under test. For nonconforming articles, the records shall include the results of analysis, cause and corrective action taken."

7.x.8 Section 5.1 of MIL-Q-9858A, Responsibility; add:

"The contractor's responsibility shall include technical assistance and training to suppliers as required to achieve required reliability and quality levels."

"5.1.1 Source Inspection. The contractor shall provide objective evidence that the subcontractor complies in detail with applicable requirements. Objective evidence does not include unverified tests performed by the subcontractor on his own products, or his own evaluation of his facilities or capabilities."

"5.1.2 Inspections and Tests. The contractor shall assure that all specified inspections and tests required for acceptance (including qualification, preproduction and quality conformance) have been performed. Tests and inspections performed at the supplier's facilities shall be verified by the contractor, and evidence of such inspections and tests shall be made available to the procuring activity upon request."

7.x.9 Section 5.2 of MIL-Q-9858A, Purchasing data; add:

"Each procurement document shall be reviewed by the contractor's quality organization prior to release, and shall be available for review by the procuring activity. This review shall encompass determination that the applicable provisions of this paragraph are included, that the supplier has been approved in accordance with the source selection requirements of 5.1, and that the articles have been qualified for their specific application in accordance with the requirements of the contract."

7.x.10 Section 6.1 of MIL-Q-9858A, Materials Control; add:

"6.1.1 Receiving Inspection. The contractor's receiving inspection shall provide that articles shall not be accepted unless they have been inspected by the supplier in accordance with the purchase orders and satisfactory evidence of such inspection is submitted. The quality program shall provide for planning and performance of inspections and tests on all procured articles to verify quality requirements of specifications and drawings and changes thereto, either at the source, or at the contractor's plant, or both. The quantity and degree of inspection performed shall be consistent with the critical nature of the article, the information available from previous inspections or tests, and the documentation requirements on the article.

"Procured articles which are subject to age deterioration shall include an indication of the date that the critical life of the article was initiated and the date at which the useful life will be expended. All such articles shall be adequately protected in subsequent stores and handling operations, and the expiration date shall be prominently marked on each of the smallest containers that may be issued for use."

"6.1.2 Identification. All receipts at the contractor's plant shall be clearly identified and this identity maintained in store rooms and during processing in order that items procured under this contract may be readily recognized. Raw materials shall be identified at receiving and this identification shall be maintained either on the fabricated article or on records traceable to the fabricated article. All purchased articles released from the contractor's receiving inspection shall be clearly identified to indicate conformance or rejection."

"6.1.3 Coordination of Contractor and Supplier Measuring and Test Equipment. The contractor shall coordinate his inspection, measuring, and test equipment and correlate his inspection and test procedures with the subcontractor."

7.x.11 Section 6.2 of MIL-Q-9858A, Production Processing; add:

"6.2.1 Special Working Environment. The contractor shall provide adequate facilities for the fabrication, assembly, and testing of supplies to be delivered in accordance with this contract. Unless otherwise specified in the detail specifications, the minimum standards for working environment of Table I shall apply."

"6.2.2 Inspection and Test Planning. The contractor's program shall provide the necessary planning function for tests and inspections conducted during the entire phase of fabrication, processing, and assembly. The planning shall be based on a comprehensive study of the articles, the fabrication and processing operations, the methods of material integration, assembly, and checkout, and the final test and inspection procedures. Inspections shall be established at points which will minimize delays resulting from deficiencies, and in all cases shall be at or before the last point at which the acceptability of the operation or quality of the characteristic may be verified."

"6.2.3 Process Control Procedures. Process control procedures shall be prepared when necessary to supplement applicable process specifications to provide detailed performance and control methods. These procedures shall document the preparation, fabrication details, conditions to be maintained during each phase of the process, the methods of verifying the adequacy of processing materials, solutions, equipment, their associated control parameters, including statistical quality control plans where applicable, and the required records to indicate the results of such inspection and process verification. The contractor's quality organization shall review the written procedures for those process controls and conduct audits to determine that the actual operations conform with approved methods and procedures."

"6.2.4 Material Control. Controls shall ensure that only conforming materials and articles are used. Materials and articles not conforming or not required for the operation involved shall be removed from work operations. Positive action shall be taken to protect controlled processes or operations from contamination by residue from nonconforming materials and from previous operations. The contractor shall ensure that each operation of inspection (and to the extent practicable, fabrication) is traceable to the individual responsible for its accomplishment."

7.x.11 Section 6.3 of MIL-Q-9858A, Completed Item Inspection; add:

"6.3 Completed Item Inspection and Testing. The system shall provide for the performance of all tests and inspections specified in the contract or item specification and for the recording of all data derived. In addition to determining contractual conformance, the contractor shall report immediately any unusual phenomenon, occurrence, difficulty or questionable condition, whose detection and correction is not specifically contained in the applicable requirements, to the procuring activity, in order that the necessary action and/or provision of contractual coverage may be initiated. After completion of final tests and inspection, any modifications, repairs or replacements, either authorized or unauthorized, shall necessitate a reinspection and retest to the extent determined necessary by the procuring activity to completely verify acceptability and compatibility with associated components, subassemblies, assemblies, and systems. The contractor shall employ detailed written procedures for acceptance inspection and testing of all parts and subassemblies, whether manufactured in house or purchased. All detailed final acceptance test procedures must be approved by the procuring activity."

Table I

MINIMUM STANDARDS FOR WORKING ENVIRONMENTS

Type of Work	Cleanliness Note 1	Lighting, Foot Candles Note 2	Air Temperature Note 3	Relative Humidity Note 4	Dust Control Note 5	Ventilation or Exhaust Note 6	Noise Note 7	Habitat Note 8
<u>Machine Shop</u>								
Tolerance to .01	Class D	70	60-100°F	U	Class D	Note 6	90db	
Tolerance to .001	Class C	100	65-95°F	U	Class C	Note 6	70db	A
Tolerance to .0001	Class C	200	65-85°F	30-70%	Class C	Note 6	60db	
Tolerances Finer than .0001	Class A	500	65-75°F	30-50%	Class A	Note 6	50db	
Propellant, Chemical and Potting Areas	Class B	100	65-95°F	30-50%	Class B	Note 6	70db	A
Plating and Heat Treating	Class C	70	55-105°F	U	Class C	Note 6	90db	A
Electronic Assembly	Class B	100	65-95°F	30-70%	Class B	Note 6	70db	A
Nonprecision Mechanical Assembly	Class B	100	65-95°F	U	Class B	Not Reqd	70db	A
Precision Mechanical Assembly								A
Tolerances to .0001	Class B	200	65-85°F	30-70%	Class B	Not Reqd	60db	
Tolerances Finer	Class A	500	65-75°F	30-50%	Class A	Not Reqd	50db	
Inspection Stations	Equal to Product Inspected					Not Reqd	70db	A

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Notes to Table I

1. Cleanliness Definitions

   a. Class D
   Daily Cleanup: Removal of scrap, clean up spilled oil, etc.

   b. Class C
   Prompt Cleanup: Scrap, oil, and residue shall not be allowed to accumulate. Food and beverages are not permitted.

   c. Class B
   Prompt Cleanup: Oil, residue, spilled chemicals removed immediately. Floor, walls and work area shall have hard, grease resistant, easily cleaned surfaces. Food and beverages are not permitted.

   d. Class A
   Cleanliness controlled in accordance with FED-STD 209. Class 100,000. Food and beverages are not permitted.

2. Lighting

   Indicated values are minimum light intensity values in the work area. Supplemental lighting shall be used when necessary to improve precision and minimize operator fatigue, but brightness ratios within the operators field of view shall not exceed 10 to 1.

3. Air Temperature

   Designated temperature limits are average temperature measurements taken in proximity of the work stations.

4. Relative Humidity

   Designated relative humidity shall be as measured at room ambient temperature. "U" indicated uncontrolled relative humidity.

5. Dust Control Definitions

   a. Class D - No dust control required
   b. Class C - Outside air shall be filtered to remove dust particles. Type of filter is unspecified.
   c. Class B - Outside and recirculated air shall be filtered to remove dust particles. Filter rating shall be 10 micron maximum.
   d. Class A - Dust control shall be in accordance with FED-STD-209, Class 100,000.

6. Ventilation or Exhaust

Forced ventilation or exhaust shall be provided whenever required to minimize operator fatigue.

7. Noise

Noise is defined as the average sound level existing at the work station when measured with a standard sound-level meter.

8. Habitat

a. No eating, drinking, or personal grooming is allowed in these work areas.

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Quality Assurance Representative
Product Verification Inspection Requirements
for the AIM 9D Sidewinder Missile

Note: Suggested levels of Government monitoring are considered as minimum requirements.

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TAB I-B

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INDEX

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A. Subject: Contractor inspection for the MK 18 Mod 1 Guidance Control Group is to be monitored by the local Quality Assurance Representative at the percentage level given. The monitoring requirements are broken into five groups.

I. General requirements.
II. Seeker requirements.
III. Miscellaneous requirements.
IV. Electronic requirements.
V. Servo requirements.

I. General Requirements.

From MIL-G-23986.

All tests of paragraph 4.7 monitor 100%
All tests of paragraph 4.8 monitor 100%

Insure interface compatibility by 100% monitoring of the use of the following gages.

2478335	Special Ring Gage-Concentricity Between Diameters and Location of Slot
2823993	Dial Fixture-Location of .2474 Datum
2409660	Fixture-Bracket Acceptance for Interchangeability

II. Seeker Requirements.

a. Refrigerated Detector Unit. It is recommended that the following requirements of WS-1592A, Purchase Description, Refrigerated Detector Unit, be monitored on a 5 percent basis.

(1) Failure Report and Analysis System as specified in paragraph 4.1.3.
(2) Certification of test equipment, ref. paragraph 4.5.1.
(3) Test Conditions, ref. paragraph 4.5.2.
(4) Acceptance Tests per section 4.6.
(5) Environmental Tests per section 4.7.

b. Magnet-Mirror BUWEPS drawing 2192519 & 2581052

(1) Specular Reflectance, Note 5 (B); Monitor 5%
(2) Sphericity, Note 5 (E); Monitor 5%
(3) Scratch & Digs. Note 5 (F); Monitor 5%

c. Mirror-Damper Assembly, BUWEPS drawing 1985163

(1) Mirror Surface flatness, Note 7, Monitor 5%
(2) Mirror Surface quality, Note 8, Monitor 5%
(3) Inspection, Note 10, Monitor 10%
(4) Visual Inspection, Note 12, Monitor 5%
(5) Specular Reflectance, Opacity & Pinholes, Monitor 5%
Ref: Drawing BUWEPS 2250957 (Coating Sheet Technical)

d. Insert, Coated, BUWEPS drawing 2166692

(1) Pinholes, Note 3, Monitor 5%
(2) Cleaning, adherence & Boiling Water, Notes 4, 5, 6, Monitor 5%
(3) Transmittance values, Note 2, ref: Drawing 223644 (S); Monitor 10%

e. Lens, Reticle Field BUORD drawing 2250928

(1) Surface Quality, Note 2, Monitor 5%
(2) Inclusions, Note 3, Monitor 5%
(3) Surface Flatness, Note 4, Monitor 5%

f. Reticle, Field Lens Assembly BUORD drawing 2103857

(1) Pattern centering, Note 3, Monitor 5%
(2) Foreign matter & Opaqueness, Note 5, Monitor 5%
(3) Scratch & Digs, Note 7, Monitor 5%
(4) Adherence, Note 9, Monitor 5%
(5) Edges sharp & clear, Note 10, Monitor 10%

g. Pattern, Reticle, BUWEPS drawing 15717548

(1) Inspect for pattern conformance with Notes 1, 2, and 3, Monitor 10%

h. Dome, Optical, BUWEPS drawing 2192624

(1) Surface Finish, Note 3, Monitor 5%
(2) Sphericity, Note 4, Monitor 5%
(3) Edge Chips, Note 5, Monitor 5%
(4) Concentricity, Note 7, Monitor 10%

i. Spin Bearing Pair, drawing 2192628, Monitor 10%

(1) Verify that the spin bearings are cleaned and lubricated in accordance with paragraph 3.9 of WS-1627A and paragraph 4.2.5 of OD-15371C and/or OD-130806.

(2) Verify that the preload of the Spin Bearing Pairs is in accordance with paragraph 3.7.2. of WS-1627A and paragraph 4.2.5.1 of OD-15371C and/or OD-30806.

j. Gimbal bearing, drawing 2103866; Monitor 10%

(1) Verify that cleaning, lubrication, and removal of excess oil is in accordance with paragraph 4.2.5 of OD-15371C and/or OD-30806.

(2) Verify that the Gimbal bearings meet the torque requirements of Note 5 of drawing 2103866.

k. Optical Gyro Assembly. It is recommended that the following in-process inspections be monitored on a 10% basis. All paragraphs refer to OD-15371C.

(1) Para 5.1.27 Gimbal axis intersection & preload.
(2) Para 5.1.3.25 40 degree Gimbal check.
(3) Para 5.2.1.15 Clamping Screw back-off torque.
(4) Para 5.2.2.7 Optical Barrel-Shielding Sleeve concentricity.
(5) Para 5.2.3.19 Optical Barrel-Stud concentricity
(6) Para 5.2.3.23 Optical Barrel-Support back-off torque
(7) Para 5.3.1.12 Reticle to Holder concentricity and perpendicularity.
(8) Para 5.3.1.11 Reticle push-off
(9) Para 5.4.1.5 Reticle runout
(10) Para 5.4.1.15 Gyro phasing and collimation
(11) Para 5.4.1.17 Mirror Magnet push-off
(12) Para 5.4.1.21 Mirror Magnet stabilization
(13) Para 5.4.1.22.1 Support Post to Lens measurements
(14) Para 5.4.1.22.3 Reticle Holder back-off torque
(15) Para 5.4.22.11 Baffle back-off torque
(16) Para 5.4.2.9 Focus
(17) Para 5.4.2.10.2 Secondary Mirror collimation
(18) Para 5.4.2.17 Dynamic Balance
(19) Para 5.2.21 Support Post, Sunshade Nut and Gravity balance
(20) Para 5.1.3.8.1 Spin Bearing outside diameter clearance
(21) Para 5.4.1.2 Spin Bearing inside diameter clearance
(22) Para 5.4.2.22 Paint Damage
(23) Para 5.1.1.6 and 5.1.2.2 Gimbal bearing fits (OD & ID Clearances)

l. Dome Housing Assembly: It is recommended that the following test be monitored on a 5 percent basis.

(1) Dome housing pressure and leak test. Ref: paragraphs 3.2.4.1 and 3.2.4.2 of OD 20573.

m. Clean Room. It is recommended that the following parameter of OD 20574, Clean Room conditions; be monitored on a weekly basis.

(1) Para 4.1. Temperature and Humidity limits
(2) Para 4.2 (B), Contamination Level

n. Head Coil. It is recommended that the following Head Coil parameters be monitored on a 10 percent basis.

(1) Head Coil Potted Assembly, ref: Drawing 1569869

(a) Sheet 1 Zone B 6, .580± .005 Dimension
(b) Sheet 1 Zone C 6, .1625 Diameter Basic dimension
(c) Sheet 1 Zone B 5, .906± .001 Dimension
(d) Sheet 2 Note 10 Painting
(e) Sheet 2 Note 11 Insulation resistance
(f) Sheet 2 Note 17 Electrical Requirements
(g) Sheet 2 Note 7 Boresight

(2) Head Coil Potted Assembly, Ref: Drawing 2319174

(a) Sheet 1, Zone U 12, .3395± .0005 Dimension
(b) Sheet 1, Zone R 9, .609R Min. Dimension
(c) Sheet 2, Zone U 13, .905-.907 Dimension-
(d) Sheet 2 Note 12 (c) Electrical requirements
(e) Sheet 2 Note 8 Boresight
(f) Sheet 2 Note 11, Painting
(g) Sheet 2 Note 12 (A & B) Insulation resistance

o. Seeker Section. It is recommended that the following requirements of drawing 2192523 be monitored on a 20 percent basis.

(1) Performance Specifications Number 1. and 4.
(2) Note 5, Cell clearance
(3) Note 3, Torque requirements

III. <u>Miscellaneous requirements.</u>

a. Cable Assembly-Umbilical
Dwg 1517791G

Note 3. Check to insure that three uniform twists are incorporated in the wire bundle. Monitor 25%

Note 10. Check to insure that the nitrogen line enters the housing on the hard potting at an angle greater than 80° (in respect to the axis of symmetry of the cable as shown on the drawing) Monitor 10%

Note 15. Insure that proper techniques are used in adhering the boot to the cable near the housing. Only the above area is of concern in the note. Monitor 25%

Note 18. Monitor 5%

Note 19. Monitor 5%

Note 22, Only the electrical and pneumatic examination of the sample cable after the 50,000 flexures. Monitor 100%

Sheet 1. The orientation of the cable referred to in section BB. Monitor 10%

The axial & position alignment of probe and contacts. Zone C3 Monitor 5%

b. Housing, Umbilical Release
Dwg. 1517793D

1.897± .002	Zone F4	Monitor 15%
1.820± .002	Zone F4	"
1.468± .005 / .000	Zone F4	"
.391± .002	Zone E5	"
.081± .001R	Zone B5	"
.111± .001R	Zone B5	"

c. Housing, G&C Unit
Dwg. 2192625U

Sheet 1

4.698/4.703	dimension	Zone FG-4	Monitor 15%
.126/.128	dimension	Zone DC-1	Monitor 10%

Detail U AB-11 thru 14

.058/.063	Zone B13	Monitor 5%
18°+0°, 20'-0°,0'	Zone B12	
.2475/.2473	Zone C12	

3.312/3.316	Zone F-16	Monitor 15%

TAB I-B

UNCLASSIFIED [redacted]

Check flags

Check	Zone	Monitor
◎ T .001 TIR	Zone A14	Monitor 5%
∥ V .002	Zone C15	
⊥ U .001	Zone C15	

or ECO equivalent
Note 3

Sheet 3

Detail M-check the following:

Dimension	Zone	Monitor
.296± .002	Zone J11	Monitor 5%
.130± .001	Zone J12	
.203± .002	Zone I11	
.036± .001	Zone I10	

d. Wiring Harness

Dwg 2439943K
Sheet 2

Cable orientation of connectors to base.
Zone B thru D, 4 thru 6. — Monitor 25%

e. Base, Umbilical

Dwg. 2439842E
Sheet 1

Dimensions:

Dimension	Zone	Monitor
.389/.393	Zone F-8	Monitor 15%
.029/.032		
.131/.127		
1.899/1.895		
1.822/1.818		
1.470/1.475		
1.440/1.445		

Sheet 2

Dimensions:

Dimension	Zone	Monitor
.188/.192	Zone C-15	Monitor 10%
.433/.438	Zone E-15 & 16	Monitor 10%
.390/.395		
.195/.197		
.216/.219		

UNCLASSIFIED [redacted]

IV. Electronic Requirements

1. Assemblies and modules deriving requirements from WS 1602 and OD20576C and drawing notes.

TITLE	DRAWING #	REQUIREMENT DRAWING NOTE NO	APPLICABLE REFERENCE	MONITOR %
Sync Filter Module	2412413	6,7,		
Driver Module	2412414	5,6,		
Resistor Module Assembly	2439994	3		
Pentode Module	2439926	3		
Preamp Module	2412385	10,11	WS 1602	5%
Self Destruct Module	2412492	1,2,3		
Detector & AGC Module	2412411	5,10		
Sync Filter Module	2412412	6, 7		

WS 1602 refers to OD 20576C, "Design and Fabrication of Resistance-Welded Electronic Circuit Modules and Assemblies". Materials to be used in the welded module and for encapsulating the modules should be monitored to assure compliance with paragraph 5.5 and 5.6.

Monitor 5%

Certification and Qualification of welding machines and operators shall be monitored to determine compliance with paragraph 4.2, 5.3.1 and 5.3.2 of OD20576C.

Monitor 100% on schedule basis

2. Assemblies deriving requirements from WS 1612 and MIL-T-27, and MIL-R-10509 and drawing notes.

TITLE	DRAWING #	REQUIREMENT DRAWING NOTE NO	APPLICABLE REFERENCE	MONITOR %
Saturable Reactor	2412388	1	WS 1612	10%
Filter Reactor	2412400	4.3.2	MIL-T-27	5%
Resistor-Low Noise	2439956	1,2B	MIL-R-10509	10%

3. Assemblies deriving requirements from WS 3820 and drawing notes.

TITLE	DRAWING #	REQUIREMENT DRAWING NOTE NO	APPLICABLE REFERENCE	MONITOR %
Transformer Assembly	2439830	1,2		
Q Multiplier	2439851	1,2		
Reactor, B+	2412391	1,3		
Reactor Regulator	2413392	1,2,4		
Reactor	2412394	1, 2,		
Transformer Detector	2412396	1,3		
Transformer Reference	2412397	1,3	WS 3820	5%
Transformer Driver	2412398	1.2,4		
Power Transformer	2412389	1,2,3		
Reactor	2412485	1,2,4		
Pulse Transformer	2412468	1,2,3		
Head Coil	2319174	16, 12		

4. Assemblies deriving requirements from WS 6536

TITLE	DRAWING #	REQUIREMENT DRAWING NOTE NO	APPLICABLE REFERENCE	MONITOR %
Gyro P.W.A.	2603356	1		
Carrier Amp P.W.A.	2603352	1	WS 6536 Wire termination, Hand solder, Machine solder	5%
Mag Amp & P.S.P.W.A.	2603348	1		
Gage Amp P.W.A.	2603344	1		
Electronics Section	2581347	1	WS 6536 Wire Termination, Hand solder, Machine solder	5%
Head Coil	2319174	2		

WS 6536, specifies that soldering materials, tools and equipment meet specific requirements.

Monitor 5%

Qualification and certification of soldering personnel shall be done per WS 6536.

Monitor 100% on a schedule basis

5. Assemblies for which all requirements are included on the drawing.

Electronics Section	2581347	3,5,6,7,8, 13,14,15, 17	NA	Monitor 5%
Preamp Assembly	2412479	1,5,6,8,9, 10	NA	Monitor 5%
Wiring Harness	2439943	2,6,7,10, 12,15	NA	Monitor 5%

V. Servo Requirements

a. Dwg. 2439855-3 - Notes of Servo Test Procedure — Monitor 100%

b. Dwg. 2319148-1 - Cylinder Block Assembly plus Alternator and Turbine Orifice

Note 1.	Install, leak test and calibrate orifices (4 cyl.)	Monitor 10%
Note 4.	Install blowout disc and plug assembly	Monitor 10%
Note 12.	Leak check around gas generator igniter seal; remove nozzle and blowout disc	Monitor 10%
Note 13.	Check overall impedance of five orifices	Monitor 10%
Notes 16 & 17	Matching & performance of alternator & orifice with magnetic amplifier	Monitor 10%

c. Dwg. 2319147 - Cylinder Block and Post Assembly

2319147-1	Note 2 - Quality of Brazing	Monitor 10%
	Note 3 - Magnaflux inspection	Monitor 10%
	Note 5 - Quality of electroless nickel plating	Monitor 10%
	Note 6 - Size, finish, location & alignment of .1718 + .0002 - .0000 holes	Monitor 10%
2319147-2	Inspect cylinder block & cylinder sleeve insert for:	
	1. Size, quality & alignment of 3.125 -20UNS -2B threads	Monitor 10%
	2. Flatness, squareness & finish on seating surfaces for O-ring	Monitor 10%
	3. Size, position, alignment & finish of cylinder bores	Monitor 10%
	4. Location of four 10-32NF-2Bx3/8 deep holes (Zone C-3)	Monitor 10%

2319147-3	Inspect cylinder block for size, alignment, location & surface finish of pressure passage Zone B-5	Monitor 10%

d. Dwg. 2439837, Forward Rocker Arm Potted Assembly - and Dwg. 2439838, Aft, Rocker Arm Potted Assembly

Note 2. Inspect preloading of fin fuze crystal — Monitor 5%

e. Dwg. 2439833, Forward Rocker Arm, Machined Dwg. 2439834, Aft Rocker Arm, Machined

On both drawings, inspect rocker arm machined, for:

1. Position, size, alignment and finish of .1715 + .0005 -.0000 holes "N" Zone E-3 & "R" Zone B-5 — Monitor 5%

2. Position, size, alignment & finish of .1715 + .0005 -.0000 holes in Zones F-2 and E-4 — Monitor 5%

3. Position, size, geometry & finish of crystal recess Zones D-2 & 3, View F Zone B-3 and B-4 & 5 — Monitor 5%

f. Dwg. 2439807-1

1. Inspect for application of enamel, electrical insulating, to screws item 8, note 5 — Monitor 20%

2. Also, to screws 1537445 as required by call out in Zone H-13 — Monitor 20%

g. Dwg. 2439806

1. Inspect for quality of potting Note 1-D — Monitor 10%

2. Inspect for resistance to ground Note 1-E — Monitor 10%

h. Dwg. 2166674, Rod Connecting Assembly

Zone E-9 Alignment of bushing hole to face of shoulder surface "A" — Monitor 10%

i. Dwg. 2439805, Case Piston

Zone F-7 - Squareness of top of case to I.D. — Monitor 10%

j. Dwg. 1985179, Relief Valve

Valve shall conform to requirements of WS-1582

Para. 3.5.1	- Operation pressure ambient	Monitor	10%
3.5.1.1	- Stability	Monitor	10%
3.5.2	- Leakage	Monitor	10%
3.5.3	- Flow rate	Monitor	10%
3.5.4	- High temperature air test	Monitor	100%
3.5.6	- High temperature gas operation	Monitor	100%
4.12	- Environmental tests following treatment	Monitor	100%

k. Dwg. 2166576, Pin, Solid Clevis and
Dwg. 2166577, Pin, Solid Rocker Arm

Inspect for conformance to drawings for physical dimensions and surface finish	Monitor	5%

l. Dwg. 1555449, Band, Heater Assembly

Notes 5 & 6 - Environmental tests of lot samples	Monitor	5%
Note 8 - Quality and Quantity of Encapsulation	Monitor	5%

m. Dwg. 1517782, Band, Heater

Note 2 - Heating element rating	Monitor	10%

n. Dwg. 1555450, Thermostat (Band, Heater)

Note 2-A(2) - Calibration	Monitor	25%
Note 2-C - Contact Resistance	Monitor	25%
Note 4 - Contact life test and environmental test of lot samples	Monitor	25%
Note 5 - Contact creepage	Monitor	25%

o. Dwg. 2580677, Generator, Power

Check the following requirements of WS 1624 (referred to in Note 1)

Para. 3.5.1	Starting torque	Monitor	5%
3.5.2	Output voltage	Monitor	5%
3.5.3	Acceleration	Monitor	5%
3.5.4	Internal inductance	Monitor	5%
3.5.5	Internal direct current resistance	Monitor	5%
3.5.6	Harmonic distortion	Monitor	5%

Para. 3.5.7	Insulation resistance	Monitor 5%
3.10	Workmanship	Monitor 5%
3.5.8	Hot gas operation	Monitor 100%
3.6	Tests following environmental procedure	Monitor 100%

B. Subject. Inspection for the MK 15 Mod 3 Target Detection Device is to be monitored by the local Quality Assurance Representative at the percentage level given.

From WS-1656A Amendment 2

Para.	Monitoring
3.2.2, 3.2.3, 3.2.4, 3.2.5.2, 3.2.5.3, 3.2.5.4, 3.2.5.5, 3.2.6.1, 3.2.6.4, 3.2.6.6, 3.2.6.7, 3.2.6.8, 3.2.7, 3.2.8	100% Monitoring

Dwg 1995254	All Requirements	100% Monitoring
Dwg 2049075	Requirements: Para 2.1, 2.2, 2.4, 2.5, 2.9, 2.14	100% Monitoring
Dwg 2186230 Dwg 2186232	Verify dimensional requirements of WS-1656A Amendment 2. Para 3.2.1 Item 130, 131, 132, 133, 134	100% Monitoring

From WS-1656A Amendment 2

Para 3.2.1
Item 1 thru 6
106 thru 110
112
113
119
122
123
137
138
139
144
145
154
155

— Monitor to the AQL specified in WS-1656A

C. SUBJECT: Inspection for the MK 13 Mod 0 Safety and Arming Device is to be monitored by the local Quality Assurance Representative at the percentage level given.

From OS 11257 (Latest edition)

Para 3.2.2.4	Laboratory Arming	
	Requirement 1 thru 6	Monitor 100%
Para 3.2.2.6	Safety Determination	
	Requirements 1, 2, and 3	Monitor 100%
Para 4.6.1	Verification of drawing requirements	
	Inspections 107, 109, 113, and 126	Monitor 100%
	Inspections 1 thru 10	Monitor 10%
Para 3.2.2.5.1	Safe Resistance	
	Requirements 1 thru 5	Monitor 10%
Para 3.2.2.5.2	Arm Resistance	
	Requirements 1 thru 4	Monitor 10%

D. SUBJECT: Inspection requirements of the Mk 48 Mod 2 Warhead shall be at least as tight as shown in Section 1-107b of DSAM 8260.1 based on its classification of characteristics. Contractor inspection is to be monitored by the local Quality Assurance Representative at a 10% level unless otherwise specified.

From WS-1656A Amendment 2

Para 3.2.1
Item 1 thru 6
106 thru 110
112
113
119
122
123
137
138
139
144
145
154
155

Monitor to the AQL specified in WS-1656A

C. SUBJECT: Inspection for the MK 13 Mod 0 Safety and Arming Device is to be monitored by the local Quality Assurance Representative at the percentage level given.

From OS 11257 (Latest edition)

Para 3.2.2.4	Laboratory Arming	
	Requirement 1 thru 6	Monitor 100%
Para 3.2.2.6	Safety Determination	
	Requirements 1, 2, and 3	Monitor 100%
Para 4.6.1	Verification of drawing requirements	
	Inspections 107, 109, 113, and 126	Monitor 100%
	Inspections 1 thru 10	Monitor 10%
Para 3.2.2.5.1	Safe Resistance	
	Requirements 1 thru 5	Monitor 10%
Para 3.2.2.5.2	Arm Resistance	
	Requirements 1 thru 4	Monitor 10%

D. SUBJECT: Inspection requirements of the Mk 48 Mod 2 Warhead shall be at least as tight as shown in Section 1-107b of DSAM 8260.1 based on its classification of characteristics. Contractor inspection is to be monitored by the local Quality Assurance Representative at a 10% level unless otherwise specified.

DL 2603878 Mk 48 Mod 2 LOADED ASSEMBLY
DWG 2603878 Mk 48 Mod 2 LOADED ASSEMBLY

SHEET 1

CRITICAL

C1:	Note 2	MONITOR 100%
C2:	Note 10	MONITOR 100%

MAJOR

M101: Note 3
M102: Note 4
M103: Note 5
M104: Note 6
M105: Note 9

SHEET 2

CRITICAL

C3:	$6.260 \pm {}^{.034}_{.000}$ (see Note 13)	ZONE D6 MONITOR 100%

MAJOR

M106:	.474 Max.	ZONE B8

DWG 2603791 CASE ASSEMBLY

SHEET 1

MAJOR

M101: Note 2A, Item 1
M102: Note 2B, Item 2(1) Material
M103: Note 2B, Item 2(4) Annealing
M104: Note 2C, Item 3

(CC not established): Note 3, Verify Encapsulation AQL 1.0

SHEET 2

CRITICAL

C6:	4.838 ± .003 Dia.	ZONE C8
C7:	4.838 ± .003 Dia.	ZONE C3

MAJOR

M105:	⊙ | A | .004	ZONE B8
M106:	⊙ | A | .005	ZONE B7
M107:	13.188 ± $^{.010}_{.000}$	ZONE D5
M108:	⊙ | B | .005	ZONE D3
M109:	4.380 ± .005 Dia.	ZONE C4
M110:	4.375 ± $^{.008}_{.000}$ Dia.	ZONE C8

SHEET 3

CRITICAL

C1:	.028 ± $^{.006}_{.002}$	ZONE C8
C2:	.028 ± $^{.006}_{.002}$	ZONE C4
C3:	72° 0' ± $^{0° 0'}_{0° 20'}$	ZONE D4
C4:	72° 0' ± $^{0° 0'}_{0° 20'}$	ZONE D7
C5:	4.636 ± $^{.000}_{.020}$	ZONE C5

MAJOR

M111:	-C- / ⊥ A .004	ZONE D7
M112:	∥ C .004 / ⊥ B .004	ZONE D4
M113:	.288 ± $^{.010}_{.000}$	ZONE C7
M114:	≋ 0.010	ZONE C1
M115:	.131 ± .001	ZONE C3

M116: $.131 \pm .001$ ZONE C1

M117: $.210 \pm ^{.010}_{.005}$ ZONE B3

M118: $.210 \pm ^{.010}_{.005}$ ZONE B1

(CC Not established:) .070 Min. Wall ZONE C6 AQL 1.0

SHEET 4

MAJOR

M119: $.187 \pm ^{.000}_{.003}$ ZONE D3

M120: $.187 \pm ^{.000}_{.003}$ ZONE C2

Insure interface compatibility by monitoring the use of the following gages 100%.

2117315	Fixture - Alignment of Slots
559426	Special Ring - Concentricity Between Diameters
559427	Special Ring - Concentricity Between Diameters
2117316	Special Plug - Mating Between Booster Enclosure and Mating Joint

E. Subject. Inspection requirements of the following Rocket Motor units shall be at least as tight as shown in Section 1-107b of DSAM 8260.1 for its classification of characteristics. Inspection is to be monitored by the local Quality Assurance Representative at a 10% level.

DL 2580617	5.0 Inch Rocket Motor
DL 2580618	5.0 Inch Rocket Motor, Mk 36 Mod 5 Load Assembly
DL-1517776	Filter, Radio Interference Assembly
DL 1568376	Igniter Rocket Motor Mk 264, Mod 1 Assembly
DL 269495	Squib Electric Mk 5 Mod 0

DL 2580617, 5.0 INCH ROCKET MOTOR, MARK 36 MOD 5 EMPTY ARRANGEMENT

DWG. 2580617, 5.0 INCH ROCKET MOTOR MARK 36 MOD 5 EMPTY ARRANGEMENT, ASSEMBLY DRAWING, NO CC NEEDED.

DWG. 1517206 HANGER, FORWARD

CRITICAL

C1:	Material: Steel, 150,000 psi minimum yield at 0.22% offset and 6% minimum elongation in 2 inches.	NOTE 1

MAJOR

M 101:	Surface D in the direction of the 1.750 dimension shall be parallel to surface C within 0.004.	NOTE 7
M 102:	$.200 \begin{smallmatrix}+.000 \\ -.005\end{smallmatrix}$ TPY	ZONE F-10
M 103:	[.002] [-C-]	ZONE F-9
M 104:	1.720 ± .010	ZONE H-12
M 105:	[-B-]	ZONE H-13
M 106:	.343 DIA through 100° CSK, .650 DIA 2 holes [⊕ .005 DIA]	ZONE D-9
M 107:	Heat treat in accordance with MIL-H-6785.	NOTE 2
M 108:	Finish: Cad plate type II .0003 thick OO-P-416 or ELEC. ZINC type II .0002 thick OO-Z-325.	NOTE 3

DWG. 1517393, RING, COUPLING MOTOR TUBE FWD

CRITICAL

C1:	.042 ± .002	ZONE I-13
C2:	.068 ± .002	ZONE I-15
C3:	.070 ± .005	ZONE I-12
C4:	$18^\circ \begin{smallmatrix}+0^\circ 0'' \\ -0^\circ 20''\end{smallmatrix}$	
C5:	Material: Steel, 150,000 psi minimum yield strength at 0.2% offset and 6% minimum elongation in 2 inches.	NOTE 1

C6: Inspection: Prior to plating and painting parts shall be 100% penetrant inspected in accordance with MIL-I-6866, Type I. Part shall be free of pits, cracks, scratches or other discontinuities. — NOTE 8

(NO CC) Surfaces shall be plated in accordance with MIL-STD-171, 1.1.2.3. — NOTE 3

(NO CC) Welding shall be in accordance with MIL-W-8611. — NOTE 4

MAJOR

M 101:	-A- 11°30" ± 30"	ZONE C-9
M 102:	5.171 DIA ± .005	ZONE E-9
M 103:	$.125^{+.003}_{-.002}$	ZONE H-12
M 104:	.129 ± .005	ZONE H-15
M 105:	$.140^{+.003}_{-.001}$ DIA	ZONE G-12
M 106:	.625 ± .005	ZONE J-14
M 107:	ALTERNATE: One piece construction optional.	NOTE 2
M 108:	.496 ± .001	ZONE G-11

DWG. 1569740, TUBE, MOTOR INTEGRAL RIB (REPLACES DWG. 1517392)
NO CC's ON PRINT

DWG. 1517404, CLOSURE, HEAD NON-PROPULSIVE

CRITICAL

C1:	$.005^{+.005}_{-.000}$ R	ZONE B-13
C2:	$.174^{+.000}_{-.006}$ DIA x .374 deep flat bottom CSK 100° x .197 DIA 6 holes equally spaced	ZONE A-10
C3:	.182 ± .005	ZONE C-13

C4:	$.664^{+.005}_{-.000}$	ZONE C-14
C5:	⊙ B .010 TIR	ZONE H-5
C6:	$3.653^{+.000}_{-.005}$	ZONE G-5
C7:	⊙ A .005 TIR	ZONE E-5
C8:	$\sqrt{32}$	ZONE B-13
C9:	$3.872^{+.000}_{-.003}$	ZONE H-4
C10:	$5^\circ\ {}^{+0^\circ}_{-5''}$	ZONE A-14
C11:	9/32 MAX	ZONE C-5

MAJOR

M 101:	.445 ± .005	ZONE I-7
M 102:	Finish in accordance with 00-P-416, type II, Class 2.	NOTE 2
M 103:	The entire head closure shall be magnetic particle inspected in accordance with MIL-I-6868. Part shall be free of cracks, laminations and inclusions.	NOTE 4

DWG 1517422, NOZZLE

CRITICAL

C1:	$.032^{+.015}_{-.000}$ R	SHEET 2 ZONE C-4
-C2:	$.190^{+.000}_{-.010}$	SHEET 2 ZONE D-4
+C3:	$.005^{+.005}_{-.000}$ R	SHEET 2 ZONE C-6
-C4:	$7^\circ\ {}^{+0^\circ}_{-7^\circ}$	SHEET 2 ZONE C-4

C5:	.975 ± .005	SHEET 1 ZONE D-11
C6:	1.032 ± .010	SHEET 1 ZONE E-9
C7:	17°20" ± 0°10"	SHEET 1 ZONE H-14
-C8:	$1.668^{+.004}_{-.000}$ DIA	SHEET 1 ZONE F-14
C9:	DELETED	
C10:	⊙ A .005 TIR	SHEET 1 ZONE H-16
C11:	.255 ± .005	SHEET 1 ZONE D-10
C12:	⊙ A .005 TIR	SHEET 1 ZONE J-9
C13:	11 B ,002	SHEET 1 ZONE J-9
C14:	$4.457^{+.000}_{-.005}$ DIA -1 (DIM BLOCK)	SHEET 1 ZONE F-7
C15:	$4.463^{+.008}_{-.000}$ DIA -1 (DIM BLOCK)	SHEET 1 ZONE F-5
C16:	2.230 ± .005	SHEET 1 ZONE C-12
C17:	$4.647^{+.000}_{-.005}$ DIA -2 (DIM BLOCK)	SHEET 1 ZONE F-6
C18:	$4.673^{+.007}_{-.000}$ DIA -2 (DIM BLOCK)	SHEET 1 ZONE F-6
C19:	⊙ A .005 TIR	SHEET 2 ZONE B-5
C20:	$4.695^{+.000}_{-.003}$ DIA -1 (DIM BLOCK)	SHEET 1 ZONE F-7

C21:	11 B .005	SHEET 1 ZONE J-12
C22:	$4.884^{+.000}_{-.003}$ DIA -2 (DIM BLOCK)	SHEET 1 ZONE F-7
C23:	_ B .002 -A-	SHEET 1 ZONE J-8
C24:	LEAK TEST Each assembly shall withstand 25 psig minimum pneumatic pressure applied to the seal in the direction of arrow G for a minimum of 30 seconds. The seal shall neither fracture, crack nor leak.	SHEET 1 NOTE 9
C25:	Material: piece 2, graphite molded (fine grain) type ATJ Material: pieces 3 and 4 asbestos-phenolic, molding RPD-150 or RPD-151.	SHEET 1 NOTE 1
C26:	The surfaces of piece -1 that will be in contact with piece -3 shall be sand blasted prior to molding.	SHEET 1 NOTE 4
C27:	Assembly of piece -2, piece -3 and piece -4: (A) Bond piece -4 to piece -3 using adhesive, MIL-A-8623, type III to form a solid joint. (B) Bond piece -2 to piece -4 and piece -3 with adhesive, MIL-A-8623 type III to form a solid joint.	SHEET 1 NOTE 6
C28:	If the molded surface of piece -3 is removed, a .0005-005 thick coat of sealer epoxy-polyamide in accordance with MIL-C-22750 shall be applied. Dimensions apply after coating.	SHEET 1 NOTE 7
C29:	The grain of the graphite insert, piece -2 shall be in a plane perpendicular to the axis of the nozzle.	SHEET 1 NOTE 8

C30:	Each assembly shall be radiographically inspected at three places 120° apart around the circumference in accordance with MIL-STD-453. Part shall have no single crack, delaminated area or void exceeding 0.13 inch in maximum dimension and the total cross-sectional area of such defects in any inch square shall not exceed 0.015 square inch.	SHEET 1 NOTE 13
(NO CC)	Surfaces bonded to piece -2 shall not be coated with sealer.	SHEET 1 NOTE 10
(NO CC)	Sealer coat shall overlap adjoining parts 1/8 ± 1/16 as indicated by ——— . . ——— (Dash Dot Dot Dash) lines.	SHEET 1 NOTE 11

MAJOR

M 101:	18° 0" ± 0° 10"	SHEET 1 ZONE E-9
M 102:	$2.222^{+.000}_{-.005}$	SHEET 1 ZONE C-11
+M 103:	$1.668^{+.004}_{-.000}$ DIA	SHEET 1 ZONE F-14
M 104:	⊙ A .005 TIR	SHEET 1 ZONE E-14
M 105:	The steel ring (piece 1) shall be finished in accordance with MIL-STD-171, finish no. 1.1.2.2 or 1.9.2.2.	SHEET 1 NOTE 2
M 106:	Projection of conical surfaces, mismatch not to exceed .005.	SHEET 1 ZONE I-14
M 107:	$4.884^{+.000}_{-.045}$ DIA (DIM BLOCK)	SHEET 1 ZONE F-7
M 108:	$4.695^{+.000}_{-.045}$ DIA (DIM BLOCK)	SHEET 1 ZONE F-7

DWG. 1517423, HANGER, FORWARD SUBASSEMBLY

MAJOR

M 101:	After potting, check continuity from item 2 to 6, and 1 to 5. Reading shall be 0.10 ohms maximum resistance. Check continuity from item 2, to item 1, reading shall be one megohm minimum resistance. Test probe should reach through hole in cap of item 2 and touch the contact button for a correct reading.	NOTE 1
M 102:	Self-locking nuts, item 8, shall be tightened to 7 ± 1 inch pounds torque prior to potting.	NOTE 5
M 103:	1/32 MAX (See Note 1)	ZONE D-3
M 104:	Check resistance from 1 to 3, reading shall be one megohm minimum resistance.	NOTE 3-A
M 105:	After assembly the cavity within item 1 shall be potted with item 10, and shall fill the cavity to the "limit of potting" surface, but shall not extend past surface X. Care shall be taken to minimize voids in the potting.	NOTE 1
M 106:	Self-locking screw, item 9 shall be tightened to 8 ± 1 inch pounds torque prior to potting.	NOTE 6

DWG 1555430, SHIELDING GASKET, ELECTRONIC
(Print has not been classified)

DWG 1555586
No comment (all minor characteristic)

DWG 1555594, RING, RETAINING

CRITICAL

C1:	.050 ± .005	ZONE D-12
C2:	4.660 ± .010 DIA	ZONE E-8

MAJOR

M 101: MATERIAL: Plastic material, laminated, thermosetting cotton fabric base, phenolic resin, mechanical grade. ALTERNATE: MIL-P-15035 Type FBM. — NOTE 1

M 102: After machining, the retaining ring shall be treated by a method that will render the resulting exposed surfaces fungus-resistant when testing in accordance with MIL-STD-810, Method 508.1, procedure 11. — NOTE 4

DWG. 1557440, SHIM, CENTER HANGER
ALL CHARACTERISTICS MINOR

DWG. 1557441, DECAL, SAFETY
ALL CHARACTERISTICS MINOR

DWG. 1557447, DECAL, IDENTIFICATION
ALL CHARACTERISTICS MINOR

DWG. 1557449, DECAL, WARNING
ALL CHARACTERISTICS MINOR

DWG. 1560588, INSULATOR
ALL CHARACTERISTICS MINOR

DWG. 1560589, BUTTON, ELECTRICAL CONTACT

MAJOR

M 101: Finish no. 1.1.2.2 or 1.9.2.2 per MIL-STD-171. — NOTE 2

DWG.1560592, LEAD IGNITER-GROUND

MAJOR

M 101: Terminal shall be crimped to the ends of the wire in accordance with MIL-T-7928, type I, using a positive action crimping tool. — NOTE 1

M 102: The maximum resistance from terminal to terminal shall be 0.1 ohm — NOTE 3

DWG. 1560600, INSULATOR, TERMINAL
ALL CHARACTERISTICS MINOR

DWG. 1560603, SPRING, NON-PROPULSIVE HEAD CLOSURE

CRITICAL

-C1:	.509 ± .020 Free length	ZONE C-8

MAJOR

M 101:	Solid length shall be .297 maximum	NOTE 2-D
+M 102:	.509 ± .020 Free length	ZONE C-8
M 103:	Load at compressed length of .445 shall be 8 ± 1 pounds.	NOTE 2-A
M 104:	Material: Steel, spring wire in accordance with QQ-W-470.	NOTE 1
M 105:	Finish 1.1.2.2 of MIL-STD-171.	NOTE 3

DWG. 1560604, "O" RING

CRITICAL

C1:	Material: Rubber, silicone, in accordance with AMS 3303.	NOTE 1
C2:	Surface of "O" ring, except for indicated flash, shall be smooth and free from nicks, cuts or any other visual surface defects or irregularities.	NOTE 3
C3:	"W" DIA .139 ± .004	ZONE D-5
C4:	Inside diameter (3 Dash #5)	ZONE E-5

DWG. 1560855, COVER, DUST MOTOR TUBE
ALL CHARACTERISTICS MINOR

DWG. 1560838, PIN, RING RETAINING

MAJOR

M 101:	$.1250 {}^{+.0003}_{-.0000}$ DIA	ZONE F-8

DWG. 1560839, SCREW

CRITICAL

C1: Inspection: Before plating, parts shall be 100% magnetic particle inspected in accordance with MIL-I-6868. Parts shall be free of pits, cracks, scratches or other discontinuities. NOTE 2

C2: Inspect in accordance with MIL-STD-414 NOTE 3

- A. Ultimate tensile strength: Inspect Level II, AQL .10, single specification limit.
- B. Hardness: Inspection Level II, AQL .10 total percent defective double specification limit.

MAJOR

M 101: Part shall be in accordance with MIL-B-7838, except as shown. NOTE 1

M 102: Cadmium plate in accordance with QQ-P-416, type II, Class 2. Embrittlement relief treatment must be performed. NOTE 4

DWG. 1560844, COLLAR, PINNED
ALL CHARACTERISTICS MINOR

DWG. 1560854, PIN, GUIDE

MAJOR

M 101: $.1240^{+.0005}_{-.0000}$ DIA ZONE D-8

DWG. 1560860, TERMINAL, WIRE
ALL CHARACTERISTICS MINOR

DWG. 1560866, TAPE
ALL CHARACTERISTICS MINOR

DWG. 1560872, COVER, PROTECTOR

MAJOR

M 101: Material: Rubber, silicone, high-temperature resistant, durometer shore hardness 70, color red. Alternate: ZZ-R-765, Class II, grade 70, color red. — NOTE 1

DWG. 1561127, BUTTON ASSEMBLY CONTACT

MAJOR

M 101: Adhesive not permitted inside of 0.170 DIA hole on exposed face of contact button, DWG. 1560589-1. — NOTE 2

DWG. 1561128, SLEEVE
ALL CHARACTERISTICS MINOR

DWG. 1561129, CAP
ALL CHARACTERISTICS MINOR

DWG. 1569517, SKID, HANGAR, CENTER

MAJOR

M 101:	$.200 \begin{smallmatrix}+.000\\-.005\end{smallmatrix}$ 2 places	ZONE E-4 1/2
M 102:	[— | .003] / [11 A .002]	ZONE E-5
M 103:	63/ 3 places	ZONE E-5
M 104:	$1.745 \begin{smallmatrix}+.000\\-.003\end{smallmatrix}$	ZONE D-5
M 105:	1/4-28UNF-3B 90° CSK .260 DIA 6 holes [⊕ .002 DIA]	ZONE A-4
M 106:	Heat treat to 180,000 to 200,000 psi ultimate tensile strength in accordance with MIL-H-6875.	NOTE 1
M 107:	Passivate in accordance with finish 5.4.1 of MIL-STD-171.	NOTE 3

M 108: .370 minimum full threads 6 places ZONE B-3

DWG. 1569518, BAND, HANGER, CENTER

CRITICAL

Note: Parallel callout of [-A-] on DIA is wrong ZONE C-6

[-A-]

C1:	5.030 $^{+.005}_{-.000}$ DIA	ZONE C-6
C2:	.060 - .010 I.D.	ZONE B-6
C3:	[11 | A | .002]	ZONE D-4
C4:	.260 $^{+.001}_{-.000}$ DIA through .437C Bore far side to depth shown 6 holes [⊕ .002 DIA]	ZONE E-6

MAJOR

M 101:	.060 + .010 O.D.	ZONE B-6
M 102:	.080 $^{+.010}_{-.000}$	ZONE B-5
M 103:	- .003	ZONE D-4
M 104:	1/4-28UNF-3B 90° CSK x .250 DIA. Both sides 4 holes equally spaced [⊕ .005 DIA]	ZONE E-3
M 105:	.272 $^{+.003}_{-.001}$ DIA .406 DIA C Bore to .063 deep 4 holes equally spaced [⊕ .005 DIA]	ZONE F-3
M 106:	Heat treat to 180,000 to 200,000 psi ultimate tensile strength in accordance with MIL-H-6875.	NOTE 1
M 107:	Passivate in accordance with number 5.4.1 of MIL-STD-171.	NOTE 3

M 108: Part shall meet the requirements of MIL-C-6021, Class 1A, grade B, except the areas indicated by DOT DOT DASH (..——) lines which shall have no defects. Impression stamp serial number with 1/16 inch high numerals in location shown. — NOTE 2

DWG. 1569519, HANGER, CENTER, ASSEMBLY
Assembly print. No CC necessary.

DWG. 1569520

MAJOR

M 101:	$.1875^{+.0005}_{-.0000}$ DIA	ZONE B-5
M 102:	⊕ .005 DIA	ZONE B-5
M 103:	$.200^{+.000}_{-.005}$ 2 places	ZONE C-5
M 104:	$.490^{+.005}_{-.000}$ 2 places	ZONE D-5
M 105:	$.505^{+.000}_{-.005}$ 2 places	ZONE F-5
M 106:	$.995^{+.005}_{-.000}$ 2 places	ZONE E-5
M 107:	$1.010^{+.000}_{-.005}$ 2 places	ZONE E-5
M 108:	$1.515^{+.000}_{-.005}$ 2 places	ZONE E-6

M 109: Material: Steel, corrosion resistant 17-4 PH, investment casting in accordance with AMS 5355. Heat treat to 180,000 to 200,000 psi ultimate tensile strength in accordance with MIL-H-6875. — NOTE 1

M 110: Part shall meet the requirements of MIL-C-6021, Class 1A, grade B, except the areas indicated by DOT DOT DASH (..——) lines which shall have no defects. Impression stamp serial number with 1/16 inch high numerals in location shown. — NOTE 2

M 111: $1.745^{+.000}_{-.003}$ ZONE D-4

M 112: [⊥ | B | .002] ZONE D-4

DWG. 1569521, BAND, HANGER, AFT

MAJOR

M 101: 1/4-28UNF-3B 90° CSK .250 DIA. Both sides ZONE B-3
4 holes equally spaced [⊕ .005 DIA.] See Note 4.

M 102: $.1875^{+.0005}_{-.0000}$ DIA 3 holes in line .005 DIA ZONE F-3

M 103: $.490^{+.005}_{-.000}$ ZONE E-4

M 104: $.505^{+.000}_{-.005}$ ZONE E-4

M 105: $.995^{+.005}_{-.000}$ ZONE E-4

M 106: $1.010^{+.000}_{-.005}$ ZONE E-4

M 107: $1.500^{+.005}_{-.000}$ ZONE E-4

M 108: 2.585 ± .005 R ZONE C-5

M 109: $.272^{+.004}_{-.001}$ DIA. See Note 4 holes equally ZONE C-3
spaced .406 DIA C Bore .063 deep [⊕ .005 DIA]

M 110: Material: Steel, corrosion resistant, 17-4 PH, investment casting in accordance with AMS 5355. Heat treat to 180,000 to 200,000 psi ultimate tensile strength in accordance with MIL-H-6875. NOTE 1

M 111: Part shall meet the requirements of MIL-C-6021, Class 1A, grade B, except the areas indicated by DOT DOT DASH (..——) lines which shall have no defects. Impression stamp serial number with 1/16 inch high numerals in location shown. NOTE 2

TAB I-B

UNCLASSIFIED [redacted]

DWG. 1569522, HANGER, AFT, ASSEMBLY

<u>CRITICAL</u>

-C1:	.065 - .010	ZONE C-6

<u>MAJOR</u>

+M 101:	.065 + .010	ZONE C-6
M 102:	.875 ± .010	ZONE E-4
M 103:	The 5.040 DIA shall average within the specified tolerance when in a free state.	NOTE 1
M 104:	[11 A B .002]	ZONE D-4
M 105:	[⊥ A .002] [-B-]	ZONE F-4

DWG. 1569740, TUBE, MOTOR INTEGRAL RIB

<u>CRITICAL</u>

C1:	[⊙ A .005 TIR]	SHEET 1 ZONE I,J-12,13
+C2:	3.880 ± .005 DIA	SHEET 1 ZONE H-12
+C3:	4.400 ± .005 DIA	SHEET 1 ZONE G,H-12
C4:	4.838 $^{+.003}_{-.002}$ DIA	SHEET 1 ZONE G-12
C5:	[⊙ D .005 TIR]	SHEET 1 ZONE F-12,13
C6:	5/16 - 24 UNF -2B (.343 MIN FULL FORM THD 2 PLACES) [⊙ .005 DIA] See Note 13	SHEET 1 ZONE D-12,13
-C7:	.060 $^{+.004}_{-.003}$ See Note 4	SHEET 1 ZONE I-9

UNCLASSIFIED

[redacted]

+C8:	1.400 ± .005	SHEET 1 ZONE D,E-10
-C9:	.460 ± .020	SHEET 1 ZONE D-9
C10:	.050 ± .015	SHEET 1 ZONE D-9
C11:	63	SHEET 1 ZONE C,D-8
C12:	See note 16 (CAD PLATE ON .460 SURFACE)	SHEET 1 ZONE B,C-8,9
+C13:	4.894 ± .005 DIA SEE NOTES 2, 19 and 26	SHEET 1 ZONE H-5,6
C14:	5.049 ± .006 DIA SEE NOTES 3 and 19	SHEET 1 ZONE H,I-5
-C15:	5.168 ± .010 DIA STA 70.905	SHEET 1 ZONE G,H-4,5
C16:	⊙ B .010 TIR	SHEET 1 ZONE F-5
-C17:	$.060^{+.010}_{-.003}$	SHEET 2 ZONE I,J-6
C18:	$.140^{+.003}_{-.002}$ SEE NOTE 19	SHEET 2 ZONE C-7
C19:	$.028^{+.006}_{-.002}$	SHEET 2 ZONE C-4,5
C20:	.269 ± .005	SHEET 2 ZONE B-4,5
C21:	$.020^{+.010}_{-.000}$ R	SHEET 2 ZONE C-2
C22:	Material: (Steel, 160,000 psi minimum yield strength at 0.2% offset and 6% minimum elongation in 2 inches.) (120,000 psi minimum yield strength is permissible within the first 2 1/4 inches from the forward end of the motor tube.)	SHEET 3 NOTE 1

C23:	(Removal of wing rib sections in the hanger cutout area, sta 54.327 to sta 57.824 shall produce a step of $.010^{+.015}_{-.000}$ above the tube OD.)	SHEET 3 NOTE 1 B-5
C24:	The surface generated by the 3.880 diameter shall not be deformed after the drilling and topping operation.	SHEET 3 NOTE 13
C25:	Within one hour max, after application of plating NOTE 16, but prior to Conversion Coating the part shall be baked at 375°F $\pm 25^\circ$ for a period of three hours.	SHEET 3 NOTE 17
C26:	Each completed motor tube shall be tested and shall withstand without deformation an internal hydrostatic pressure of 3300 psi.	SHEET 3 NOTE 19
C27:	The entire OD of the motor tube, the ID 1.400 aft of the forward end shall be magnetic partial inspected in accordance with MIL-I-6868, crack or indications related to the original mill rolled surface such as laps, seams, sheets or folds shall be cause for rejection.	SHEET 3 NOTE *18 (A)
C28:	$18^\circ\ 0'\ {}^{+1^\circ\ 0'}_{-0^\circ\ 0'}$	SHEET 2 ZONE B,C-4,5

MAJOR

M 101:	⊥ B .004	SHEET 1 ZONE J-11,12
-M 102:	4.400 ± .005 DIA	SHEET 1 ZONE G,H-12
M 103:	$30^\circ \pm 3^\circ$	SHEET 1 ZONE C-8,9
-M 104:	1.400 ± .005	SHEET 1 ZONE D,E-10
M 105:	4.894 ± .005 DIA SEE NOTES 2, 19 and 26	SHEET 1 ZONE H-5,6
M 106:	$.1245^{+.0005}_{-.0000}$ DIA ⊕ .005 DIA SEE NOTE 22	ZONE H,I-4

M 107:	$30^\circ \pm 3^\circ$	SHEET 1 ZONE D-3,4
M 108:	$1/16\ ^{+5/64}_{-1/64}$	SHEET 1 ZONE E-2
M 109:	$30^\circ \pm 3^\circ$	SHEET 1 ZONE C,D-1,2
M 110:	.033 TIR MAX	SHEET 2 ZONE H-16
M 111:	.049 TIR MAX	SHEET 2 ZONE H,I-15
M 112:	.055 TIR MAX	ZONE I-14,15
M 113:	.053 TIR MAX	SHEET 2 ZONE I-13,14
M 114:	.200 ± .020	SHEET 2 ZONE C-15
M 115:	$.147\ ^{+.006}_{-.009}$ SEE NOTE 20	SHEET 2 ZONE C,D-13
M 116:	$.175\ ^{+.000}_{-.015}$ R TYP	SHEET 2 ZONE B,C-12,13
M 117:	.188 TYP	SHEET 2 ZONE J-8
M 118:	5.970	SHEET 2 ZONE J-4
M 119:	$45^\circ \pm 2^\circ$ TYP SEE NOTE 11	SHEET 2 ZONE J-4
-M 120:	.455 ± .015 TYP	SHEET 2 ZONE I,J-4
M 121:	20.00 ± .005	SHEET 2 ZONE E-6
M 122:	16.000 ± .005	SHEET 2 ZONE E-5

M 123: 8.000 ± .005 — SHEET 2, ZONE F-4,5

M 124: 4.000 ± .005 — SHEET 2, ZONE F-4

M 125: Material: (Steel, 160,000 PSI minimum yield strength at 0.2% offset and 6% minimum elongation in 2 inches.) 120,000 PSI minimum yield strength is permissible within the first 2 1/4 inches from the forward end of the motor tube.) — SHEET 3, NOTE 1

M 126: The 5.014 ± .011 diameter at the forward end of the motor shall blend smoothly with the OD of the .060 wall thickness area, so that when a functional test fixture is attached to the motor tube, plane "Y" of the test fixture shall be 11 B .003. — SHEET 3, NOTE 9

M 127: Datum [-B-], for purposes of inspection, shall be those outside surface contacting inspection rollers "M" and "O" at the positions indicated in the "indicator and roller locations" detail. Concentricity and perpendicularity of features shall be inspected by rotating the tube on rollers "M" and "O." The total indicator valves apply at locations shown. (After meeting the above conditions, the motor tube shall meet the 0.980 minimum condition described in the hanger location checkout.) — SHEET 3, NOTE 10

M 128: The tolerance of the 45° angle may be ± 2°; however, the maximum variation between the angles of the slots on any one rib shall not exceed 0° 30' non-cumulative relative to each other. — SHEET 3, NOTE 11

M 129: After testing, each 21 1/32 length of wing rib as described in "rib layout" sheet 2 shall accept a test fixture 22 inches long, having a cross section configuration as defined in "functional fixture" sheet 2. The 22-inch length of the 0.154 groove may have a maximum bow of 0.001. The base of the fixture shall bottom on each surface of the rib described by the 0.175 radius in section G-G.

DWG. 1571828, PIN, HANGER, AFT

MAJOR

M 101:	— .003 M	ZONE C-3
M 102:	Material: Steel wires, AMS 5673. Heat treat to 250,000 to 280,000 psi tensile strength in accordance with MIL-H-8675.	NOTE 1

DWG. 1571861, DECAL, CLAMP RING SCREW
ALL CHARACTERISTICS MINOR

DWG. 1571862, DECAL WING SCREWS
ALL CHARACTERISTICS MINOR

DWG. 458498, LOCKWIRE, BOOSTER NOZZLE

CRITICAL

C1:	.187 ± .003	ZONE E-8
C2:	Material: Steel, cold drawn 70,000 psi minimum yield strength at 0.2% offset, 10% minimum elongation in 2 inches.	NOTE 1
C3:	Finish 1.1.2.2 or 1.9.2.2 of MIL-STD-171.	NOTE 3
C4:	.187 ± .003	ZONE E-8

DL 2580618, 5.0 INCH ROCKET MOTOR, MARK 36 MOD 5 LOADED ASSEMBLY

DWG. 2580618, 5.0 INCH ROCKET MOTOR, MARK 36 MOD 5 LOADED ASSEMBLY

CRITICAL

C1:	.308 MAX	SHEET 2 ZONE B-6
C2:	.020 MAX	SHEET 2 ZONE F-3
C3:	.015 ± .015 (See note 11)	SHEET 2 ZONE E-2
C4:	The motor shall conform to the requirements of WS 4225.	SHEET 3 NOTE 1

UNCLASSIFIED [redacted]

C5:	Items 4 and 22 shall be coated with item 5 prior to assembly.	SHEET 3 NOTE 3
C6:	Check the continuity of the Rocket Motor ignition circuit using an approved tester (or test set).	SHEET 3 NOTE 5
C7:	Items 21 shall be bonded to the grain, tube and tube liner with item 20. In Zone G there shall be no unbonded areas or voids larger than 1/4 inch in a radial direction within .100 inch of the propellant. No voids or unbonded areas are permitted between item 21, the tube, and the tube liner. In Zone F, a total of 1/2 square inch of unbonded area or voids is permitted. In Zone H, no voids or unbonded areas are permitted.	SHEET 3 NOTE 6
C8:	Radiographic examination shall be performed at ambient temperature in accordance with WS 4225.	SHEET 3 NOTE 8

MAJOR

M 101:	$90^{\circ} \pm 30^{\circ}$	SHEET 2 ZONE C-2
M 102:	After assembly of item 2, assemble item 7 and item 8, to item 2 as shown (Red lead to ceramic insulated terminal). Tighten nuts, item 9 to 6 ± 1 inch pounds torque and coat area shown in dashed lines, with sealing compound, item 10.	SHEET 3 NOTE 4
M 103:	All bearing surfaces of items 23 and 24 shall be coated with item 5 prior to assembly. Assembly of item 24 shall be accomplished with approximately 1 1/2 turns of item 23, so that the ends of the lock-wire are not visible through the entrance hole in the tube.	SHEET 3 NOTE 7
M 104:	Each wire rib shall accept a gage 22 inches minimum in length, having a cross-section configuration as shown in figure 1. The length of the .154 groove may have a maximum bow of .001 inch. The base of the gage shall bottom on each surface at the base of the rib. The base of the gage shall be slotted to clear aft hanger band.	SHEET 3 NOTE 9

[redacted]

DWG. 1557475, INHIBITOR, AFT

CRITICAL

C1:	Material: Rubber base inhibiting compound, WS 6529, type II.	SHEET 1 NOTE 1
C2:	Exterior surfaces shall be free of contamination. Advisory: Clean plastic gloves should be worn by personnel handling part.	SHEET 1 NOTE 3

MAJOR

M 101:	In Zone G there shall be no voids larger than 1/4 inch in a radial direction within .100 inch of surface E. In Zone F, a total of 1/2 square inch of voids is permitted. In Zone H, no voids are permitted.	SHEET 1 NOTE 2
M 102:	Flash shall not exceed .031 inches and is only permissible on corners indicated.	SHEET 1 NOTE 4
M 103:	.440 ± .030	SHEET 1 ZONE C-2
M 104:	.080 ± .030	SHEET 1 ZONE B-2

DWG. 2580609, PAINTING AND MARKING ASSEMBLY

MAJOR

M 101:	Painting and Marking Requirements	SHEET 1 NOTE 1
M 102:	Locate items 2, 3, 4, 9 and 10 on the finished surface of the tube, 90° from the plane of the vertical centerline. The second item of items 3, 4 and 10 shall be located diametrically opposite those shown.	

DWG. 2580611, HANGER ASSEMBLY MOD 5

CRITICAL

C1:	Item 2 shall be assembled with item 1 using item 9, the screws shall be coated with items 10 and 14 and tightened to 140 ± 5 inch pounds torque.	NOTE 1

C2: Item 7 shall be assembled to meet requirements of note 3. Pins tightened to a torque of 40 ± 5 inch pounds after coating with items 10 and 14. NOTE 2-A

C3: The eight (8) screws, item 8, used in the center and Aft Hanger assemblies shall be coated with sealing compound and primer, items 10 and 14, and tightened to 40 ± 5 inch pounds torque. Excess compound shall be wiped away. NOTE 2-D

C4: Item 4 shall be secured permanently before propellant is cast in tube. NOTE 2-E

C5: After compliance to notes 1 and 2, items 2, 3 and 4, shall pass without interference into and through a functional fixture which has dimensions shown in figure 1 and is sixty (60) inches long minimum. NOTE 3

C6: All threaded fasteners shall be treated in accordance with MIL-S-22473 in the following sequence. NOTE C-6

A. All fastener threads shall be vapor degreased, stored in an atmosphere of low humidity and kept clean until ready for use.
B. Prior to assembly, all fastener threads shall be dipped in grade O primer and allowed to dry.
C. The primed fastener threads shall then be dipped in grade AA sealing compound, installed and tightened, any fastener disturbed within 6 hours, shall be removed and redipped in the sealing compound.

C7: Each hanger assembly shall be inspected with ultraviolet light to verify the presence of sealing compound on all threaded fasteners. NOTE 6

MAJOR

M 101: The adhesive support tape, items 5 and 6, shall be saturated with adhesive, item 11. NOTE 2-B

M 102: The height of item 3 shall be adjusted using item 7 to comply with note 3. — NOTE 2-C

DWG. 2580613, TUBE, MOTOR, LOADED

CRITICAL

C1:	Item 2 shall be in accordance with WS 4225 and shall be vacuum cast into item 1.	SHEET 1 NOTE 1
C2:	Item 4 must be permanently installed prior to casting propellant. Hangers omitted for clarity.	SHEET 1 NOTE 2
C3:	The liner shall be bonded to both the motor tube wall and to the propellant, no separation is permitted as determined by X-ray examination.	SHEET 1 NOTE 7
C4:	Surfaces indicated by dot dot dash (..——) lines shall be free of propellant, inhibitor, or other foreign material.	SHEET 1 NOTE 8

MAJOR

M 101:	The total weight of the cast propellant within the motor tube shall be 59.4 pounds minimum to 61.6 pounds maximum.	SHEET 1 NOTE 4
M 102:	Aft end grain configuration shall be verified by inspection of the tooling prior to each casting.	SHEET 1 NOTE 11
M 103:	$.060^{+.060}_{-.000}$ (See note 6)	SHEET 1 ZONE D-1
M 104:	2.588 DIA ± .010 [⊙ A .020 TIR] [-B-]	SHEET 1 ZONE B-2
M 105:	3.766 DIA ± .010 [⊙ .020 TIR]	SHEET 1 ZONE E-1

DWG. 2580615, TUBE, MOTOR, LINED

CRITICAL

C1: The motor tube, item 1, shall be prelined as shown using item 2. The pre-liner shall be flush with surface "W" within 0.015. The pre-lining may be performed as prescribed in OD 30728. — NOTE 2

C2: .060 ± .040 liner thickness throughout 3.000 MAX LENGTH. — SHEET 1 ZONE B-5

C3: $.030^{+.020}_{-.010}$ (See note 3) — ZONE C-3

MAJOR

M 101: The internal surfaces shall be clean and free of foreign material. The motor tube item 1, shall be cleaned as per note 1 A, B, C and D. — NOTE 1

DWG. 2580650, CLOSURE ASSEMBLY

CRITICAL

C1: All threaded fasteners shall be treated in accordance with MIL-S-22473 in following sequence: — NOTE 6

A. All fastener threads shall be vapor degreased, stored in an atmosphere of low humidity and kept clean until ready for use.
B. Prior to assembly, all fastener threads shall be dipped in primer, item 13, and allow to air dry.
C. The primed fastener threads shall then be dipped in item 6 or item 11, installed and tightened. Any fastener disturbed within 6 hours, shall be removed and redipped in the sealing compound.

MAJOR

M 101: Assemble item 10 on item 12. Apply item 11 to threads of item 2. Assemble item 2 in item 1 as shown, and tighten to 450 to 550 inch pounds torque. (See note 6.) NOTE 1

M 102: Remove items 8 and 9, and locate items 4, 12, 9 and center terminal of item 3. Apply item 7 to threads of item 2 and tighten item 8 to 4 ± 1 inch pounds torque. NOTE 2

M 103: The igniter circuit shall be checked with an approved tester on test set. Resistance test may be accomplished as specified in OD 30728. NOTE 3

M 104: Coat area shown with dash dot dot (—..) lines with item 7. NOTE 4

M 105: Apply item 6 to item 5, assemble, and tighten to 5 ± 1 inch pounds torque. (See note 6.) NOTE 5

DL 1517776, FILTER, RADIO INTERFERENCE ASSEMBLY

DWG. 1517776, FILTER, RADIO INTERFERENCE ASSEMBLY

MAJOR

M 101: Solder Item 2 to Item 1, Item 11 to Item 1 and all lead connections in accordance with MIL-S-6872, using Item 13. NOTE 1

M 102: Pot assembly as follows: All cavities within the housing, Item 1, excluding the cavity indicated as area A, shall be filled NOTE 3

$1/32^{+1/64}_{-0}$ from surface Z using Item 14. Care shall be taken to minimize voids in the potting. All electrical elements and connections in the cavities shall be completely covered with sealing compound and

$1/32^{+1/64}_{-0}$ below surface Z.

TAB I-B

UNCLASSIFIED [redacted]

M 103: Each assembly shall meet the following requirements when tested as specified. NOTE 4

A. Test number 1 as shown.

B. Capacitance to ground shall be 9.90 microfarads minimum when tested in accordance with MIL-STD-202, Method 305, at 60 ± 6 cps test frequency. Limit of accuracy of test equipment shall be ± 2 percent.

C. High potential: When tested in accordance with MIL-STD-202, Method 301, by applying a direct current voltage of 35 volts maximum between the housing, Item 1, and the insulated feedthru terminal, Item 2, and the wire terminal, Item 9 connected together, leakage current shall be limited to one ampere maximum.

DWG. 1517777, HOUSING

MAJOR

M 101: Finish 1.4.3.1 of MIL-STD-171, .001 thick. NOTE 2

M 102: Part shall be inspected for internal discontinuities in accordance with MIL-C-6021, Class II A, Level C. After coating presence of any defect listed in Table III of MIL-C-6021 shall be cause for rejection, except surface irregularities. Misruns and core shifts are permitted within drawing tolerances. NOTE 3

M 103: .906 BSC PAGE 1 ZONE C-6

M 104: 1.124 BSC PAGE 1 ZONE B-5

M 105: .500 PAGE 1 ZONE D-3

UNCLASSIFIED [redacted]

DWG. 1555427, CAPACITOR, FIXED, FEEDTHRU

MAJOR

M 101: Capacitor shall meet the construction performance and environmental requirements of MIL-C-110 15/13 Type CK 70 AW 152M, except design and dimensions shall be as specified on this drawing. NOTE 1

DWG. 1555428, CAPACITOR, FIXED, FEEDTHRU

MAJOR

M 101: Capacitor shall meet the performance requirements of the Sprague Electric Company Engineering Bulletin Number 3525, Type 180D Tantalex Feedthru capacitors dated May 1962 when tested in accordance with the applicable sections of the bulletin. NOTE 4

DWG. 1555431, TERMINAL, FEEDTHRU, INSULATED

MAJOR

M 101: Terminal stud shall be brass, electro-tin plated. Plating shall be 0.00025 inch minimum thick. NOTE 3

M 102: When terminal is soldered securely to a metal chassis, using 1/16 inch nominal wide metallized band, thread portion of terminal stud shall withstand 10 inch-pounds minimum torque without breaking metallized band or fracturing ceramic to stud bond. NOTE 4

M 103: Terminal shall withstand subjection to any temperature from minus 55°C to plus 150°C without fracturing of ceramic or loosening of metallizing. NOTE 5

DWG. 1557518, IDENTIFICATION PLATE

MAJOR

M 101: The mask shall be a 1.0 inch diameter paper disc insulating the area under it from the pressure sensitivity. NOTE 5

DL 1568376, IGNITER ROCKET MOTOR MARK 264 MOD 1 ASSEMBLY

DWG. 1555641, GRAIN

NOTE 1 Material: The grain shall meet the requirements of WS 1620.

NOTE 3 Grain shall be free of microscopic imperfections (such as scratches, cracks, laminations, inclusions, voids and foreign material).

DWG. 1560892, BOOSTER ASSEMBLY

MAJOR

M 101:	(A) Coat surface "A" of body with sealing compound. Synthetic rubber accelerator required MIL-S-8516, Class 1.	NOTE 1
M 102:	Before assembly, coat rim of cup, surface B .562 diameter reference, DWG. 1560895 with sealing compound, synthetic rubber, accelerator required MIL-S-8516, Class 1.	NOTE 2

DWG. 1560894, BODY

MAJOR

M 101:	$.011 \pm .002$	SHEET 1 ZONE G-8
M 102:	$.115^{+.000}_{-.010}$	SHEET 1 ZONE C-10
M 103:	$.018 \pm .003$	SHEET 1 ZONE C-8

DWG. 1560895, CUP

MAJOR

M 101:	$.090^{+.000}_{-.005}$	SHEET 1 ZONE F-8
M 102:	$.010 \pm .001$	SHEET 1 ZONE F-8

M 103: $.562^{+.000}_{-.010}$ DIA — SHEET 1, ZONE C-6

DWG. 1568376, IGNITER ROCKET MOTOR MARK 264 MOD 1

MAJOR

M 101: Prime grain assembly Item 1 and tube assembly threads Item 2 with grade Q primer. Item 10 allow primed parts to dry for 2 hours. Apply grade A sealing compound Item 6 to grain assembly. Insert grain assembly Item 1 into aft end of tube assembly Item 2. Seating against depth gage DWG. 1556359 align screwdriver slots to correspond with either set of .101 diameter holes. — NOTE 2

M 102: Coat threads of electric squib MARK 5 MOD 0 Item 5 with grade Q primer Item 10. Allow squib threads to dry for 2 hours. — NOTE 4

M 103: Apply grade A sealing compound Item 6, to electric squib Item 5; and insert electric squib Item 5 into tube assembly, Item 2 until flange seats against tube assembly. Torque to 300 ± 50 inch pounds. — NOTE 5

M 104: Prior to and after assembly the igniter rocket motor assembly shall be free of oil, grease, and all foreign material. — NOTE 7

M 105: Radiographically examine each igniter in accordance with MIL-STD-453 to determine the presence, proper location and acceptable condition of internal component parts. — NOTE 10

M 106: After assembly, inspect all surfaces coated with Item 6 with fluorescent light to verify sealing of the threaded surfaces of Items 1 and 5. — NOTE 11

DWG. 1568377, GRAIN ASSEMBLY

MAJOR

M 101: Prior to and after assembly, the grain, Item 1, the igniter setscrew Item 2, and insulation sleeve Item 3, shall be free of oil, grease, and all foreign material. NOTE 1

M 102: Insert grain Item 1, into igniter setscrew Item 2, before grain has been inserted into insulation sleeve Item 3. NOTE 2

M 103: Place grain assembly in 170 ± 10°F oven for 15 minutes to allow shrinkage of the insulation sleeve Item 3 onto the grain Item 1, and igniter setscrew Item 2. The aft end shall be trimmed as shown. The installed insulation sleeve shall be free of fissures, wrinkles, and blisters. NOTE 3

DWG. 1568380, TUBE ASSEMBLY

MAJOR

M 101: Prior to and after assembly, the tube Item 1 shall be free of oil, grease, and all foreign material. NOTE 1

M 102: Prior to assembly of insulation sleeve Item 2 the tube, Item 1 shall be coated with epoxy resin adhesive Item 3. While the adhesive is still tacky, the insulation sleeve shall be heat shrunk on the tube and the adhesive allowed to cure. After cooling the insulation sleeve shall be trimmed flush to 1/8 inch maximum from each end of tube. The installed insulation sleeve shall be free of fissures, wrinkles, and blisters. NOTE 2

M 103: Tube assembly when supported at each end with a leak tight fixture shall meet the leak requirements of WS 3853. NOTE 3

M 104: Four .101 diameter holes shall be kept free of adhesive Item 3. NOTE 4

DWG. 1556359, GAUGE, DEPTH

MAJOR

M 101: 1.060 $^{+.000}_{-.005}$ — PAGE 1, ZONE B-3

DL 269495, SQUIB ELECTRIC MARK 5 MOD 0

DWG. 1296819, SQUIB ELECTRIC MARK 5 MOD 0

CRITICAL

C1: The final assembly shall be shorted with nut, AN 340-6, and shorting washer, DWG. 1560571 during handling and storage. Install nut with 4 ± 1 inch pound torque. NOTE 7

MAJOR

M 101: Body and bridge wire assembly DWG. 1296833 shall be free of oil, grease and other foreign material. NOTE 1

M 102: Bridge wire shall be covered with a bead of 15 ± 5 milligrams of initiation charge, drawing 1560576. The bead shall be dried for a minimum of 4 hours at 110°F to 150°F before further loading of assembly. NOTE 2

M 103: The bottom cavity of the body and bridge wire subassembly DWG. 1296833 shall be filled with 30 ± 5 milligrams of boron-potassium-nitrate granules 458505-3, in such a manner as to completely cover the beaded bridge wire. It shall extend up to, but not beyond the 0.180 dimension of the squib body DWG. 1517178. Installed granules shall be encrusted by adding 2 drops (0.7 ± 0.2 milligrams) of ethyl cellulose lacquer DWG. 652243 and shall be dried for a minimum of 4 hours at 140° to 160°F before further loading. NOTE 3

M 104: Loose charge 70 ± 5 milligrams of boron-potassium-nitrate granules, DWG. 458505-1 shall be placed into cup, DWG. 458694. NOTE 4

M 105: The loaded cup DWG. 458694 shall then be installed into squib body, DWG. 1517178, to minimum of 0.030 from lip. Exposed surface of cup shall be coated with epoxy Type I, MIL-A-8623. Epoxy shall dry at 70 ± 10°F temperature for a minimum of 1 hour. A fillet of silicone rubber compound MIL-S-23586 Type II, Class 3, Grade A, shall be applied as shown. Within 5 minutes the lip of squib body shall be crimped 360° to secure cup. Finished crimp must be 90° + 5° - 0° to the axis of the assembly. Exposed surface of cup must be free of compound. — NOTE 5

M 106: The resistance of the bridge wire circuit must be 0.7 ± 0.2 ohms when measured with a maximum of 50 milliamps. — NOTE 6

DWG. 1296833, BODY AND BRIDGE WIRE SUBASSEMBLY

MAJOR

M 101: The bridge wire shall be resistance wire QQ-R-175 composition D, except as noted: — NOTE 1

A. The resistance shall be between 165-180 ohms per foot at 50°C.

B. The proportions of nickel, chromium and iron may vary from the specification provided that the resistance requirements of Note 5 are met.

M 102: The welded bridge wire shall form a sound electrical and mechanical joint that will support a load of 25 ± 1 grams applied normal to the axis of the wire. Each leg of the bridge shall be tested. — NOTE 4

DWG. 1517178, BODY SQUIB

MAJOR

M 101:	⊥ A .005	SHEET 1 ZONE J-10
M 102:	⊥ A .005	SHEET 1 ZONE J-9
M 103:	3/4-16UNF-2A | PD | ⊙ A. 003 TIR |	SHEET 1 ZONE 1-6

M 104: .260 + .003 - .000 DIA — SHEET 1, ZONE H-7

M 105: .030 + .010 - .000 — SHEET 1, ZONE G-8

DWG. 1560572, PIN

<u>MAJOR</u>

M 101: Material: Nickel 51%, iron 49% tensile strength 70,000-150,000 psi, yield strength 0.2% offset 50,000 psi average elongation in 2 inches 35%. — NOTE 1

DWG. 458694, CUP

<u>MAJOR</u>

M 101: .0030 + .0000 - .0015 — SHEET 1, ZONE G-12

M 102: .0040 + .0000 - .0025 — SHEET 1, ZONE F-12

DWG. 1560576, CHARGE, INITIATION

<u>MAJOR</u>

M 101: Material: Uniform by weight consisting of: — NOTE 1

A. Normal lead styphnate in accordance with MIL-L-17186. The lead styphnate shall be milled in accordance with NAVORD OD 6699 to provide the approximate particle size range specified in section 4.4.

B. Zirconium in accordance with JAN-Z-399. Prior to use, the zirconium shall be washed with distilled water to remove all traces of impurities and then wet-screened through a 325 U.S. sieve. All material passing through the sieve shall be dried at 75 to 80° C. Discard all the zirconium not passing through the 325 U.S. sieve.

C. Lead dioxide in accordance with MIL-L-376, Class I.

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D. The resin shall be a vinyl acetate copolymer. It shall contain 85 to 88 percent vinyl chloride and 12 to 15 percent vinyl acetate. The resin shall have a specific gravity of 1.35 to 1.37. Material shall be furnished as a powdered white solid, not less than 98 percent of which shall pass through a No. 20 sieve, conforming to specification RR-S-366. Prior to use, vinyl resin shall be dissolved in normal butyl acetate conforming to TT-B-838.

M 102: For standard testing sieves refer to RR-S-366. NOTE 2

F. Subject. Inspection requirements of the following wing units shall be at least as tight as shown in Section 1-107b of DSAM 8260.1 for its classification of characteristics. Inspection is to be monitored by the local Quality Assurance Representative at a 10% level.

DL 1517560 Damper Assembly
DL 1517540 Rolleron Assembly
DL 1517535 Wing Assembly Guided Missile Mk 1 Mod 0

DL 1517560, DAMPER ASSEMBLY

DWG. 1517560, DAMPER ASSEMBLY

MAJOR

M 101: Lubricate O-Rings, Item 6, Rod, Item 8, and ends of shaft, damper assembly, Item 2, outside of O-Rings grooves with grease, Item 12. NOTE 2

M 102: After filling, crimping and cutting the bellows tube, (solder end of tube with solder, Item 14, in accordance with MIL-S-6872. End of tube after crimping shall be free of Item 13 prior to soldering). NOTE 4

M 103: With the damper housing, Item 1, held stationary and the damper shaft assembly, Item 2, attached to a torque test fixture, the breakaway torque shall not exceed 0.10 foot pounds. The damping torque shall be as follows: NOTE 5

UNCLASSIFIED [redacted]

A. 0.020 to 0.30 ft-lbs at 1 Radian per second.
B. 0.35 to 0.50 ft-lbs at 2 Radians per second.
C. 0.80 to 2.00 ft-lbs at 5 Radians per second.
D. 1.75 to 5.00 ft-lbs at 10 Radians per second.

Hysteresis shall not exceed 1.00 ft-lbs at 5 Radians per second.
Measurements shall be made while turning the damper shaft assembly, Item 2, through an arc of 20°. (10° on both sides of a neutral position).
Advisory. See SA 492583 for tooling which has been used satisfactory.

M 104: Compress bellows to .945 ± .010 before filling. ZONE B-3

M 105: After tightening of screws, Item 4, apply epoxy, Item 19, over screws to fill cavity between screws, Item 4, and housing, damper, Item 1. NOTE 8

M 106: After tightening of bellows assembly, Item 11, to housing, damper, Item 1, apply epoxy, Item 19, as shown to bond bellows to housing.

M 107: Parts list, Item 10, torque to 30 in-lbs ± 1 in-lb. ZONE B-1

M 108: Parts list, Item 4, torque to 8 in-lbs ± 1 in-lb. ZONE B-1

M 109: Parts list, Item 11, torque to 15 in-lbs ± 1 in-lb. ZONE B-1

DWG. 1298080, O-Ring

MAJOR

M 101: ID per tabulation block-1, -2 and -3 ZONE C-3

M 102: DIA W per tabulation block -1, -2 and -3 ZONE C-3

M 103:	.005 MAX 2 places	ZONE B-3
M 104:	.003 MAX 2 places	ZONE C-3
M 105:	Surface of O-Ring, except for indicated flash, shall be smooth and free from nicks, cuts, or any other surface defects or irregularity in excess of .001 in height or depth.	NOTE 2
M 106:	Original source of supply	ZONE B-4

DWG. 1517561, SEGMENT, DAMPER

M 101:	√32	ZONE B-3
M 102:	√32	ZONE E-5
M 103:	√32	ZONE E-4
M 104:	⊥ A .0002	ZONE E-4
M 105:	⊥ A .0002	ZONE E-5

DWG. 1517562, HOUSING, DAMPER

M 101:	.5016 DIA $^{+.0003}_{-.0000}$	ZONE D-5
M 102:	√8	ZONE D-5
M 103:	.030R TYP.	ZONE C-3
M 104:	√125	ZONE D-3
M 105:	√32	ZONE C-3
M 106:	⌖ .005 DIA	ZONE C-5
M 107:	10-32 UNF-28 (90° CSK x .314 DIA)	ZONE B-3

DWG. 1517563

MAJOR

M 101:	Coat the $.5009^{+.0000}_{-.0005}$ DIA surfaces and vertical surfaces, indicated by DASH DASH DOT (— —.) lines at the 1.750 dimension with lubricant, solid film, dry per MIL-L-22273. All dimensions and tolerances apply after application of film.	NOTE 2
M 102:	Damper Segment, DWG. 1517561, shall be selectively fitted into this area and shall maintain a (Maximum of 0.0002 total clearance between ends of damper segment and 1.750 ± .005 dimension damper segment shall fit freely with damper shaft.)	NOTE 3
M 103:	Material: Steel, cre, AISI 416, 98,000 PSI minimum tensile strength. Alternate: QQ-S-763, Class 416, 98,000 PSI minimum tensile strength.	NOTE 1
M 104:	$\surd$ 16	ZONE F-4
M 105:	$\surd$ 16	ZONE F-4
M 106:	.387 ± .003 DIA TYP	ZONE B-6
M 107:	Edge of holes to be free of nicks, burns and chatter marks, 2 places.	ZONE C-5
M 108:	⊥ A .0002	ZONE C-5
M 109:	⊥ A .0002	ZONE C-4
M 110:	⊙ A .003 TIR	ZONE C-6

DWG. 1555358, SHAFT, DAMPER ASSEMBLY
Assembly print no cc necessary

DWG. 156980, DRIVE SCREW, DAMPER
No cc on print

[redacted]

DWG. 1560981, ROD, DAMPER
No cc on print

DWG. 1560983

MAJOR

M 101: .040 DIA (Edge of hole to be free of nicks and burns.)

DWG. 1560984

MAJOR

M 101:	.005 ± .001	ZONE C,D-3,4
M 102:	.386 ± .004 DIA	ZONE B-4
M 103:	.001 ± .001 Radial split	ZONE B-3

DWG. 1560985

MAJOR

M 101: Material: QQ-S-766, Class 302 to 304 incl. (Condition half-hand)

DWG. 1561092, SCREW SEGMENT
No CC's on print

DL 1517540, ROLLERON ASSEMBLY

DWG. 1517540, ROLLERON ASSEMBLY

MAJOR

M 101: The bearings, Item 2, shall be selectively fitted to each wheel hub such that an interference fit of 0.000025 to 0.000025 clearance shall be maintained between the bearing inner race bore and the outside diameter of the hub of the wheel assembly, Item 3. — NOTE 3

[redacted]

[redacted]

M 102: Press the bearings, Item 2 into the rolleron case machined assembly, Item 1, until securely seated, without deforming the case or the bearing. Assemble the wheel, Item 3 and the shim, Item 4, into the case. Select shims that shall maintain a 4 lb ± 1 lb preload on the bearing, install the right hand preload screw, Item 5, and the left hand preload screw, Item 6, with a torque of 45-47 inch pounds. Any contamination of the bearing grease will necessitate cleaning of the bearings and the installation of new grease, Item 4, in accordance with WS 1615. NOTE 4

M 103: Seal the bearing dust caps, part of 1517544, in place using base, Item 15, and hardener, Item 16.

M 104: The wheel, Item 3, shall be balanced dynamically within 200 micro-ounce inches in each plane (i.e. each side of the wheel). Balancing holes to be 0.014 DIA by 0.080 maximum deep and drilled in areas shown on a 3.000 ± 0.015 DIA circle.

M 105: The wheel, Item 3, shall be operated at 30,000 RPM for five (5) minutes prior to checking the rundown time. The wheel after the driving source is removed, shall slow down from 6,000 RPM ± 50 RPM to 3,000 RPM ± 50 RPM within 8.75 seconds ± 1.75 seconds.

DWG. 1517541, CASE ROLLERON (Right hand)
No CC's on print

DWG. 1517542 ROLLERON CASE (Machined assembly)

MAJOR

M 101: Right and left hand rolleron cases, Items 1 and 2, shall be assembled, machined and kept in matched sets in accordance with paragraph 2-101.3.5 MIL-STD-100A.

M 102: .7495 ± .0001 DIA — ZONE F-4

M 103: ⊥ B .0001 — ZONE F-4

[redacted]

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M 104: [⌖ .005 DIA] ZONE F-4

M 105: [○ .0001] ZONE F-4

M 106: [⌯ .010 Ⓢ | A Ⓢ] ZONE E,F-3

M 107: [∥ B .0002] ZONE E,F-3

M 108: [⊙ C .0001] TIR ZONE E-3

M 109: [○ .0001] ZONE F-3

M 110: [⌖ .005 DIA] ZONE A,B-5

DWG. 1517544, BEARING, ROLLERON

MAJOR

M 101: The 0.265 ± .001 dimension between surface "X" and surface "W" shall be verified when the bearing is supported on the surface "W" and a 4.00 ± .010 pound load is applied to the inner race in the direction shown. NOTE 3

M 102: $.2500 {}^{+.0000}_{-.0002}$ DIA ZONE D-3

M 103: $.7500 {}^{+.0000}_{-.0002}$ DIA ZONE C,D-2

DWG. 1517754, CASE, ROLLERON (Left hand)
No CC's on print

DWG. 1555363, WHEEL ASSEMBLY

MAJOR

M 101: Establish an interference fit between Items 1 and 2 at the 0.980 DIA REF of 0.003 minimum. NOTE 1

M 102: .063 ZONE B-4

M 103: [⊥ A .002]

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DWG. 1555365 WHEEL

MAJOR

M 101: The 63° angle and the 0.100 depth of the side bracket shall be maintained for a minimum of 0.610 with a 0.750 R minimum runout. NOTE 2

M 102: The .100 $^{+.005}_{-.010}$ depth tolerance applies to bucket depth except that the depth of all buckets shall not vary more than 0.002 total on each side. NOTE 4

M 103: 3.294 DIA over .1250 DIA gaging pins ZONE C-2

M 104: 3.250 $^{+.005}_{-.015}$ DIA ZONE C-4

DWG. 1555673, GUIDE VANE RIGHT HAND

MAJOR

M 101: When cast, 100% radiographic inspection per MIL-C-6021 is required. Zone A shall be class B minimum and Zone B shall be class D minimum as specified in MIL-C-6021. NOTE 1

M 102: Cadmium plate in accordance with QQ-P-416, Class 3, Type II, baking at 375° ± 25° F for a minimum of 3 hours after plating is mandatory. NOTE 2

DWG. 1560949 SCREW, PRELOAD (Right hand)

MAJOR

M 101: Screw head to withstand 40 in-lb of torque without evidence of failure. Test shall be in accordance with FF-S-86. NOTE 3

M 102: Finish 1.1.2.3 + 5.1.1.2 of MIL-STD-171 hydrogen embrittlement relieve. NOTE 4

M 103: .310 MIN perfect thread ZONE B-2,3

DWG. 1560950 SCREW, PRELOAD (Left hand)

MAJOR

M 101:	Screw head to withstand 50 in-lb of torque without evidence of failure. Test shall be in accordance with FF-S-86.	NOTE 3
M 102:	Finish 1.1.2.3 + 5.1.1.2 of MIL-STD-171 hydrogen embrittlement relieve.	NOTE 4
M 103:	.310 MIN perfect thread.	ZONE B-2,3

DWG. 1560952 SCREW, CASE

MAJOR

M 101:	Self-locking element shall be in accordance with MIL-F-18240. Type A.	NOTE 2
M 102:	$.598^{+.000}_{-.020}$	ZONE B-3
M 103:	.375 ± .015	ZONE B-3

DWG. 1560953 SCREW, GUIDE VANE

MAJOR

M 101:	Self-locking element shall be in accordance with MIL-F-18240 Type A.	NOTE 2
M 102:	.175 ± .015	ZONE C-3

DWG. 1561102, SHIM
No CC's on print

DWG. 1562367, PIN, STRAIGHT

MAJOR

M 101:	.1252 ± .0001, -3 part, D DIA	ZONE B-3

DWG. 1567572 HUB

MAJOR

M 101: The taper of the wheel shaft shall not exceed 0.000050 regardless of size (S) over the entire length. — NOTE 3

M 102: $.25000 \begin{matrix} +.00000 \\ -.00020 \end{matrix}$ DIA TYP — ZONE D-3

M 103: [○ A .0001 TIR] — ZONE C-3

M 104: [○ Ⓢ .00005] — ZONE C-3

M 105: Case harden external surfaces to Rockwell C 55 minimum to a depth of 0.015 maximum in accordance with MIL-S-6090. Core properties shall be 90,000 psi minimum yield with 15% minimum elongation.

M 106: [PD ⊙ B .003 TIR] — ZONE D-3

M 107: [PD ⊙ B .003 TIR] — ZONE D-4

DL 1517535 WING ASSEMBLY GUIDED MISSILE MARK 1 MOD 0

DWG. 1571691 RIVET, BLIND

MAJOR

M 101: Material: Rivet and drive pin, aluminum alloy 2117, QQ-A-430. — NOTE 1

M 102: .0875 DIA — ZONE B-4

M 103: .080 DIA — ZONE C-4

M 104: $.125 \begin{matrix} +.003 \\ -.001 \end{matrix}$ — ZONE C-3

DWG. 1517535 WING ASSEMBLY, GUIDED MISSILE, MARK 1 MOD 0

MAJOR

M 101: Torque to 32 ± 1 in-lb — PAGE 1, ZONE F-3

M 102:	Torque to 18 ± 1 in-lb	PAGE 1 ZONE E-3
M 103:	Action of cager assembly Item 5, shall be tested at final assembly with the wing and rolleron assembly. A. The cage assembly shall not uncage at less than 150 pounds test pull and shall uncage at less than 180 pounds test pull. Pressure of spring, Item 11, may be adjusted to meet cage test requirements.	NOTE 4
M 104:	The wing and rolleron assembly shall fit freely over the functional test fixture as shown and seat to surface Y.	NOTE 5

DWG. 1517536 WING ASSEMBLY

MAJOR

M 101:	Apply coating, Item 8, .025 $^{+.000}_{-.005}$	NOTE 5-B
M 102:	Thermofoam 607, Type I & IA	PARTS LIST ITEM 12
M 103:	BAC #607	PARTS LIST ITEM 11
M 104:	E-400	PARTS LIST ITEM 8
M 105:	TYPE III, Class 2 MIL-A-25463	PARTS LIST ITEM 6
M 106:	Mask all holes	NOTE C-5
M 107:	45° Ref 5 places to be set to functional Fixture DWG. 1517535	ZONE C-3

DWG. 1517537, FRAME, WING

MAJOR

M 101:	Material: Aluminum alloy in accordance with federal specification QQ-A-367, composition 2618.	SHEET 3 NOTE 1

Alternate: Aluminum alloy with the following properties at the temperatures indicated.

Temperatures °F Minimum	Yield Strength PSI Minimum	Elongation % Minimum
72	41,000	4
300	33,000	4
500	22,000	4

Two specimens per fed. test method STD 151 from each heat shall be tested at each temperature listed above after uniformly heating the specimens from room temperature to test temperature in a period of not less than 10 minutes nor more than one hour. The specimens shall be loaded at a strain rate of 0.016 ± .005 inches per second.

Yield strength shall be determined by 0.2% offset method.

M 102:	Apply chemical film to all surfaces of frame in accordance with MIL-A-8625.	SHEET 3 NOTE 7
M 103:	.1870 $^{+.000}_{-.005}$	SHEET 1 ZONE C-2
M 104:	.1870 $^{+.000}_{-.005}$	SHEET 1 ZONE D-3
M 105:	⊕ .005 DIA	SHEET 1 ZONE C-2
M 106:	2.050	SHEET 1 ZONE E-2
M 107:	7/16 DIA X .5 deep .501 ± .001 DIA X 3 1/8 deep .005 DIA	SHEET 1 ZONE D-1
M 108:	Sym within ± .015 as described by a plane located by points A, B, and C.	SHEET 1 ZONE F-1
M 109:	.130 ± .002	SHEET 1 ZONE F-2
M 110:	≡ .005 (S)	SHEET 1 ZONE F-2

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M 111: .218 ± .003 DIA, .275 ± .001 C bore to depth shown in section F-F. — SHEET 1, ZONE F-3

DWG. 1568846 FRAME, WING

MAJOR

M 101:	Material: Aluminum alloy in accordance with federal specification, QQ-A-367, composition 2618T61.	SHEET 4 NOTE 1
M 102:	[≡ .005 Ⓢ]	SHEET 1 ZONE F-2
M 103:	.1870 $^{+.0003}_{-.0000}$	SHEET 1 ZONE D-2
M 104:	.1870 $^{+.0003}_{-.0000}$	SHEET 1 ZONE D-3
M 105:	[⌖ .005 DIA]	SHEET 1 ZONE D-3
M 106:	2.050	SHEET 2 ZONE F-2
M 107:	7/16 DIA X 6 7/16 deep .501 DIA ± .001 √32 X 3 1/8 deep [⌖ .005 DIA]	SHEET 2 ZONE D-1
M 108:	℄ Sym within ± .015 as described by a plane located by points A, B, and C.	SHEET 1 ZONE F-1
M 109:	.130 ± .002	SHEET 1 ZONE F-2
M 110:	.218 ± .003 DIA X DEPTH shown .275 ± .001 DIA C bore X depth shown .150 DIA MAX Drill point permissible [⌖ .005 DIA]	SHEET 2 ZONE E-1

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DWG. 1517538, CORE, HONEYCOMB

MAJOR

M 101:	Material: Core, material, honeycomb, 4.5 ± .045 PCF average density, 1/8 cell size, 0.001 inch foil thickness, performed .5052 aluminum alloy in accordance with MIL-C-7538, 4.5-1/8-10P (5052).	NOTE 1

DWG. 1517539, SKIN, WING

MAJOR

M 101:	Material: Aluminum alloy 2024-T-3. Alternate: AMS 4037, 3024-T-3.	NOTE 1
M 102:	.016	ZONE C-3

DWG. 1517543, COVER, ROLLERON

MAJOR

M 101:	(Mark "REMOVE BEFORE FLIGHT") in 1/4 characters in area shown using red, color no. 11105 FED-STD-595 using roll-leaf, hot stamping, enamel pigment.	NOTE 3

DWG. 1555671, HINGE, ROLLERON

MAJOR

M 101:	375 ± .001 DIA	ZONE B-2
M 102:	[⌖ .002 DIA]	ZONE B-2
M 103:	45°	ZONE B-2
M 104:	$.196^{+.005}_{-.001}$ 100° CSK, .392 DIA 2 holes [⌖ .005 DIA]	ZONE D-3

DWG. 1555672 CORE, HONEYCOMB, AFT

MAJOR

M 101: Material: Core, material, honeycomb 4.5 ± 0.045 PCF average density, 1/8 cell size, 0.001 inch foil thickness, perforated 5052 aluminum alloy. Alternate: MIL-C-7438 4.5 1/8-10P (5052).

DWG. 1556363 SLUG, CAGER

MAJOR

M 101:	Coat part with polytetrafluoroethylene resin in accordance with OD 10362 on all external surfaces.	NOTE 3
M 102:	$.126^{+.001}_{-.000}$	ZONE D-2
M 103:	.063 ± .002	ZONE D-2
M 104:	$.497^{+.000}_{-.001}$	ZONE D-2
M 105:	$.197^{+.005}_{-.000}$	ZONE D-2
M 106:	1.340	ZONE D-3
M 107:	.500	ZONE C-3
M 108:	.625	ZONE C-3
M 109:	.125	ZONE C-4
M 110:	.093R	ZONE D-4
M 111:	$.187^{+.001}_{-.000}$	ZONE B-3
M 112:	.375	ZONE B-3
M 113:	.130 ± .002	ZONE A-3
M 114:	.125	ZONE A-3
M 115:	.120 ± .001	ZONE A-3

M 116: .074 ± .001 — ZONE A-3

M 117: $.1250 {}^{+.0001}_{-.0002}$ — ZONE C-2

M 118: 2.050 — ZONE D-3

DWG. 1555392 SCREW, WING

MAJOR

M 101:	Material: Steel AISI 4037. Part shall meet the requirements of MS 16998-48. Heat treat to Rockwell C36-40 in accordance with MIL-H-006875.	NOTE 1
M 102:	Induction harden area indicated by DOT DOT DASH ( ) 0.015 to 0.30 inch depth to Rockwell C45-55.	NOTE 2
M 103:	5/8	ZONE C-3
M 104:	1 3/4	ZONE C-3
M 105:	3/16 Sphere R	ZONE C-3
M 106:	Self locking element shall be in accordance with MIL-F-18240. Type A.	NOTE 3

DWG. 1560937 SCREW

MAJOR

M 101:	Material: Steel AISI 4130, condition A. Alternate: QQ-S-624 condition A. Heat treat to Rockwell C38-41, per MIL-H-6875.	NOTE 1
M 102:	Self-locking element shall be in accordance with MIL-F-18240. Type A.	NOTE 3
M 103:	Finish 1.1.2.3 of MIL-STD-171 hydrogen embrittlement relieve.	NOTE 2

DWG. 1560938 SCREW, ROLLERON

MAJOR

M 101: Self-locking element shall be in accordance with MIL-F-18240, Type A, except to 350° F. — NOTE 2

M 102: .500 — ZONE B-3

DWG. 1560939 SCREW, HINGE

MAJOR

M 101: Material: (Screw head shall withstand 40 inch pounds of torque without evidence of failure.) Test shall be in accordance with Federal Spec FF-S-86 unless otherwise specified, the requirements of NAS 51 P11032-10 apply. — NOTE 1

M 102: Self-locking element shall be in accordance with MIL-F-18240. Type A.

DWG. 1560941 SPRING, HELICAL COMPRESSION

MAJOR

M 101: Material: Steel, cre, wire AISI 302
Alternate: QQ-W-423, Comp FS 302, Cond B — NOTE 1

M 102: $.209 \begin{smallmatrix} +.000 \\ -.010 \end{smallmatrix}$ — ZONE B-2

M 103: Load at comp. length of 0.180 8 lbs ± 3 1b — ZONE B-4

DWG. 1560946 CAGER ASSEMBLY

CRITICAL NONE
MAJOR NONE

DWG. 1560947 CAGER

MAJOR

M 101: Material nylatron GS (to be changed to MIL Spec) — NOTE 1

M 102:	$.125^{+.000}_{-.001}$	ZONE D-4
M 103:	$.128 \pm .001$	ZONE B-3
M 104:	$.124^{+.000}_{-.001}$	ZONE B-3
M 105:	.345	ZONE B-3
M 106:	.065	ZONE A-3

DWG. 1555416 SPRING, CAGER

MAJOR

M 101:	Material: Steel, cre, wire, AISI 304, spring temper. Alternate: QQ-W-423 form II, condition B composition 304.	NOTE 1
M 102:	Finish 5.4.1 of MIL-STD-171	NOTE 2
M 103:	$.125^{+.000}_{-.003}$ DIA	ZONE C-3
M 104:	$.260 \pm .005$	ZONE C-3
M 105:	1 lb 6 oz to deflect $.125 \pm .010$	ZONE A-3

TAB I-C

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UNCLASSIFIED

JANUARY 1967

AEROSPACE TECHNOLOGY

RESEARCH REPORT

Report Number 20

DESIGNING FOR RELIABILITY

AUTHOR: Frank A. Barta

Presented at the 1967 Annual Symposium on Reliability— 10 through 12 January 1967, Washington, D.C.

HUGHES

HUGHES AIRCRAFT COMPANY
SPACE SYSTEMS DIVISION

SSD 60482R

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CONTENTS

SUMMARY

This paper presents reliability's role in influencing the design of hardware for two major Hughes Aircraft Company programs: the lunar soft-landing spacecraft, Surveyor (developed for NASA/JPL) and the communications satellites: Syncoms 1, 2, and 3, the Applications Technology Satellites (developed for NASA), Early Bird, and four Intelsat IIs) developed for Comsat).

Since an overview of approximately 6 years of the programs' operation (or a combined total of more than 12 years) is covered, only a selected number of reliability items are presented.

Some of the results obtained early in the programs, such as the evolution of the parts program during the various phases of design, are reviewed. The savings resulting from elimination of parts failures during system tests, Hughes' derating policy with previously unpublished derating curves for high reliability operation, and levels of parts acceptance are also reviewed.

Included are management controls involving Trouble and Failure Reports, necessary steps to ensure corrective action, and methods of transmitting pertinent information to key management personnel. Operation of the consent-to-ship and consent-to-launch procedures and the review of actions taken at lower organizational levels by top-management committees are described. (Acceptance or rejection of the committees' findings determines whether or not a spacecraft is shipped or launched.)

In addition, a brief status report of all operational hardware, data on hardware approaching operational readiness, and data affecting failure rates are presented.

INTRODUCTION

LUNAR SOFT-LANDING SPACECRAFT

The National Aeronautics and Space Administration supported several types of systems for the purpose of unmanned exploration of the moon. One of these, the Surveyor spacecraft system, includes spacecraft to be launched several months apart. On the first launch, 30 May 1966, Surveyor I softlanded on the moon after 63 hours, 36 minutes. During its launch, transit, landing, and postlanding operations, it accomplished all mission objectives.

The basic objectives of the system are: 1) to develop a technology for and accomplish a series of soft landings on selected areas of the moon, and 2) to perform operations on the lunar surface that will contribute to scientific knowledge of the moon and provide basic information for the Apollo program.

Other objectives are to demonstrate the capability of midcourse and terminal maneuvers; maintain communications with the spacecraft; prove the Atlas/Centaur launch vehicle; obtain in-flight engineering data on spacecraft subsystems in cruise and midcourse maneuver and on the closed-loop terminal descent guidance and control system; obtain data on the subsystems used on the lunar surface; televise a footpad, material surrounding it, and the moon's topography; determine radar reflectivity of the lunar surface; and obtain temperature data of both the spacecraft and the moon.

COMMUNICATIONS SATELLITES

Three of the first four Hughes-built communications satellites are in orbit. Synchronous, spin-stabilized, and continuously operational, they are providing high quality, reliable communications throughout the world.

Syncoms 2 and 3, under operational control of the Air Force Systems Command, are the only truly reliable link with the Far East. Early Bird, owned by the Communications Satellite Corporation (Comsat), is the first satellite to provide 24-hour commercial television and telephone communications between the United States and Europe.

As of 11 January 1967, the trio of satellites had accumulated impressive records of reliable operation (see Table 1). One failure occurred on Syncom 2 in 1964. Investigation indicated that a PNP silicon alloy transistor used as a commutator switch had sustained a collector-to-emitter short. The data is still readable, but operation was switched from encoder 1 to encoder 2.

TABLE 1. HUGHES COMMUNICATIONS SATELLITE OPERATION

Satellite	Customer	Orbit Objective in Days	Days in Orbit*	Percent of Objective
Syncom 2	NASA	30	1272	4240
Syncom 3	NASA	30	882	2940
Early Bird	Comsat	548	615	112

*Status as of 11 January 1967.

COMMON OPERATION PHILOSOPHY

At the start of both programs, each spacecraft had a short life objective--90 days for Surveyor I and 30 days for Syncom. The basic philosophy of both programs is to:

1) Select the best parts and components available for the assemblies and use only those that can be qualified as satisfactory

2) Maintain stringent subcontractor controls

3) Emphasize failure mode and effects analyses and design reviews

4) Assemble carefully and test until all weak spots and failures have been detected

5) Correct all failures and determine the failure mechanisms and eliminate them

6) Test until the hardware is capable of operating over the period required under specified environmental conditions

COMPONENT PARTS AND MATERIALS PROGRAM

An uncertainty facing designers in both programs was the effect of space environments on parts and materials which had satisfactorily performed in earth-associated environments. Each material and part used in the fabrication of a spacecraft required extensive testing to demonstrate its ability to withstand the new environments. The magnitude of the problem was also related to the quantity of parts to be used. Syncom 1 contained 3500 electronic parts or approximately 10 percent of the 36,000 required for the initial Surveyor spacecraft design. Surveyor I, a modified version of the first design, contained 29,000 parts. Surveyor program personnel were the first to face the problem of selecting parts that would be reliable in space environments.

SURVEYOR PROGRAM

The management of parts and materials for Surveyor spacecraft was the responsibility of the Reliability function of the Surveyor Laboratory. Implementation of the parts and materials program was shared between the Reliability function and the Components and Materials Laboratory of the Research and Development Division. The Reliability Section furnished technical direction, funding, and monitoring of the effectiveness of tasks performed under funds provided. This section also analyzed, evaluated, and surveyed the tasks contributing to reliability to gain needed assurance of adequate performance.

The primary responsibility of the Components and Materials Laboratory was the preparation of component and part specifications, participation in negotiations of contracts with vendors, and procurement and testing of samples. The laboratory performed other supporting tasks, attended design reviews, and provided expert consultation and guidance in the application and selection of parts and materials. The laboratory provided the necessary test support to Receiving Inspection on high reliability electronic components. They also initiated a preliminary Preferred Parts List which was periodically updated.

Preferred Parts List

The Surveyor Preferred Parts List was Hughes' first step in establishing a standard in terms of a preferred list of multiple-use component parts for space applications. The parts were chosen on the basis of proven history in Hughes systems. In the beginning, the parts listed were only design guides for breadboard and experimental fabrication. All components on the list were capable of withstanding the 48-hour temperature soak at 125°C without degradation, in compliance with sterilization requirements. Another consideration in their selection was that the parts be common to all Surveyor units and assemblies.

Parts Program

In order to acquire highly reliable parts and components for Surveyor, the following actions were performed:

1) Preparation of a specification defining specific environments the parts must withstand and their performance characteristics

2) Review of parts application in a system

3) Performance of a detailed failure diagnosis when a malfunction occurred to determine if the assignable cause was a result of an inherent design characteristic of the part, a quality control defect, or a misapplication

4) Performance of test and analysis of data acquired to verify that the failure rate of the part meets requirements.

5) Publishing and distributing a preferred parts handbook to various design activities. (This later resulted in a formal Approved Parts List (Spec) for Surveyor.)

6) Preparation of a Surveyor Standard Practices Handbook describing how to assemble parts in the spacecraft and how to safeguard against any reliability degradation that could occur because of in-process handling and routing

The parts specifications prepared by the Components and Materials Laboratory required that the vendor:

1) Perform acceptance testing of each lot

2) Carry out a 240-hour burn-in on all deliverable parts (subject to some exceptions)

3) Perform accelerated environmental tests on selected samples off the production line

4) Furnish data showing the results of acceptance and environmental tests

The critical parameters of all parts received were 100-percent inspected and tested by Hughes Receiving Inspection. If excessive failures occurred in fabricated assemblies, a Failure Review Board determined the cause and the corrective action required. Before release of Surveyor I parts, all bills of material were reviewed to verify that only acceptable parts were listed.

Materials Program

Implementation of the materials program followed closely that of the parts program. Specifications, processes, acceptance requirements, materials data book, and other analogous directives were prepared. A major critical element was the delineation of process specifications and acceptance requirements. In many cases such as potting compounds, various chemicals were mixed just prior to application in assembly. The correct mixture of compounds and elements under controlled temperatures and cleanliness was mandatory. To maintain quality, documentation of such procedures was vital considering batch-to-batch variability has to be low and intervals between batches were sometimes 6 months to a year.

The materials program required other special studies and tests. Of particular importance in the finishing medium was the selection of seals (inorganic and organic) and polishing techniques (vapor-deposited metal, brightening chem-milled surfaces, etc.) to maintain thermal control of the spacecraft. Investigation of many insulating materials, such as aluminized teflon tape and mylar, was also required along with the development, testing, and documentation of sealing and assembling techniques using adhesives, riveting, brazing, welding, soldering, potting, lubricants, etc.

The materials program required extensive testing in high vacuum to assure that foreign material of large quantities did not outgas or sublime and deposit on various portions of the spacecraft. For instance, outgassing of foreign materials or sublimation could have deposited on the Surveyor I television mirrors preventing taking pictures. Also, if thin film had coated a thermal control surface, its function would have been destroyed and the temperature of the device would have varied widely.

COMMUNICATIONS SATELLITE PARTS PROGRAM

Establishment of Criteria for Long Life

At the start of the communications satellite program, many of the items found successful in Surveyor were incorporated in the Syncom parts program. As new programs with much longer life objectives were undertaken, it was necessary to determine what could be done to secure even more reliable, failure-free parts. Figure 1 shows the key points considered in the revised parts procurement plan.

Based on knowledge gained in the Syncom program, a revised list of parts, materials, and processes was issued authorizing items for long-life communications satellites. The list was constantly updated and under control. Any deviations from the list required full justification and project management approval before incorporation in flight hardware. Standardization to a few common parts minimized the number of items requiring stringent qualification.

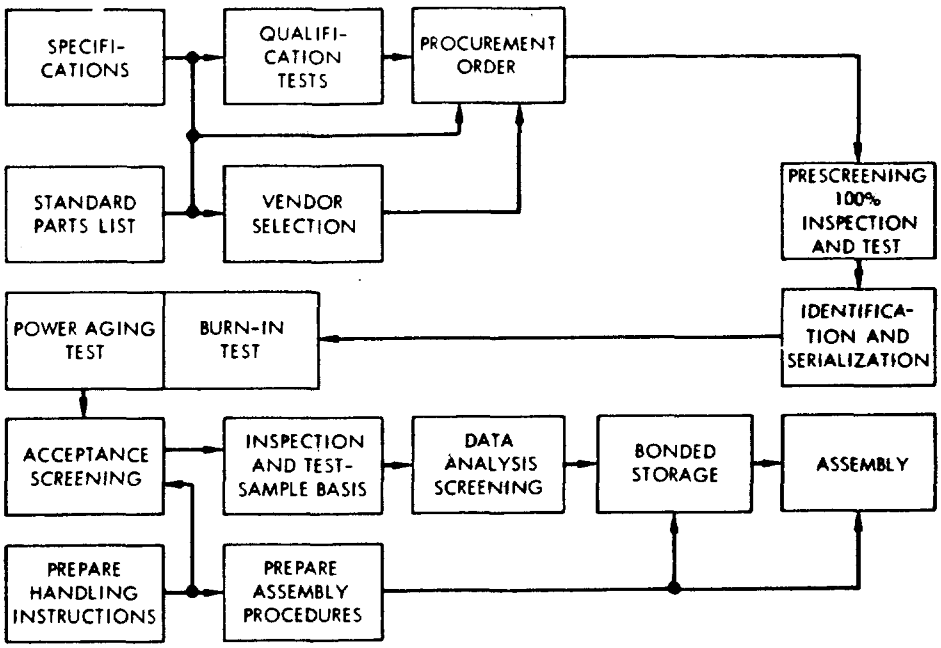

Figure 1. High Reliability Parts Program

Supplier reliability and acceptance test specifications were revised as needed to more accurately reflect the necessary requirements. An innovation introduced in the parts test programs was power aging for a specified number of hours after the burn-in.

Existing suppliers were reviewed and evaluated, and potential suppliers investigated. Suppliers were selected on the basis of:

1) Manufacturing process control capability

2) Achievement of product uniformity

3) Documentation and visibility of manufacturing process and process control

4) Understanding of product limitations

5) Knowledge of device failure modes

6) Active programs for elimination of major failure modes through failure analysis and recurrence prevention measures

7) Evidence of reliability improvement

8) Thorough quality control

Computerized Parts Data Program

Another innovation in the selection of parts was programming a computer to select parts for flight units. A 7094 computer selected only the best parts on the basis of stability and minimum drift of critical parameters.

The suppliers were responsible for prescreening, identification, and serialization of acceptable parts; a 240-hour burn-in; a 510- or 1260-hour power aging; acceptance tests; and transcribing the results of these tests to IBM cards. In addition to checking certain parameters on an attribute basis, the supplier was required to measure and record critical parameter measurements at 0, 240, 750, and 1500 hours. These measurements were printed out on a tab list by serial number and submitted to Hughes. Suppliers certified that all parts shipped were within specification throughout the tests.

In the Syncom program, the 100-percent inspection and test had been performed in Receiving Inspection. In the revised program, incoming parts shipments were sampled, accepted, or rejected after testing to uncover out-of-specification parts. On all parts accepted, the tab list accompanying the lot was submitted to the Components Department for flight parts selection. Table 2 lists tests performed on the satellite programs.

TABLE 2. COMMUNICATIONS SATELLITE INSPECTION AND TEST PROGRAMS

Item	Syncom	Early Bird	ATS	Intelsat IIA
Source inspection	No	Yes	Yes	Yes
100-percent receiving inspection	Yes	No (sample)	No (sample)	No (sample)
Qualification tests	Yes	Yes	Yes	Yes
Specification tests	Yes	Yes	Yes	Yes
Prescreening	No	Yes	Yes	Yes
240-hour burn-in	Yes*	Yes**	Yes**	Yes**
510-hour power aging	No	Yes**	Yes**	Yes**
1260-hour power aging (510 plus 750)			Yes**	

*Attributes only.
**Attributes and variables.

The net result of more reliable parts plus improved designs and better derating was to greatly reduce parts failures during major subsystem and system tests. Figure 2 illustrates the actual number of failures in these different satellite test programs. Because of the difference in the number of parts used per spacecraft in each program, failures are shown in terms of a 100,000-part spacecraft; actual failures are shown on the left side of the figure.

Probably the failure reduction in testing is not apparent until the comparison of parts program costs versus costs due to part failures is examined in Figure 3.

Table 3 shows that the parts screening cost for the Early Bird program is approximately three times that of the Syncom program. The combined testing cost of Early Bird, based on 14,000 parts, is only $305 thousand - a difference of over $1 million above the actual Syncom testing cost.

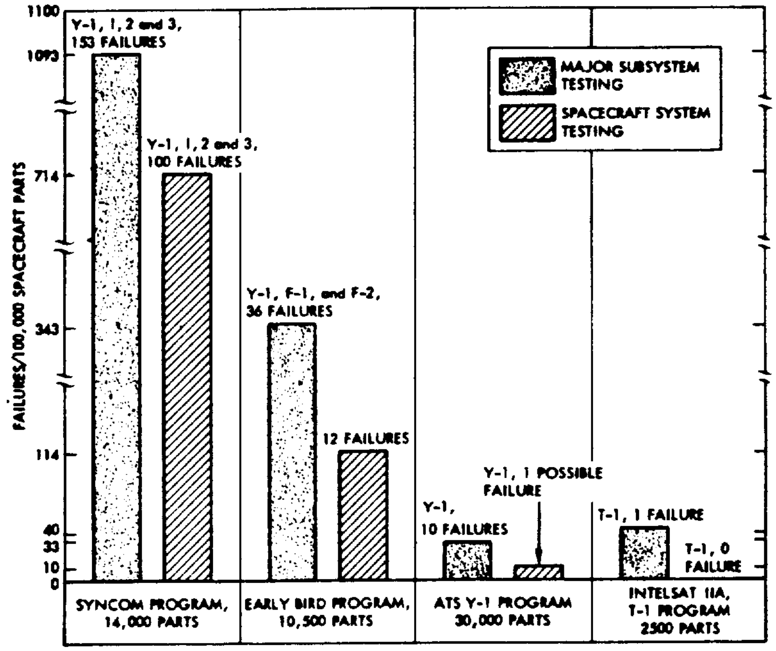

Figure 2. Comparison of Program Part Failures per 100,000-Part Spacecraft Experienced During System and Major Subsystem Tests

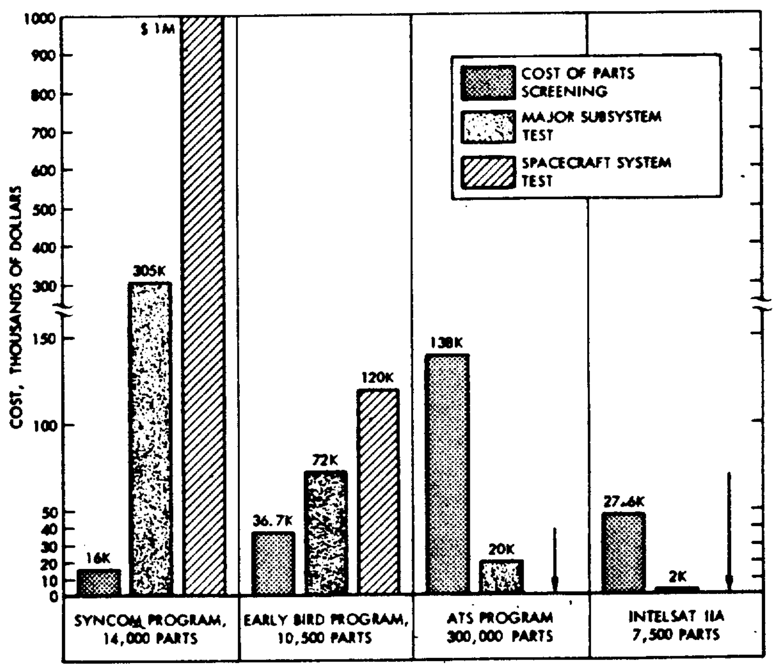

Figure 3. Parts Program Costs Versus Cost Due to Failure of Parts During System and Major Subsystem Tests

In Figure 3, the costs presented for ATS and Intelsat IIA - the only figures available at the time of preparation of this paper - are shown for information purposes only. The costs used in the bar charts are based on estimated cost of rework, personnel involved, test equipment time, and lost schedule time.

TABLE 3. COMPARISON OF TEST COSTS DUE TO PARTS FAILURES AND PRESCREENING COSTS FOR SYNCOM AND EARLY BIRD PROGRAMS

Item	Syncom Costs	Comparison of Costs	Early Bird Costs (based on 14,000 parts)
Parts screening	$ 16,000		$ 49,000
Subsystem testing	305,000		96,000
System testing	1,000,000		160,000
Syncom total	$1,321,000	$1,321,000	$305,000
Early Bird total		305,000	
Difference in costs		$1,016,000	

COMPARISON OF OBSERVED FAILURE RATES WITH MIL-HDBK-217

Data Sources for Reliability Prediction

Useful by-products have resulted from monitoring and analyzing data from Hughes Aircraft Company's three operational satellites. The purpose of the analysis is to obtain realistic part failure rates. Predictions based on these failure rates are probably more meaningful than those based on individual part testing since operational data includes certain variables such as design of circuits, part utilization, and standards of procurement otherwise difficult to take into account.

The validity of before-the-fact reliability predictions and estimates can always be questioned on the grounds of the basic assumptions made in the analysis and the failure rates used. The MIL-HDBK-217 failure rates can be modified in those cases where Hughes has operational satellite experience.

Operational Experience

Evidence of the low failure rates achieved is given by operational data from the communications satellites. With only one part failure, these satellites have accumulated over 95-million-electronic-part hours. Using the minimum failure rates in MID-HDBK-217A (Table 12-IX, page 4-32), the expected part failures predicted would be 26.4, while the probability of only one failure would be less than 10^{-6}. A sharp decrease in part failures during major control item testing has been observed, indicating future reliability of parts will be higher than that of parts used on Syncoms 2 and 3, and Early Bird.

Parts Derating and Applications

In the parts count prediction, assumptions are often made about parts derating and temperature. During design of electronics, reliability can be enhanced and established by sufficient derating of voltage, power, or other stresses, and by providing environmental control of temperature and possibly of radiation and mechanical vibration. By extrapolation of MIL-HDBK-217 data, guideline curves for derating electronic parts are shown in Figure 4. The policy established for their use is shown in Table 4. This work was started and completed before MIL-HDBK-217A had been issued. The same extrapolation described in the following paragraphs can be carried out on the 217A handbook data.

Extrapolation of MIL-HDBK-217

The derating curves of Figure 4a through 4h show the electrical stress derating versus temperature necessary to achieve a given failure rate. These curves were derived by straightforward linear extrapolation of the MIL-HDBK-217 failure rate curves beyond the point of cutoff curvature. For simplicity, a straightline approximation is made that introduces slight deviation at the bottom of the curves. The format used to present the failure rate stress derating information is arranged to show a constant failure rate curve. These curves emphasize the importance of stress derating in improving reliability. They also simplify the selection of optimum ratio of electrical to temperature stress, depending on prevailing conditions. The relationship of failure rate for solid-state devices to temperature stress only, as presented in MIL-HDBK-217A and other recent publications, substantiates these derating policies. Failure rate values for digital transistors, switching, high voltage, and mixer diodes were assigned for each stress level curve based on operational results and published data.

When the failure rate derating curves of the handbook were linearly extrapolated (avoiding the cutoff curvature) to the lower levels of derating, as actually applied in the design of previous space systems, the figures

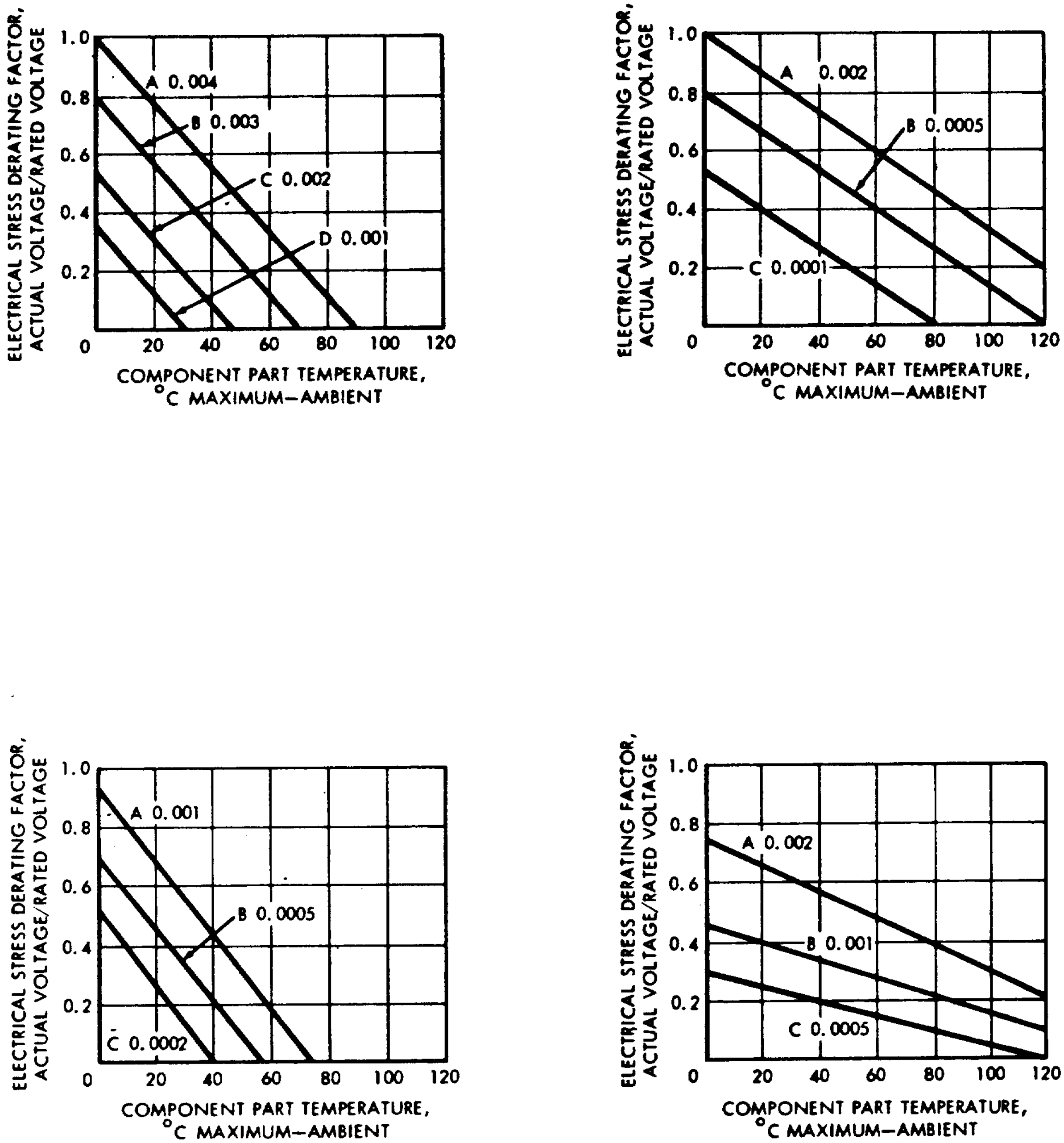

Figure 4. Derating Curves
Failure rate in failures per 10^5 hours

TAB 1–C

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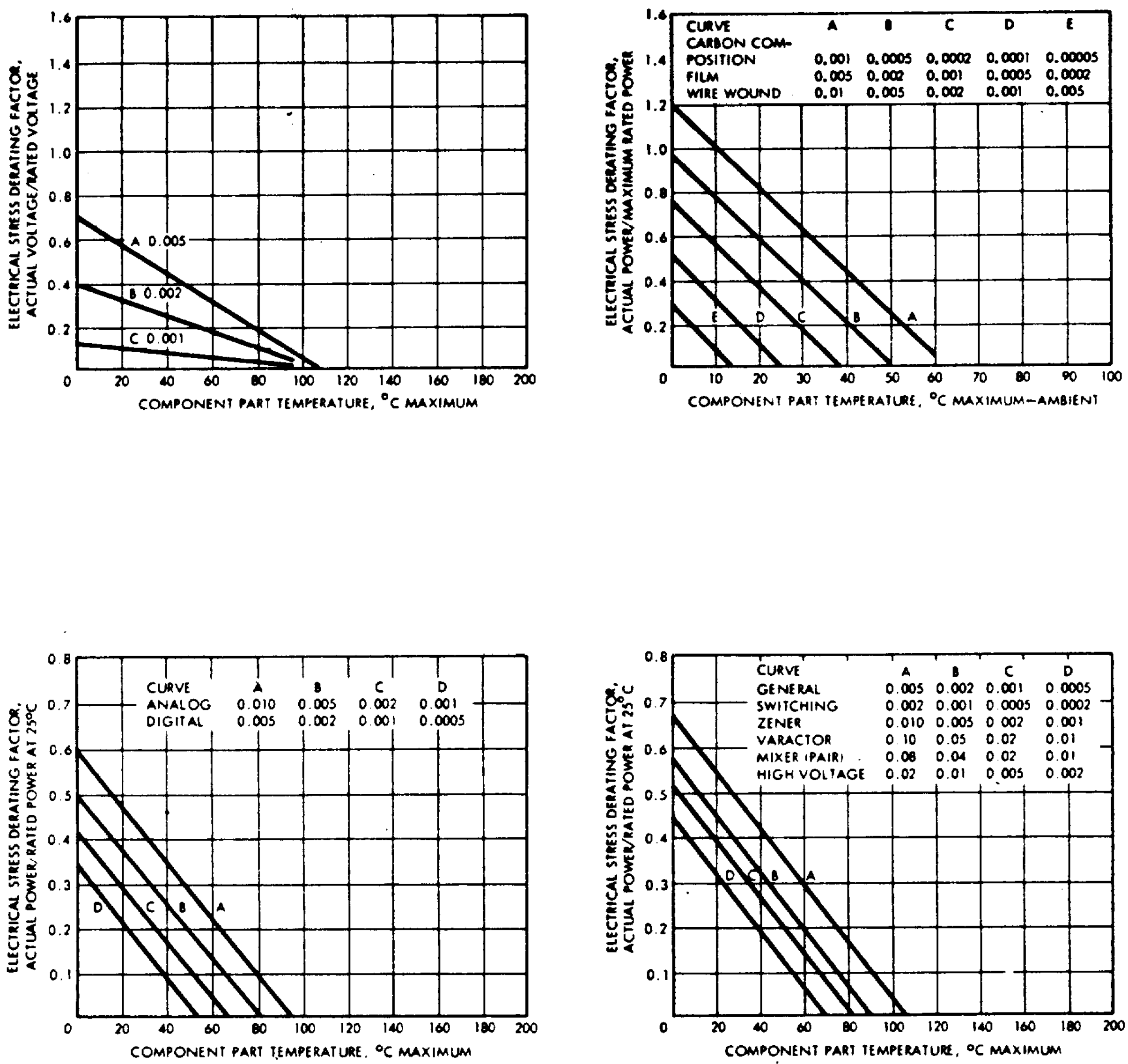

Figure 4 (continued). Derating Curves
Failure rate in failures per 10^5 hours

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TABLE 4. ELECTRONIC PARTS DERATING POLICY

Part Type	A* Recommended Stress Level for High Reliability Applications	B** Tolerable Stress Level in Isolated Cases	C*** Overstressed - Approval of Application Requirement
Capacitors			
Tantalum	Below curve B	-	Above curve B
All others	Below curve C	To curve B	Above curve B
Resistors			
All types	Below curve D	To curve C	Above curve C
Diodes	Below curve D	To curve C	Above curve C
Silicon	30-percent rated voltage	To 50-percent rated breakdown voltage	50-percent rated breakdown voltage
Transistors	Below curve D	To curve C	Above curve C
Silicon	30-percent rated voltage	To 50-percent rated breakdown voltage	50-percent rated breakdown voltage

*Most parts should be derated to this level.
**To be used only when Level A imposes unrealistic requirements.
***Justification of this deviation must be addressed to the Program Product Effectiveness Manager prior to design review.

showed agreement with the operational data accumulated to date. The resulting failure rates were used for system reliability predictions, and the corresponding stress levels were used to establish the derating policy for the spacecraft design outlined in Table 4.

[redacted]

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Using the knowledge gained from the communications satellite operational analysis and optimum derating data from the extrapolated curves, Table 5 shows the failure rates for synchronous satellite application. This data is indicative of part failure rates in synchronous satellite application that are possible under optimized conditions.

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TABLE 5. FAILURE RATES FOR SYNCHRONOUS SATELLITES USING OPTIMUM DERATING

Parts	In Failures per 10^5 Hours
Capacitors	
Ceramic	0.0001
Glass	0.0002
Paper	0.0005
Mylar	0.0010
Tantalum	0.0030
Connectors	
Coax	0.0002
Multipin	0.0020
Crystals	0.0040
Crystal filters	0.0050
Diodes	
General purpose	0.0005
Mixer (pair)	0.0100
Switching	0.0002
Varactor	0.0100
Zener	0.0010
High voltage	0.0020
Ferrite devices	0.0200
Coils, chokes, and inductors	0.0014
Transformers	0.0028
Resistors	
Carbon components	0.0001
Film	0.0005
Wirewound	0.0010
Transistors	
Analog	0.0010
Digital	0.0005
Tunable cavities	0.0020
Traveling-wave tubes	0.1280
Sensistors	0.0020
Solder or weld connection (assume 2.2 connections per part)	0.00002
Integrated circuits	0.1 times the failure rate of the equivalent discrete circuit. (Quoted manufacturer's failure rate may be used if available.)

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TAB I-D

Addendum No.
to MIL-D-18243A(AS)

STANDARD PRODUCTION MONITORING TEST PLAN

PRODUCTION MONITORING REQUIREMENTS

FOR

AIR-LAUNCHED GUIDED MISSILE SYSTEM

Approved:____________

Date:____________

[redacted] UNCLASSIFIED

TAB I-D

UNCLASSIFIED [redacted]

Addendum No.
to MIL-D-18243A(AS)

PRODUCTION MISSILE TEST PROGRAM
FOR
AIR-LAUNCHED GUIDED MISSILE SYSTEM

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Addendum No.
to MIL-D-18243A(AS)

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PRODUCTION MISSILE TEST PROGRAM
FOR
AIR-LAUNCHED GUIDED MISSILE SYSTEM

1. SCOPE, CLASSIFICATION AND PURPOSE

1.1 SCOPE. - This addendum covers the requirements of the Naval Air Systems Command for the production missile test program of the Air-Launched Guided Missile. This addendum is complete within itself. No reference to Specification MIL-D-18243(Aer) is necessary for the interpretation of the requirements contained herein.

1.2 CLASSIFICATION. - The production missile test program consists of tests specified herein utilizing approved service type support and test equipment and service configured aircraft.

1.3 PURPOSE. - The purpose of the production missile test program is to determine whether or not the producer is meeting:

(a) The missile system performance requirements of____ Specifications__________.

(b) The missile performance and reliability requirements of ____ Specification__________.

(c) The missile motor performance requirements of____ Specification__________.

(d) The missile warhead performance requirements of ____ Specification __________.

(e) The missile safety-arming device performance requirements of Specification__________.

2. APPLICABLE SPECIFICATION, OTHER PUBLICATIONS AND DRAWINGS. -

The following documents are applicable to the extent specified herein. (List)

3. REQUIREMENTS. -

3.1 GENERAL

3.1.1 DEVIATIONS. - Deviations from this addendum shall not be permitted except by written authorization from the NAVAIRSYSCOM or as specifically stated herein. When deviations are needed, the deviations shall be requested from the NAVAIRSYSCOM for each production missile test at least 15 days prior to the scheduled test. Deviations shall not affect the missile configuration, and handling and test procedures, and shall not introduce any delay factor that may prevent the missiles being launched within the specified time. When installing telemetering, provisions for telemetering which are a part of the basic missile configuration as delivered shall be utilized.

3.1.2 RESPONSIBILITY. - The production missile test program will be conducted by the NAVMISCEN, hereafter called the testing activity, and shall be observed by the producer.

3.1.2.1 PRODUCER RESPONSIBILITY. - The production missile test program shall be conducted under the technical observation (see paragraph 6.1.10) of the producer. At the earliest practicable date the testing activity is to notify the producer when the unpacking is expected to start in order that the producer shall provide personnel to be present to observe the unpacking and operational and flight tests of all missiles to be tested. The producer shall observe all tests performed by the testing activity and shall indicate by concurrence or nonconcurrence that each equipment has or has not been checked out in accordance with the applicable handbooks (see 6.1.6). When the producer does not concur that the missile, the missile installation, the aircraft equipment and test equipment were checked out in accordance with applicable handbooks or instructions, the producer shall inform the NAVAIRSYSCOM in writing and in detail wherein any of these were not checked out properly. The producer shall be responsible for the furnishing of one set of missile equipment schematic drawings to the testing activity, which completely and accurately reflects the configuration of each production lot.

3.1.2.2 GOVERNMENT. - The testing activity will exercise technical direction (see 6.1.2) and technical control (see 6.1.1) of the production missile test program. The Government will furnish and utilize the specified complement of test equipment for this missile as well as equipment peculiar to the requirements of production missile testing.

3.1.3 LOCATION OF PRODUCTION MISSILE TESTING. - Production missile testing will be normally conducted at the Naval Missile Center, Point Mugu, California.

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3.1.4 WEIGHT AND BALANCE. - The actual weight and center of gravity locations encountered in operation of the guided missiles shall be simulated. This may be accomplished by installation of actual equipment or by substitution of ballast such that weight, center of gravity, and moment of inertia characteristics (where of importance to the test concerned) of the missiles are simulated.

3.1.5 HANDLING PROCEDURE. - The production test missiles, specified in 4.1.1, shall be handled in accordance with the handling requirement of applicable handbooks (see 6.1.6). This paragraph (3.1.5) is intended to cover packaging, transporting, storage, preparing, assembling, and loading of the missile.

3.1.6 RETEST. - Missiles which fail to pass checkout equipment tests may be given one retest to establish that the missile (not the test equipment) was at fault. If the test then indicates that the missile is satisfactory the previous test shall be indicated as satisfactory and so scored.

3.2 GROUND AND PRELAUNCH TESTS

3.2.1 RECEIVING INSPECTION. - Each missile received as an assembled round shall be unpacked and subjected to disassembly into major component sections in accordance with the applicable handbook (see 6.1.6). In the disassembly process, the missile sub-assemblies and major component sections shall be visually inspected and tested in accordance with the following paragraphs of applicable NAVORD QAP:

Item	Paragraph (QAP-)
Unpacking inspection	
Assembled round inspection	
Guidance-control section/warhead mating inspection	
Warhead/rocket motor mating inspection	
Safety-arming device and electronic firing switch installation inspection	
Guidance-control accessory inspection	

Item	Paragraph (QAP-)
Guidance-control section inspection	
Safety-arming device inspection	
Electronic firing switch inspection	
Warhead inspection	
Rocket motor MK____Mods________inspection	
Rocket motor MK____ Mods________inspection	

Missiles found to contain defects of class "Critical" or "Major" as defined in appropriate QAP- shall be rejected from further testing and set aside for examination. Missiles which pass the receiving inspection test (i.e., have no defects of "Critical" or "Major" classification) shall be scored as satisfactory on the chart of figure 9, and shall then be given the "Depot Test." Missiles which fail the receiving inspection test shall be examined by the producer and the testing activity to establish the reason(s) for failure and action shall be taken as follows:

(1) MISSILE DEFECT. - If it is determined that a defect (of "Critical" or "Major" classification) was due to deficient producer assembly, inspection, test, or packaging, the missile shall be scored as unsatisfactory on the chart of figure 9.

(2) DAMAGE IN SHIPMENT OR HANDLING. - If it is determined that a defect was due to damage in shipment or handling beyond the control of the supplier, the defect shall be scored as "No Test" and the missile not scored as unsatisfactory for that defect on the chart of figure 9. Missiles which contain "Critical" or "Major" defects due to damage in shipment or transportation handling shall not be utilized in subsequent testing; such missiles will be replaced by other missiles.

3.2.2 DEPOT TEST. - Missile guidance-control sections which pass the Depot Test step shall be scored as satisfactory on the chart of figure 1. Missile guidance-control sections which fail the Depot Test shall be scored as unsatisfactory on figure 1. One retest will be allowed to establish that the missile (and not the test equipment) was at fault. Missiles which fail this test shall be examined by the testing activity (with producer observing), to establish the reason(s) for failure.

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3.2.3 TELEMETERING INSTALLATION. - Telemetering equipment shall be installed subsequent to the Depot Test on required missiles, by the testing activity, in accordance with applicable procedures and instructions. Complete telemetering installations shall be calibrated in accordance with applicable procedures and instructions.

3.2.4 REPEATED DEPOT TEST. - Following the installation or removal of telemetering equipment, each missile guidance-control section shall be given a repeated depot test in accordance with the applicable handbook (see 6.1.6). Each missile which passes this test shall be scored as satisfactory on the chart of figure 1. Missile guidance-control sections which fail this test shall be examined by the testing activity (with producer observing) to establish the reason(s) for failure and action shall be taken as follows:

(1) MISSILE FAILURE. - If it is determined that the failure was due to a guidance-control section malfunction and not a result of installing telemetering, the missile shall be scored as unsatisfactory on the chart of figure 1. If it is determined that the failure was due to installation of telemetering, the missile shall be scored as "No Test" and omitted from the scoring chart.

(2) TELEMETERING FAILURE. - If it is determined that the failure is due to the telemetering equipment, the telemetering shall be repaired and recalibrated, or replaced, and the missile shall receive another repeated Depot Test in accordance with the applicable handbook.

3.2.5 MISSILE ASSEMBLY. - Guidance-control sections which have telemetering installed and have successfully passed the repeated Depot Test shall be mated to selected rocket motors and safety-arming devices for the free-flight configuration.

3.2.6 PRELAUNCH TEST. - Missiles which have successfully passed assembly tests and have been installed on an aircraft and carried aloft and energized, shall be considered to be in the prelaunch test step of the test sequence until an attempt is made to launch the missile, or the missile is off loaded or is jettisoned. Each missile selected for flight test shall be subjected to at least one prelaunch test, of at least 30 minutes energized time duration, followed by aircraft landing, prior to the airborne test in which launching is attempted. This test shall not be conducted so as to specifically avoid exposure to any of the captive flight environments within the requirements of________ of Specification________. This paragraph shall not limit the missile to one airborne flight prior to the launching attempt.

3.2.6.1 READY LIGHT OBTAINED. - Missiles installed on an aircraft, which are carried aloft and energized and which properly actuate the missile ready indication in the aircraft weapon system shall be considered to have successfully passed the prelaunch test step of the test sequence and shall be so scored on the chart of figure 2. Each test during which the missile properly actuates the missile ready indication in the aircraft weapon system shall be considered a successful prelaunch test even though no attempt is made to launch the missile.

3.2.6.2 READY LIGHT NOT OBTAINED. - Missiles which when installed on an aircraft do not properly actuate the missile ready indication shall be examined by the testing activity (and observed by the producer) to establish the reason(s) for failure and action shall be taken as follows:

(1) MISSILE FAILURE. - If it is determined that the failure was due to a missile guidance-control section malfunction the missile shall be scored as unsatisfactory on the chart of figure 2.

(2) OTHER EQUIPMENT FAILURE. - If it is determined that the failure was due to failure of aircraft equipments or to causes other than a missile malfunction, the missile prelaunch test shall be scored as "No Test" and omitted from the scoring chart, and the missile continued in the test program.

3.2.6.3 NO ATTEMPT TO LAUNCH. - Missiles which when carried aloft and which actuate the missile ready indication in the aircraft weapon system but on which launch is not attempted, shall be continued in the launching program provided that telemetry data indicates no failure of the missile. Both the testing activity and the producer shall examine the telemetry data on missiles in the prelaunch test. When launch is not attempted and the telemetry data indicates that a missile failure has occurred which was not indicated by either the missile ready indication then action shall be taken as follows:

(1) MISSILE FAILURE. - If it is determined and confirmed by ground examination, that the failure was due to a missile guidance-control section malfunction the missile shall be removed from the launching program and shall be scored as unsatisfactory on the charts of figures 3 and 4 as a free-flight failure.

(2) OTHER EQUIPMENT FAILURE. - If it is determined that the failure was due to failure of aircraft equipment, missile telemetering, or to causes other than a missile malfunction, the missile shall be continued in the launching program, upon correction of the problem,

provided that internal disassembly of the guidance-control section has not occurred.

3.3 FREE-FLIGHT TESTS

3.3.1 ATTEMPT TO LAUNCH. - The Free-Flight test step of the test sequence shall commence when the pilot has obtained the correct indications selecting and readying the missile and has attempted to launch the missile by depressing the missile trigger switch.

3.3.1.1 LAUNCHED

3.3.1.1.1 SUCCESSFUL GUIDANCE-CONTROL SECTION. - Those missile guidance-control sections which, when launched, meet the performance requirements in both guidance and fuzing signal specified for the specific flight test in the flight test plan, shall be scored as satisfactory on the chart of figure 3. In addition, those missiles which meet the guidance performance requirements specified in the flight test plan shall be scored as satisfactory on the chart of figure 4, and those missiles which meet the guidance and fuzing performance requirements specified in the flight test plan shall be scored as satisfactory on the chart of figure 5.

3.3.1.1.2 UNSUCCESSFUL GUIDANCE-CONTROL SECTION. -

(a) Due to guidance-control section - Those missiles which, when launched, fail to meet the performance requirement specified in flight test plan, Appendix and the failure is due to malfunction in other than GFE components of the missile guidance-control section as indicated by telemetry data, shall be scored as unsatisfactory on the chart of figure 3. When the failure is due to guidance performance it shall also be scored as unsatisfactory on figure 4. When the failure is due to fuzing performance it shall also be scored as unsatisfactory on figure 5.

(b) Due to other causes - Those missile guidance-control sections which, when launched, fail to meet the performance requirements specified in the Flight Test Plan and the failure is due to malfunction in GFE components of the missile, shall be scored as "No Test." Additional missiles may be launched.

(c) No Agreement - If no agreement is reached between the producer and the testing activity on the assignment of the cause of the failure, the matter shall be referred to the NAVAIRSYSCOM for resolution.

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3.3.1.1.3 SUCCESSFUL MOTOR PERFORMANCE. - Those missiles which, when launched, indicate that the missile motor has met the performance requirements of ________ Specification ________ shall be scored satisfactory on the chart of figure 7.

3.3.1.1.4 UNSUCCESSFUL MOTOR PERFORMANCE. -

(a) Due to motor - Those missiles which, when launched, indicate by telemetry data that the missile motor has failed to meet the performance requirements of ________ Specification ________ shall be scored as unsatisfactory on the chart of figure 7.

(b) Due to other causes - Those missiles which, when launched, indicate by telemetry data the missile motor performance has failed to meet the requirements of ________ Specification ________ and the failure is due to malfunction of components other than the motor, shall be scored as "No Test" and omitted from the scoring chart.

3.3.1.1.5 SUCCESSFUL SAFETY-ARMING DEVICE PERFORMANCE. - Those missiles which, when launched, indicate by telemetry data that the missile safety-arming device has met the performance requirements of Specification shall be scored as satisfactory on the chart of figure 9.

3.3.1.1.6 UNSUCCESSFUL SAFETY-ARMING DEVICE PERFORMANCE. -

(a) Due to safety-arming device - Those missiles which, when launched, indicate by telemetry data that the missile safety-arming device has failed to meet the performance requirements of Specification shall be scored as unsatisfactory on the chart of figure 9.

(b) Due to other causes - Those missiles which, when launched, indicate by telemetry data that the missile safety-arming device performance has failed to meet requirements of ________ Specification ________ and the failure is due to malfunction of components other than the safety-arming device, shall be scored as "No Test" and omitted from the scoring chart.

3.3.1.2 NOT LAUNCHED. - Missiles which are carried aloft but which fail to launch when so ordered shall be examined by the testing activity with the producer observing to establish the reason therefor. Action shall be taken as follows:

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(a) Due to missile - If it is determined by examination that the failure was due to a missile guidance-control section malfunction in other than GFE components, the missile shall be scored as unsatisfactory on the chart of figure 3 and figure 4.

(b) Due to other causes - If it is determined that the failure to launch resulted from causes other than missile guidance-control section malfunction, the test shall be considered "No Test" and omitted from the chart of figure 3 and figure 4. The missile shall be kept in the production missile test program provided that damage or internal disassembly of the guidance-section has not occurred; otherwise, another guidance-control section shall be used as a replacement.

(c) No Agreement - If no agreement is reached between the producer and the testing activity on the assignment of the cause of the failure, another missile shall be used as a replacement, and the matter shall be referred to the NAVAIRSYSCOM for resolution.

3.4 LAUNCHING CONDITIONS

3.4.1 LAUNCH AIRCRAFT. - Aircraft used for missile launch in the production missile test program shall utilize missile launching and control equipment functionally representative of that used in the Fleet. The testing activity shall check the launch aircraft and the producer shall observe the checking of this equipment in accordance with applicable handbooks and the producer shall accept the launching airplane installation. This check shall include a determination that weapons control system is operating within normal accuracy limits and shall include adjustments and/or servicing as necessary to assure such normal accuracy. No missiles shall be launched unless the aircraft and the aircraft installation have been accepted by both the testing activity and the producer within 24 hours prior to the flight. It shall be an objective to launch the missiles on the second carried flight.

3.4.2 INSTRUMENTATION. -

(1) Missile Telemetering - In accordance with Specifications and as required for the missile configuration (see 6.1.8).

(2) Launch Aircraft Instrumentation - Instrumentation necessary to measure AMCS performance is required as a minimum. Additional instrumentation to measure aircraft pilot, or fire control equipment functions may be installed in the aircraft when it is desired to gain additional system or missile data.

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3.4.3 TARGET. - The target description will be as specified in the applicable test plan prepared by the testing activity for the particular missile configuration under test.

3.4.4 FLIGHT TEST CONDITIONS. - The flight test conditions will be as specified in the applicable test plan for the missile configuration under test as prepared by the testing activity and approved by the NAVAIRSYSCOM.

3.4.5 ALLOCATION. - Launching aircraft and flight conditions shall be chosen in a random fashion from the flight test plan, so as to exercise the missile across the performance envelope while avoiding extreme or marginal performance regions.

3.4.6 MEASUREMENT AND ANALYSIS. - The testing activity shall monitor and record telemetered information from each attempted launch or launch. Information so recorded shall be analyzed by the producer and the testing activity following each flight; the results of such analysis shall be contained in the test reports and summarized in the reports required under 5.1 herein.

3.5 LABORATORY EVALUATION TESTS. - At least one sample of each production lot of guidance-control sections, motors, warheads and safety-arming devices shall be subjected to laboratory evaluation tests. conducted by the testing activity and which may be observed by the producer. Samples subjected to this test shall not be subsequently subjected to the ground and prelaunch tests of 3.3 or the free-flight tests of 3.4. Sample equipment performance in the laboratory evaluation tests shall be summarized by the testing activity and significant results documented in the final report of 5.1; and the results of these tests shall be included in the scoring requirements of 4.1.4. As a minimum test requirement of the guidance-control section, the testing activity shall perform (a) a disassembly inspection of the sample to determine its conformance with accepted quality standards of manufacture, and conformance to applicable drawings and documentation, and (b) tests of selected circuits to determine the extent of tolerance variations. In addition, when the flight tests of a lot have not included tests of the certain performance objectives, then a randomly selected guidance-control section of the lot, following the flight test series, shall be subjected to laboratory tests to observe operation of components which perform these functions.

When a missile deficiency is observed in any of these tests, the remaining samples of the lot shall be subjected to the test, in order to determine whether the observed deficiency is of a random or systematic nature. Results of laboratory tests conducted shall include information and analysis of random component failures encountered during the course of testing.

3.5.1 WARHEAD FIRING TEST. - One sample warhead of each production lot shall be subjected to a static firing test, utilizing a simulated safety-arming device, in a suitable arena. The test conditions shall be in accordance with Specification , and shall utilize a varying stabilization temperature from sample to sample. Assessment of warhead performance shall be as follows:

3.5.1.1 SUCCESSFUL WARHEAD PERFORMANCE. - Those warheads, which when subjected to the static firing test, indicate that the warhead has met the performance requirements of of Specification shall be scored as satisfactory on the chart of figure 11.

3.5.1.2 UNSUCCESSFUL WARHEAD PERFORMANCE. -

(a) Due to warhead - Those warheads which, when tested, fail to meet the performance requirements of of Specification , and it is determined that the failure was due to the warhead, shall be scored as unsatisfactory on the chart of figure 11.

(b) Due to other causes - Those warheads which, when tested, fail to demonstrate satisfactory performance of the warhead, and it is determined that the failure was due to other than the warhead, shall be scored as "No Test" and omitted from the scoring chart.

3.5.1.3 INSPECTION TO DOCUMENTATION. - One missile from each test sample which has passed the individual test shall be shipped to the NAVAIRSYSCOM Tech. Rep., Pomona for inspection to documentation. This missile shall conform to the applicable documentation to be accepted. Lot rejection may occur only for lack of conformity.

4. SAMPLING, INSPECTION, AND TEST PROCEDURES.

4.1 SELECTION. - All missile guidance-control sections, motors, warheads, and safety-arming devices selected for the production missile test program will be chosen by the cognizant Government representative from the production quantities accepted by the cognizant Government representative at the producer's plant. Samples will be selected at random in such a manner as to assure a fair representation of the production lot (see 4.1.2). Samples shall not be selected which have been subjected to environmental testing or any other special tests which would render the passed all previous tests, shall be installed on a compatible aircraft and taken aloft and given the prelaunch test. The aircraft launching equipment may be modified so as to provide the option of energizing the missile during the airborne period. Sufficient missile guidance-control sections shall be selected at random from the missiles which have successfully passed the Depot Test, for configuration with telemetering for the Free-Flight Test. Missiles subjected to the Free-Flight Test shall have successfully passed all previous tests.

4.1.3.4 CONFIGURATION OF FREE-FLIGHT TEST MISSILES. - The configuration of Free-Flight Test missiles shall consist of the missile guidance-control section, rocket motor, complete telemetry (6.1.8(a)) and safety-arming device.

4.1.3.5 LABORATORY EVALUATION TESTS. - Sample missile guidance-control sections, motors, warheads, and safety-arming devices remaining after the Free-Flight Tests shall be selected as required for the Laboratory Tests of 3.5.

4.1.4 SCORING

4.1.4.1 SCORING - ASSEMBLED ROUND QUALITY. - For appraisal of compliance with the assembly requirements of 3.1.4 (Specification for Assembled Round AIM-7E-2 Guided Missile), all missiles given receiving inspection tests shall be scored on figure 9.

4.1.4.2 SCORING - GUIDANCE-CONTROL SECTIONS. -

(a) Reliability - For appraisal of compliance with the reliability requirements of ________ of Specification ________, all Depot Tests, repeated Depot Tests, and Prelaunch Tests shall be scored on figures 1 & 2.

(b) Performance - For appraisal of compliance with the performance requirements of ________ of Specification ________, all missiles tested in the Free-Flight Tests (except those designated "No Test") shall be scored on figures 3, 4, and 5.

4.1.4.3 SCORING - MOTOR. -

(a) Inspection - For appraisal of compliance with the quality requirements of Specification ________, all motor inspection tests and assembly mating checks shall be scored on figure 6.

(b) Performance - For appraisal of compliance with the performance requirements of________of Specification__________, all motors tested in the Free-Flight Test (except those designated "No Test") shall be scored on figure 7.

4.1.4.4 SCORING - SAFETY-ARMING DEVICE. -

(a) Inspection - For appraisal of compliance with the quality requirements of Specification __________, all safety-arming device inspection tests and assembly mating checks shall be scored on figure 8.

(b) Performance - For appraisal of compliance with the performance requirements of Specification__________, all safety-arming devices tested in the Free-Flight Test (except those designated "No Test") shall be scored on figure 9.

4.1.4.5 SCORING - WARHEAD. -

(a) Inspection - For appraisal of compliance with the physical design requirements of________of Specification__________, all warhead inspection tests and assembly mating checks shall be scored on figure 10.

(b) Performance - For appraisal of compliance with the performance requirements of________of Specification__________, all warheads tested in warhead static firing tests of 3.5.1 (except those designated "No Test") shall be scored on figure 11.

4.1.5 MISSILE LAUNCHING. - Each missile selected for flight test shall be launched by the testing activity within 60 days from the date of acceptance of the last sample missile of the lot. Specific extensions of the 60-day firing requirement may be granted by the NAVAIRSYSCOM.

4.1.6 DELIVERY OF PRODUCTION TEST MISSILES. - Production test missiles shall be delivered as directed by the NAVAIRSYSCOM.

4.1.7 DISPOSITION. - The disposition of missile components not expended in flight tests, upon the completion of the test program, shall be as directed by the NAVAIRSYSCOM.

4.1.8 INSPECTION. - All samples selected shall have received individual tests as specified in the applicable design data addendum prior to delivery for production testing.

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4.2 SATISFACTORY PRODUCTION. - Production shall be considered satisfactory when the following criteria are satisfied.

4.2.1 PRODUCTION LOT CRITERIA - GUIDANCE-CONTROL SECTION. - Production lot acceptance criteria are as follows:

4.2.1.1 RECEIVING INSPECTION TEST. - No failures as defined in 3.2.1 as attributable to the missile are observed in the sample of 13 missiles subjected to receiving inspection test.

4.2.1.2 DEPOT AND PRELAUNCH TESTS. - No more than 2 failures as defined in 3.2 as attributable to the missile are observed in the 13 missiles subjected to test.

4.2.1.3 FREE-FLIGHT TEST. -

4.2.1.3.1 TEST CRITERIA. - Table I presents by stages, the number of missiles of each test sample which shall be subjected to the Free-Flight Test, and indicates the number of missile failures which are cause for rejection of the lot represented by the sample.

(a) In Stage I, if three missiles fail, testing shall cease, the lot shall be rejected.

(b) In Stage II, if the test sample exceeds the number of failures permitted in Table I, the lot represented by such test samples shall be suspended pending the outcome of the succeeding lot; should the succeeding lot be rejected the suspended lot shall also be rejected; should the succeeding lot be accepted, suspended lot shall also be accepted provided no general discernible cause of failure of the suspended lot has been disclosed.

(c) In Stage III, if the test sample exceeds the number of failures permitted in Table I, the lot represented by such test samples shall be suspended pending the outcome of the succeeding lot. Testing of the succeeding lot shall immediately revert to Stage II. Should the succeeding lot be rejected the suspended lot shall also be rejected. Should the succeeding lot be accepted, the suspended lot shall also be accepted provided no general discernible cause of failure of the suspended lot has been disclosed.

(d) In every case of lot suspension either in Stage II or Stage III an accept/reject decision must be made on the basis of testing the succeeding lot sample.

Table 1. Stages for Free-Flight Tests

Stage	Test Sample	Successes/Accept	Failures/Reject
I	8	6	3
II	5	4	2
III	2	2	2
	4	3	2

Stage I shall be used at the start of a contract, after a major design or model change, and when two successive lot samples fail to meet either the criteria for Stage II or Stage III acceptance.

Stage II shall be used after two successive test sample quantities have passed while in Stage I, and when the preceding test sample quantity fails to meet the criteria of Stage III acceptance. Once Free-Flight testing has advanced from Stage I to Stage II, or has reverted to Stage II from Stage III, testing shall remain in Stage II until two successive lot samples have either failed or passed.

Stage III shall be used after two successive test sample quantities have passed while in Stage II. Once free-flight testing has advanced from Stage II to Stage III, testing shall remain in Stage III until a lot sample fails to meet the acceptance criteria of Stage III; in which case the succeeding lot shall be tested in Stage II.

4.2.1.4 CUMULATIVE GUIDANCE-CONTROL SECTION PRODUCTION CRITERIA. - The cumulative results of tests, including both initial tests conducted on first submittal of lots and subsequent tests conducted after resubmittal, lie above the low limits shown in figures 1, 2, 3, 4, and 5, as calculated by 6.2.

4.2.2 PRODUCTION LOT CRITERIA - ROCKET MOTOR MK__MOD___.- Production lot acceptance criteria are as follows:

4.2.2.1 MOTOR INSPECTION AND ASSEMBLY MATING CHECKS. - No failures as defined in 3.2 as attributable to the rocket motor are observed in the rocket motors subjected to inspection and assembly mating checks.

4.2.2.2 MOTOR FREE-FLIGHT TEST. - No failures as defined in 3.3.1.1.4 as attributable to the rocket motor are observed in the rocket motors subjected to free-flight test.

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4.2.2.3 CUMULATIVE ROCKET MOTOR PRODUCTION CRITERIA. - The cumulative results of tests, including both initial tests conducted on first submittal of lots and subsequent tests conducted after resubmittal, lie above the low limits shown in figures 6 and 7.

4.2.3 PRODUCTION LOT CRITERIA - SAFETY-ARMING DEVICE. - Production lot acceptance criteria are as follows:

4.2.3.1 SAFETY-ARMING DEVICE INSPECTION AND ASSEMBLY MATING CHECKS. - No failures as defined in 3.2 as attributable to the safety-arming device are observed in safety-arming devices subjected to inspection and assembly mating checks.

4.2.3.2 SAFETY-ARMING DEVICE FREE-FLIGHT TEST. - No failures as defined in 3.3.1.1.6 as attributable to the safety-arming device are observed in the safety-arming devices subjected to Free-Flight Test.

4.2.3.3 CUMULATIVE SAFETY-ARMING DEVICE PRODUCTION CRITERIA. - The cumulative results of tests, including both initial tests conducted on first submittal of lots and subsequent tests conducted after resubmittal, lie above the low limits shown in figures 8 and 9.

4.2.4 PRODUCTION LOT CRITERIA - WARHEAD. - Production lot acceptance criteria are as follows:

4.2.4.1 WARHEAD INSPECTION AND ASSEMBLY MATING CHECKS. - No failures as defined in 3.2 as attributable to the warhead are observed in the warheads subjected to inspection and assembly mating checks.

4.2.4.2 WARHEAD FIRING TEST. - No failures as defined in 3.5.1 as attributable to the warhead are observed in the warheads subjected to the static firing test.

4.2.4.3 CUMULATIVE WARHEAD PRODUCTION CRITERIA. - The cumulative results of tests, including both initial tests conducted on first submittal of lots and subsequent tests conducted after resubmittal, lie above the low limits shown in figures 10 and 11.

4.3 CESSATION OF FLIGHT TESTS

4.3.1 CESSATION OF GUIDANCE-CONTROL SECTION TESTS. - Flight tests of a guidance-control section lot shall be terminated when one of the following conditions have occurred: (list)

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4.3.2 CESSATION OF ROCKET MOTOR TESTS. - Flight tests of a rocket motor production lot shall be terminated when one failure (3.3.1.1.4) is observed in a sample motor of the production lot in the Free-Flight Test; flight tests of a rocket motor production lot may be terminated when one failure is observed in inspection and assembly mating checks and, in the judgment of the testing activity, such cessation action is warranted. Cessation of tests in a rocket motor production lot shall not cause cessation of flight tests of the missile when other rocket motor production lots are available and may be used.

4.3.3 CESSATION OF SAFETY-ARMING DEVICE TESTS. - Flight tests of a safety-arming device production lot shall be terminated when one failure (3.3.1.1.6) is observed in a sample device of the production lot in the free-flight test; flight tests of a safety-arming device production lot may be terminated when one failure is observed in inspection and assembly mating checks and, in the judgment of the testing activity, such cessation action is warranted. Cessation of tests in a safety-arming device production lot shall not cause cessation of flight tests of the missile when other safety-arming device production lots are available and may be used, or when the device is not required for specific flight tests of other missile components.

4.4 UNSATISFACTORY PRODUCTION

4.4.1 UNSATISFACTORY PRODUCTION - GUIDANCE-CONTROL SECTION. - Production shall be considered unsatisfactory when one or more of the conditions of 4.2.1 are not satisfied.

4.4.2 UNSATISFACTORY PRODUCTION - ROCKET MOTOR. - Production shall be considered unsatisfactory when one or more of the conditions of 4.2.2 are not satisfied.

4.4.3 UNSATISFACTORY PRODUCTION - SAFETY-ARMING DEVICE. - Production shall be considered unsatisfactory when one or more of the conditions of 4.2.3 are not satisfied.

4.4.4 UNSATISFACTORY PRODUCTION - WARHEAD. - Production shall be considered unsatisfactory when one or more of the conditions of 4.2.4 are not satisfied.

4.5 ACTION IN THE EVENT OF UNSATISFACTORY PRODUCTION. - The action to be taken in the event of unsatisfactory production shall be as follows:

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4.5.1 FAILURE OF A MISSILE LOT SAMPLE TO SATISFY CRITERIA

4.5.1.1 RECEIVING INSPECTION. - If a lot fails to satisfy the criteria of 4.2.1.4, each failed missile shall be examined by the testing activity and the producer to establish the reason for failure. Lots, and samples which fail due to established defects in material, workmanship, or other non-conformance to the requirements of the assembled-round contract shall be returned to the contractor for correction in accordance with the guaranty provisions of the contract. Upon reacceptance by the cognizant Government inspector, another sample of 13 missiles shall be selected at random from the lot and tested as provided in 4.1.3.

4.5.1.2 DEPOT AND PRELAUNCH. - If a lot fails to satisfy the criteria of 4.2.1.1, each failed guidance-control section shall be examined by the testing activity and the producer to establish the reason(s) for failure. Lots, and samples which fail due to established defects in material, workmanship, or other non-conformance to the requirements of the contract shall be returned to the producer for correction in accordance with the guarantee provisions of the contract. Upon reacceptance by the cognizant Government inspector, another sample of 13 missiles shall be selected at random from the lot and tested as provided in 4.1.3; new sample being selected at random so as not to exclude the missiles in the previous sample.

4.5.1.3 FREE-FLIGHT. - If a lot, or several lots collectively, fail to satisfy the criteria of 4.2.1.3, the producer and the testing activity shall investigate the possible causes of failure. Acceptance of guidance-control sections at the producer's plant may be suspended pending investigation of the problems and an agreed on course of corrective action between the producer and the NAVAIRSYSCOM. When it is concluded that the indicated failure of the lot or lots was due to the guidance-control section, the lot or lots shall be returned to the producer for correction in accordance with the guarantee provisions of the contract. Upon reacceptance by the cognizant Government inspector, another sample shall be selected from the lot and tested as provided in 4.1.3.

4.5.1.4 CUMULATIVE PRODUCTION CRITERIA. - If the cumulative results of tests plotted or calculated in accordance with 4.2.1.3 fall below the lower limits and thus in the rejection area, acceptance of guidance-control sections at the producer's plant may be suspended pending investigation of the problems and an agreed on course of corrective action between the producer and the NAVAIRSYSCOM. The NAVAIRSYSCOM reserves the right of determination of the final course of action including the resumption of acceptance.

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to MIL-D-18243A(AS)

4.5.2 FAILURE OF ROCKET MOTOR LOT SAMPLE TO SATISFY CRITERIA

4.5.2.1 ROCKET MOTOR INSPECTION AND ASSEMBLY MATING TESTS. - If a lot fails to satisfy the criteria of 4.2.2.1, and additional sample of 20 motors of the production lot shall be selected and examined by the testing activity and the producer to establish whether additional reason(s) for failure exist. Lots, and samples which fail due to established defects in material, workmanship, or other non-conformance to the requirements of the contract shall be returned to the producer for correction in accordance with the guarantee provisions of the contract. Upon reacceptance by the cognizant Government inspector, another sample of six rocket motors shall be selected at random from the lot and tested as provided in 4.1.3; new sample being selected at random so as not to exclude the motors in the previous sample.

4.5.2.2 ROCKET MOTOR FREE-FLIGHT TESTS. - If a lot fails to satisfy the criteria of 4.2.2.2, an additional sample of four rocket motors shall be selected and subjected to instrumented restrained firing tests. The producer and the testing activity shall analyze the test data and shall investigate the possible causes of failure. Acceptance of rocket motors at the producer's plant may be suspended pending investigation of the problems and an agreed on course of corrective action between the producer and the NAVAIRSYSCOM. When it is concluded that the indicated failure of the lot was due to the motor, the lot shall be returned to the producer for correction in accordance with the guarantee provisions of the contract. Upon reacceptance by the cognizant Government inspector, another sample shall be selected from the lot and tested as provided in 4.1.3.

4.5.2.3 ROCKET MOTOR CUMULATIVE PRODUCTION CRITERIA. - If the cumulative results of motor tests plotted or calculated in accordance with 4.2.2.3 fall below the lower limits and thus in the rejection area, acceptance of rocket motors at the producer's plant may be suspended pending investigation of the problems and an agreed on course of corrective action between the producer and the NAVAIRSYSCOM. The NAVAIRSYSCOM reserves the right of determination of the final course of action including the resumption of acceptance.

4.5.3 FAILURE OF SAFETY-ARMING DEVICE LOT SAMPLE TO SATISFY CRITERIA

4.5.3.1 SAFETY-ARMING DEVICE INSPECTION AND ASSEMBLY MATING TESTS. - If a lot fails to satisfy the criteria of 4.2.3.1, an additional sample of 20 safety-arming devices shall be selected and examined by the testing activity and the producer to establish whether additional reason(s) for failure exist. Lots and samples which fail due to established defects in material, workmanship or other non-conformance to the requirements of the contract shall be returned to the producer for correction in accordance with the guarantee provisions of the contract. Upon reacceptance by the cognizant Government inspector, another sample of six safety-arming devices shall be selected at random from the lot and tested as provided in 4.1.3; new sample being selected at random so as not to exclude the devices in the previous sample.

4.5.3.2 SAFETY-ARMING DEVICE FREE-FLIGHT TESTS. - If a lot fails to satisfy the criteria of 4.2.3.2, an additional sample of four safety-arming devices shall be subjected to instrumented simulated flight operation at the testing activity environmental test facility. The producer and the testing activity shall analyze the test data and shall investigate the possible causes of failure. Acceptance of safety-arming devices at the producer's plant may be suspended pending investigation of the problems and an agreed on course of corrective action between the producer and the NAVAIRSYSCOM. When it is concluded that the indicated failure of the lot was due to the safety-arming device, the lot shall be returned to the contractor for correction in accordance with the guarantee provisions of the contract. Upon reacceptance by the cognizant Government inspector, another sample shall be selected from the lot and tested as provided in 4.1.3.

4.5.3.3 SAFETY-ARMING DEVICE CUMULATIVE PRODUCTION CRITERIA. - If the cumulative results of safety-arming device tests plotted or calculated in accordance with 4.2.3.3 fall below the lower limits and thus in the rejection area, acceptance of safety-arming devices at the producer's plant may be suspended pending investigation of the problem and an agreed on course of corrective action between the producer and the NAVAIRSYSCOM. The NAVAIRSYSCOM reserves the right of determination of the final course of action including the resumption of acceptance.

4.5.4 FAILURE OF WARHEAD LOT SAMPLE TO SATISFY CRITERIA

4.5.4.1 WARHEAD INSPECTION AND ASSEMBLY MATING TESTS. - If a lot fails to satisfy the criteria of 4.2.4.1, an additional sample of 20 warheads shall be selected and examined by the testing activity and the producer to establish whether additional reason(s) for failure exist. Lots, and samples which fail due to established defects in material, workmanship or other non-conformance to the requirements of the contract shall be returned to the producer for correction in accordance with the guarantee provisions of the contract. Upon reacceptance by the cognizant Government inspector, another sample of six warheads shall be selected at random from

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the lot and tested as provided in 4.1.3; new sample being selected at random so as not to exclude the warheads in the previous sample.

4.5.4.2 WARHEAD FIRING TESTS. - If a lot fails to satisfy the criteria of 4.2.4.2, an additional sample of four warheads shall be subjected to the static firing test of 3.5.1. The producer and the testing activity shall analyze the test data and shall investigate the possible causes of failure. Acceptance of warheads at the producer's plant may be suspended pending investigation of the problems and an agreed on course of corrective action between the producer and the NAVAIRSYSCOM. When it is concluded that the indicated failure of the lot was due to the warhead, the lot shall be returned to the producer for correction in accordance with the guarantee provisions of the contract. Upon reacceptance by the cognizant Government inspector, another sample shall be selected from the lot and tested as provided in 4.1.3.

4.5.4.3 WARHEAD CUMULATIVE PRODUCTION CRITERIA. - If the cumulative results of warhead tests plotted or calculated in accordance with 4.2.4.3 fall below the lower limits and thus in the rejection area, acceptance of warheads at the producer's plant may be suspended pending investigation of the problems and an agreed on course of corrective action between the producer and the NAVAIRSYSCOM. The NAVAIRSYSCOM reserves the right of determination of the final course of action including the resumption of acceptance.

5. REPORTS

5.1 TEST REPORTS. - Within 24 hours after completing all Depot and Prelaunch Tests of a lot sample, and after each launching the testing activity shall submit a preliminary report of the results to the NAVAIRSYSCOM. The testing activity shall furnish the producer(s) with the conclusions contained in the preliminary report. Within eight working days following the completion of the lot test the testing activity shall submit five copies of the final report to the NAVAIRSYSCOM (Attn: AIR-5108C) and one copy of this final report to the producer(s). If the producer does not concur with the testing activity final report, he shall, within one working day of receipt of such reports, inform the NAVAIRSYSCOM, (AIR-5108C) directly with reasons therefor. The producer shall simultaneously send a copy of this non-concurrence to the testing activity.

6. NOTES

6.1 DEFINITIONS. - Definitions and interpretations of terminology used herein are as follows:

6.1.1 TECHNICAL CONTROL. - Technical control is defined as the specialized or professional guidance and direction exercised by an authority of the Naval Establishment in technical matters. Included in technical control is the authority to conduct, alter, or stop tests authorized by the NAVAIRSYSCOM according to the dictates of safety, interference to other projects, compliance with contractual specifications, or undue expenditures of Government funds or property.

6.1.2 TECHNICAL DIRECTION. - Technical direction is defined as including the formulation of general test programs and detail test plans, the preparation of articles to be tested, the prosecution of article tests, the evaluation of test data, the reporting of test results, and the orientation of the test program and plans based on these data.

6.1.3 NAVAIRSYSCOM. - Any reference to the "NAVAIRSYSCOM" herein shall mean the Naval Air Systems Command, Department of the Navy, Washington, D. C.

6.1.4 OBSERVERS. - Qualified personnel, that will closely follow the progress of the missile through test and flight evaluation.

6.1.5 PRODUCER. - The producer is the contractor or rework activity responsible for manufacture, repair, refurbishment, assembly, and test of air-launched missiles.

6.1.5.1 CONTRACTOR. - Reference to contractor herein shall mean the contractor(s) of the guidance-control section, rocket motor, safety-arming device or warhead, as applicable.

6.1.5.2 REWORK ACTIVITY. -

6.1.6 APPLICABLE HANDBOOKS. - Any reference to applicable handbooks herein shall mean those publications promulgated by the NAVAIRSYSCOM for the adjustment, test, assembly, and handling of the equipments involved. When available publications do not completely reflect current equipment, modified test procedures may be used subject to concurrence between the testing activity and the contractor.

6.1.7 DEPOT TEST. - As used herein the term Depot Test shall mean those tests normally performed on missiles received at the Naval Weapons Stations, in accordance with the Handbook of Operational Checkout Instructions Using Test Set AN/DPM, NAVWEPS __________.

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6.1.8 TELEMETERING. - For information, telemetry as used herein, consists of:

(a) (Complete Telemetry) Transmitter Group, Telemetric Data _________, in accordance with Specification _________, and Transmitter Group, Telemetric Data ________, in accordance with Specification

(b) (Video Telemetry) Transmitter Group, Telemetric Data __________, in accordance with Specification _________.

6.1.9 INSTRUMENTATION. - A photon scoring system, utilizing a gamma ray emissive element installed in the missile and a sensing system installed in the target, may be used for measurement of missile to target miss distance.

6.1.10 TECHNICAL OBSERVATION. - Technical observation is defined as including observation of the following: (1) formulation of general test programs and detail test plans; (2) the preparation of articles to be tested; (3) the prosecution of article tests; (4) the evaluation of test data; (5) the report of test results; and (6) the reorientation of the test program.

6.1.11 PRELAUNCH TEST. - Missiles shall be considered to be in a prelaunch status when: (1) they have successfully passed Depot Tests, (2) have successfully passed complete missile assembly checks, and (3) have been mounted on the launchers, taken aloft and powered.

6.1.12 FREE-FLIGHT TEST. - Missiles shall be considered to be in Free-Flight Test status when they have successfully passed Depot and Prelaunch Tests, and the pilot attempts to launch, or launches the missile.

6.1.13 AMCS. -

6.2 ASSUMPTIONS. -

(a) The curves shown in figures 1 through 11 illustrate the 2.0 sigma limit (lower 95 percent confidence limit) of the basic reliability line. Figures 1 through 11 may be constructed to include the scoring of all missile tests in a test program, in the following manner:

Sigma is computed by assuming that the Binominal distribution is applicable and thus using the formula

$$= n\ p\ q$$

in which n = the cumulative number of tests

p = the specified probability of success

q = 1 - p

Sample computation:

In figure 1, the specified reliability of 95 percent at n = 20 tests, produces a cumulative success number of 19.

Now = n p q, in which n = 20, p = .95 and q = .05

So = 0.95 = 0.9746 . . . (approximately).

then 2.0 = 1.949 . . . (approximately).

So the limit line is at

19 - 1.949 = 17.051 (approximately),
successful missiles in 20 tests.

(b) The upper curves shown in figures 4 and 5 illustrate the 1 sigma limit (upper 68 percent confidence limit) of reliability lines designated as performance targets. The upper curves of figures 4 and 5 may be utilized for award of incentive fees, as provided for in the production contract.

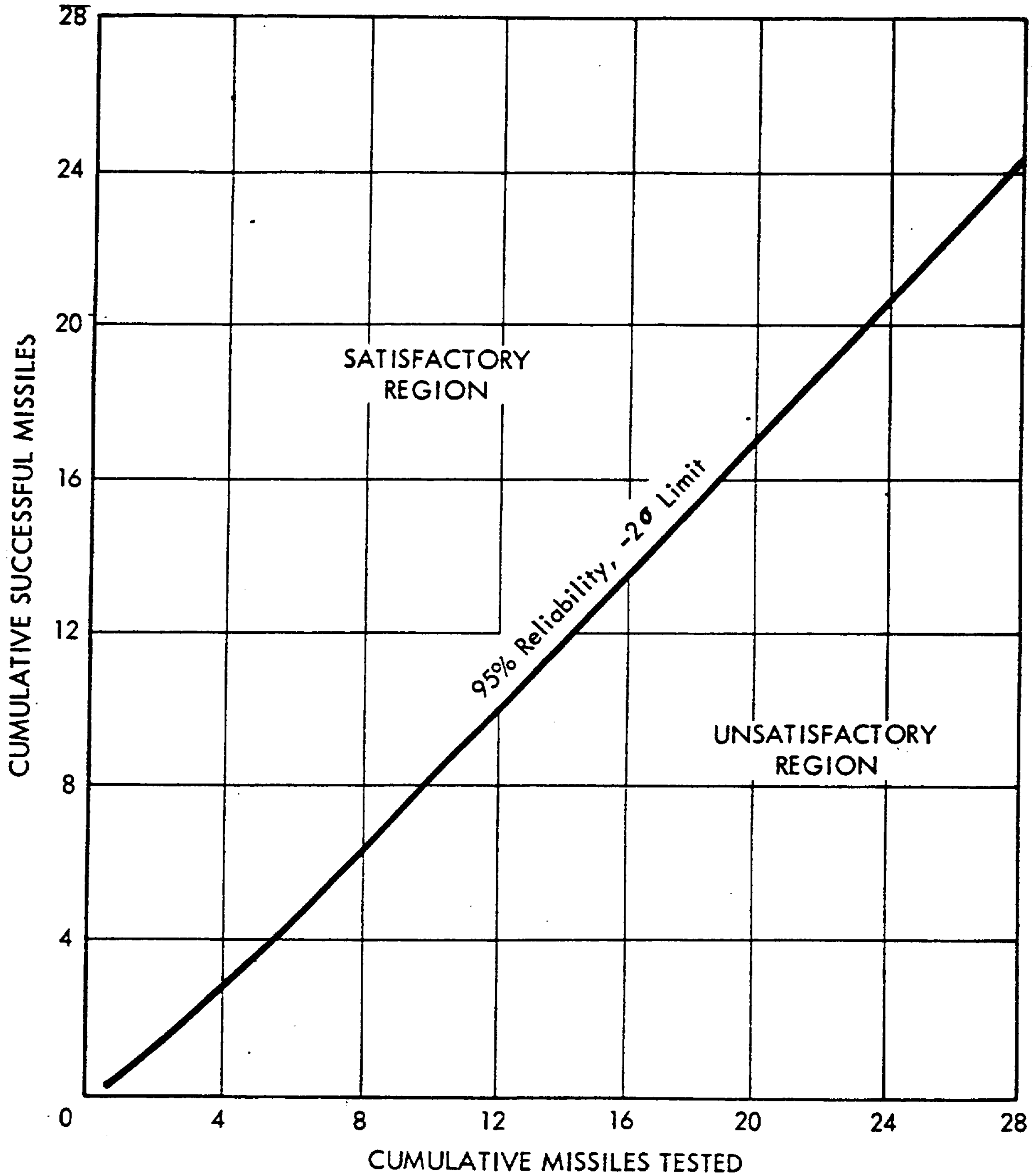

Figure 1. Score Chart for Depot Tests

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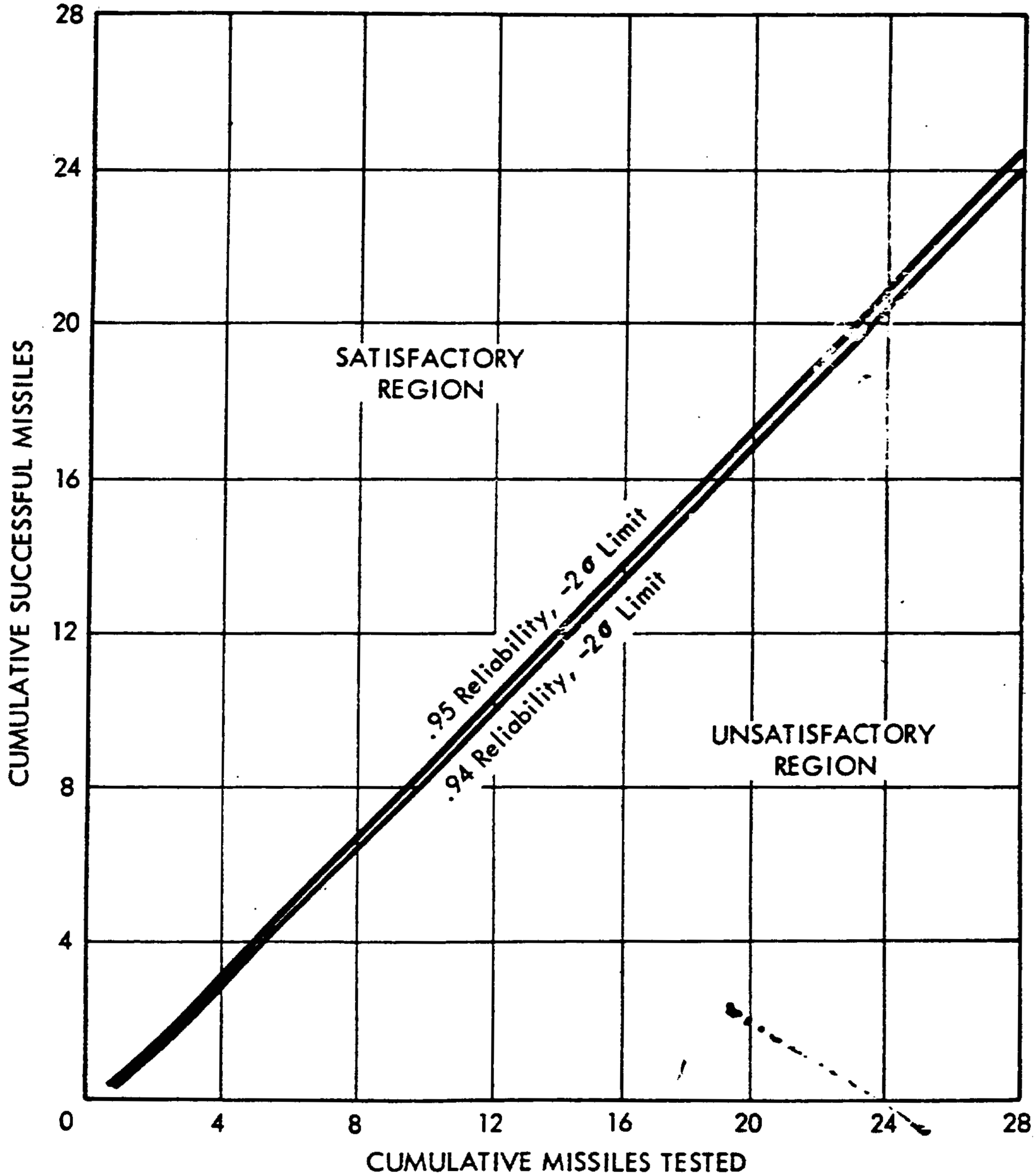

Figure 2. Score Chart for Prelaunch Tests

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Addendum No.
to MIL-D-18243 A(AS)

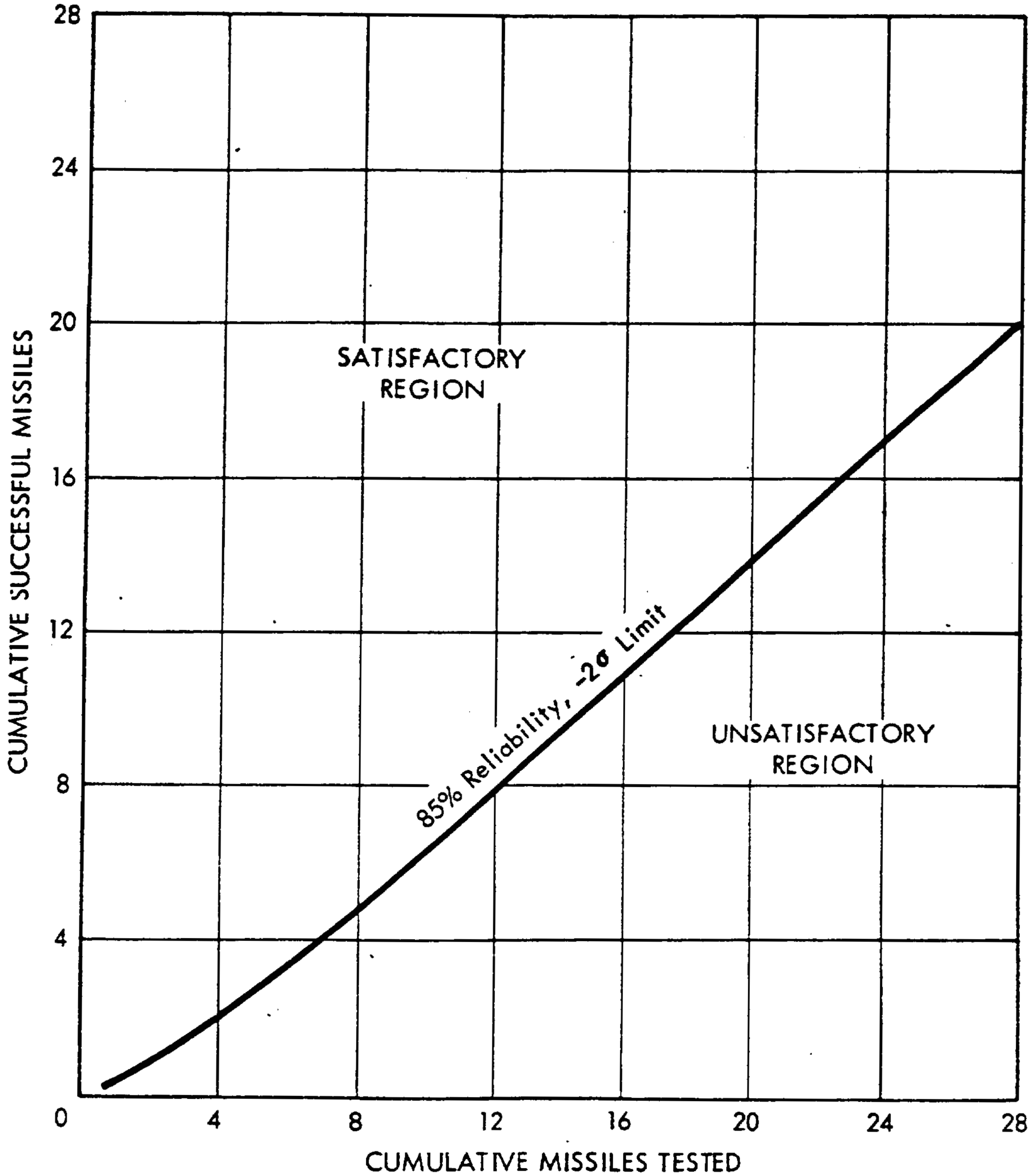

Figure 3. Score Chart for Flight Tests

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to MIL-D-18243 A(AS)

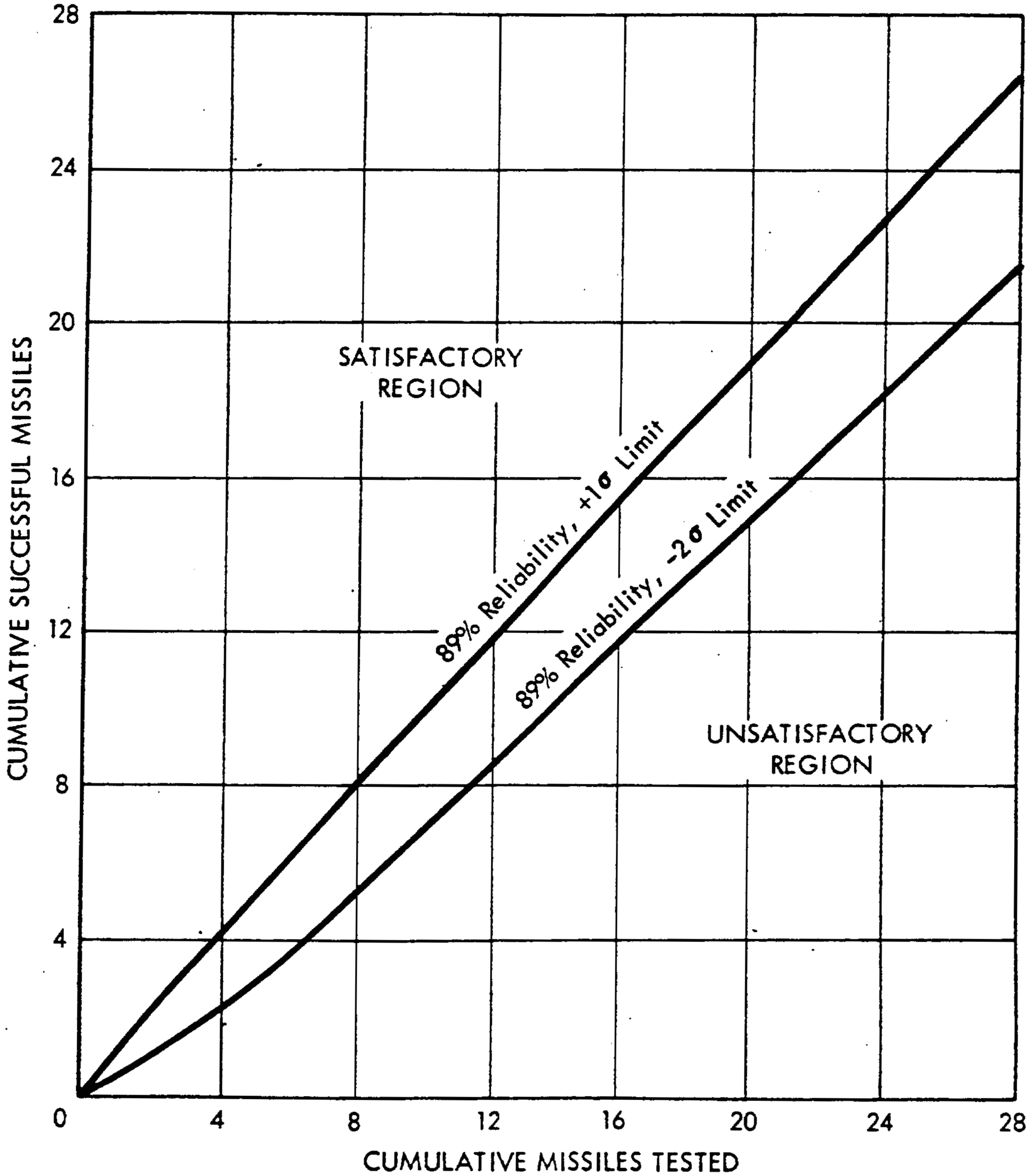

Figure 4. Score Chart for Launch and Guidance Tests

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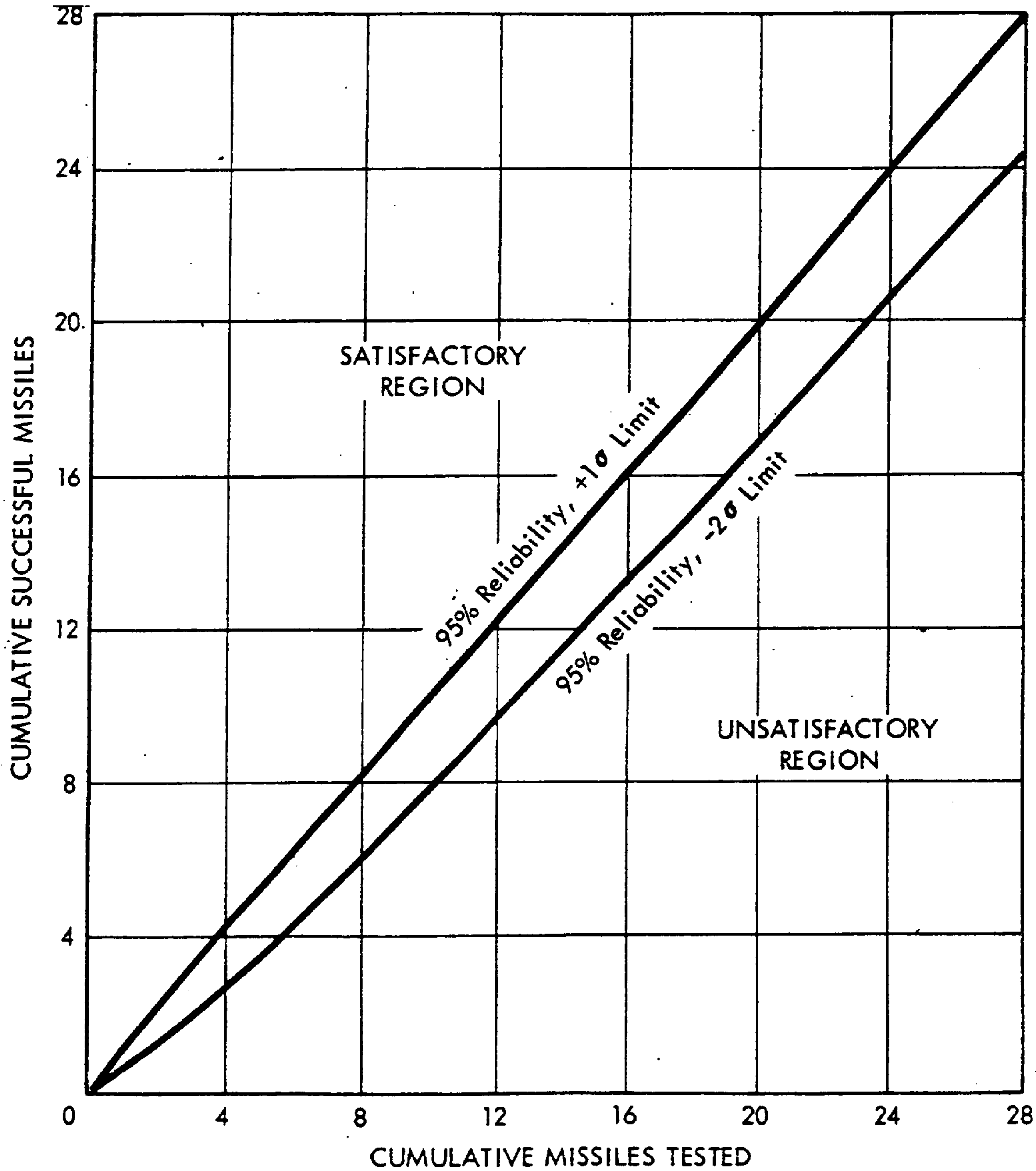

Figure 5. Score Chart for Fuzing Tests

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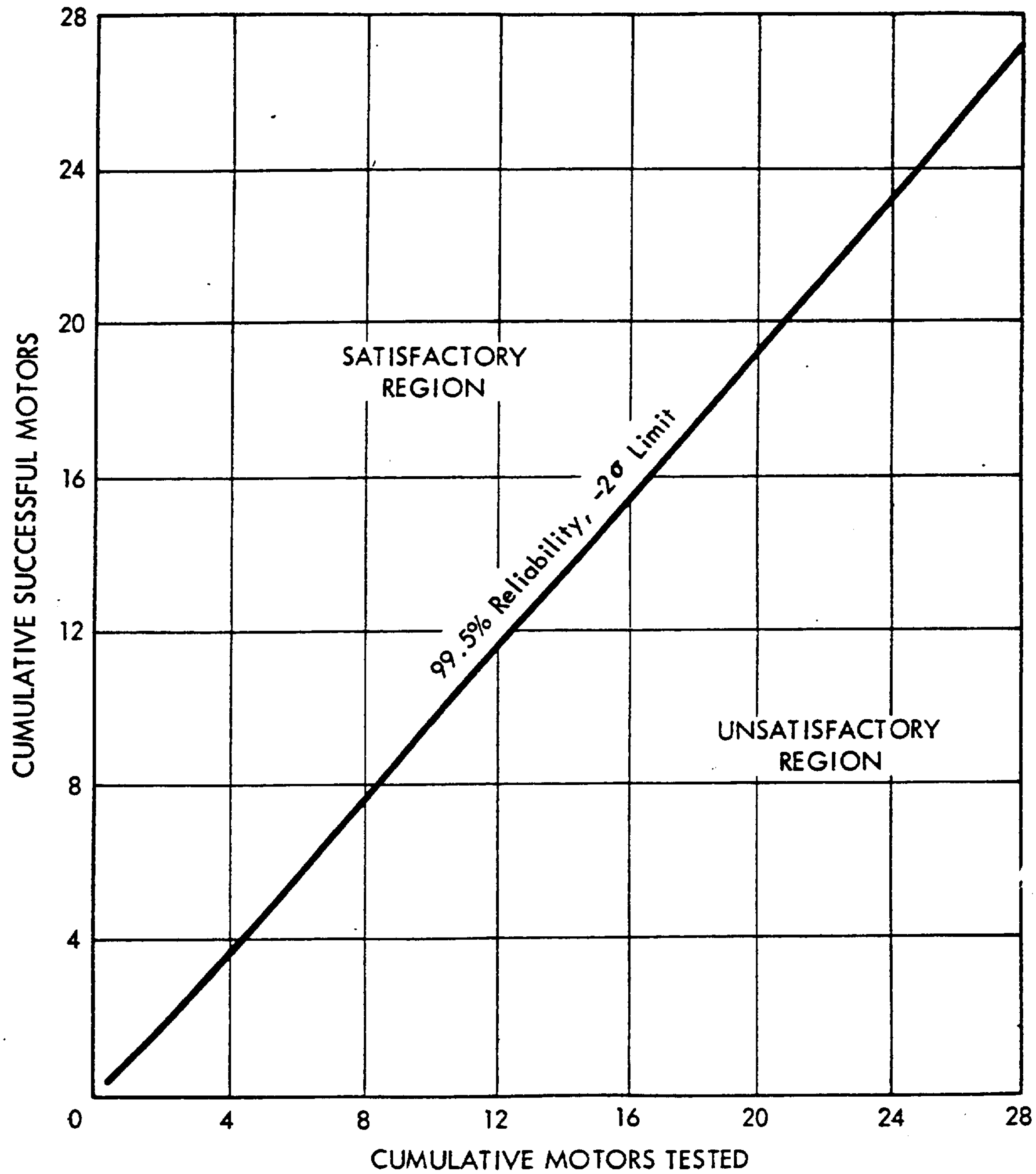

Figure 6. Score Chart for Rocket Motor Inspection and Assembly Mating Checks

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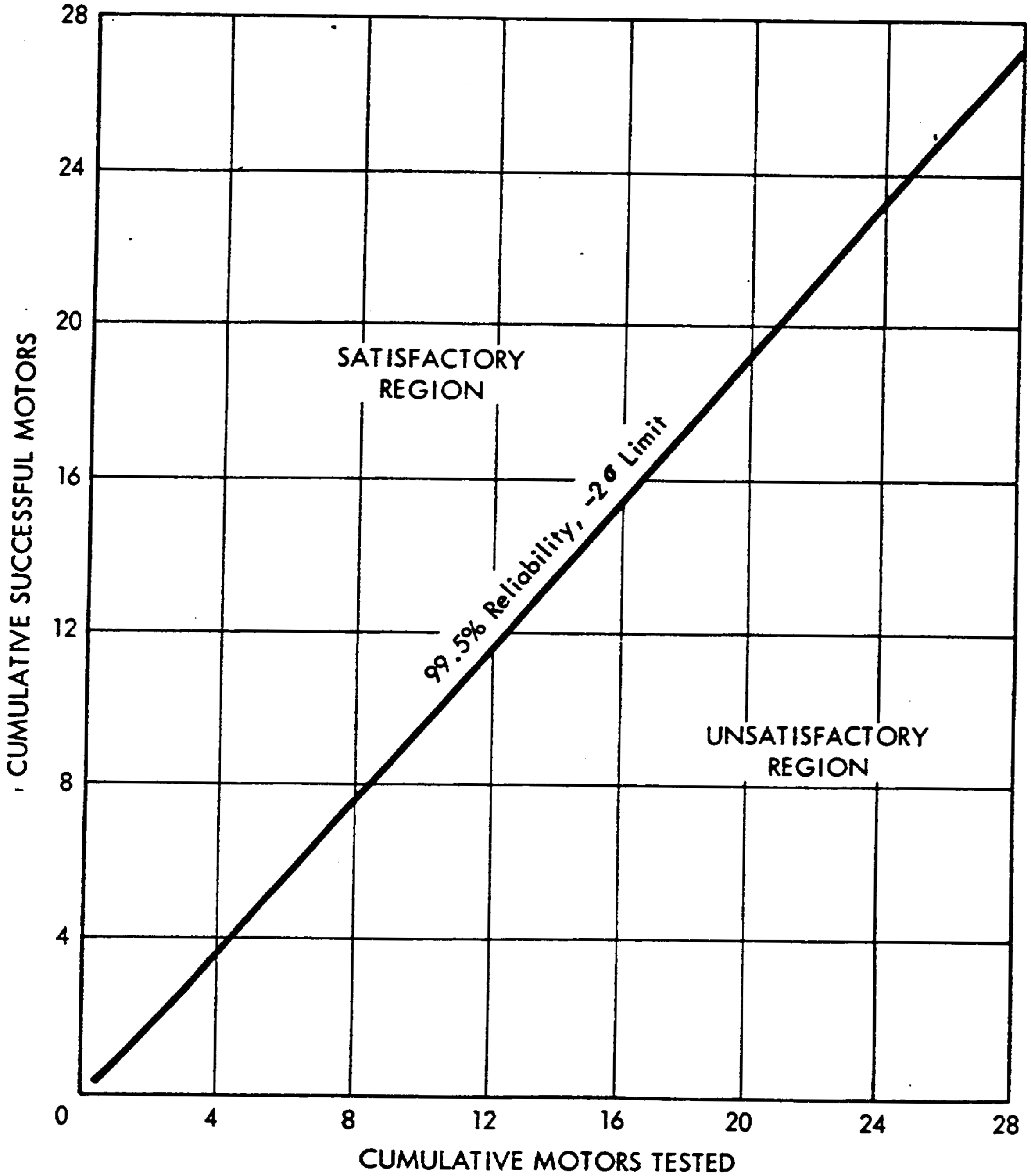

Figure 7. Score Chart for Rocket Motor Flight Tests

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[redacted] UNCLASSIFIED

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to MIL-D-18243 A(AS)

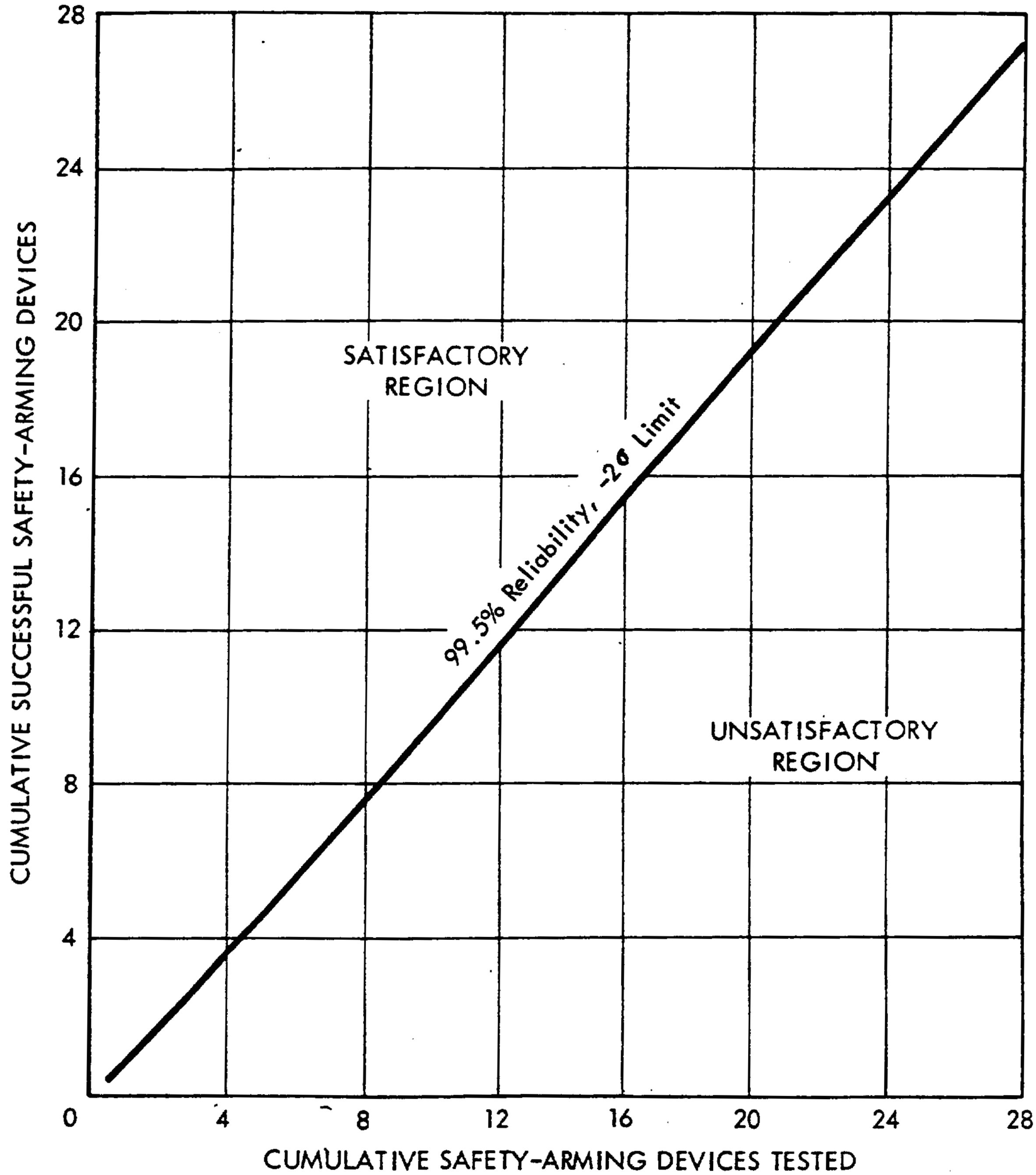

Figure 8. Score Chart for Safety-Arming Device Inspection and Assembly Mating Checks

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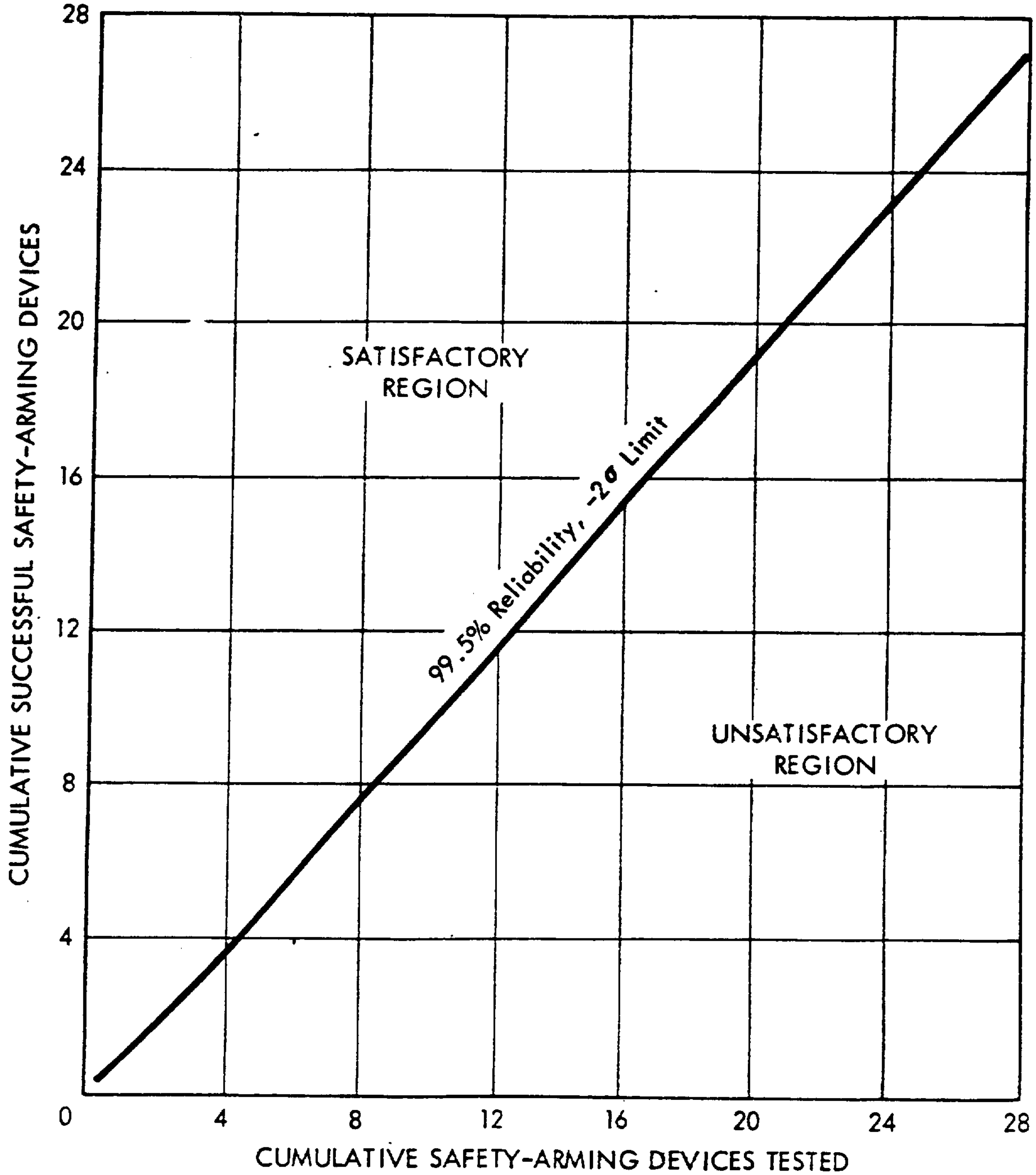

Figure 9. Score Chart for Safety-Arming Device Flight Tests

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to MIL-D-18243 A(AS)

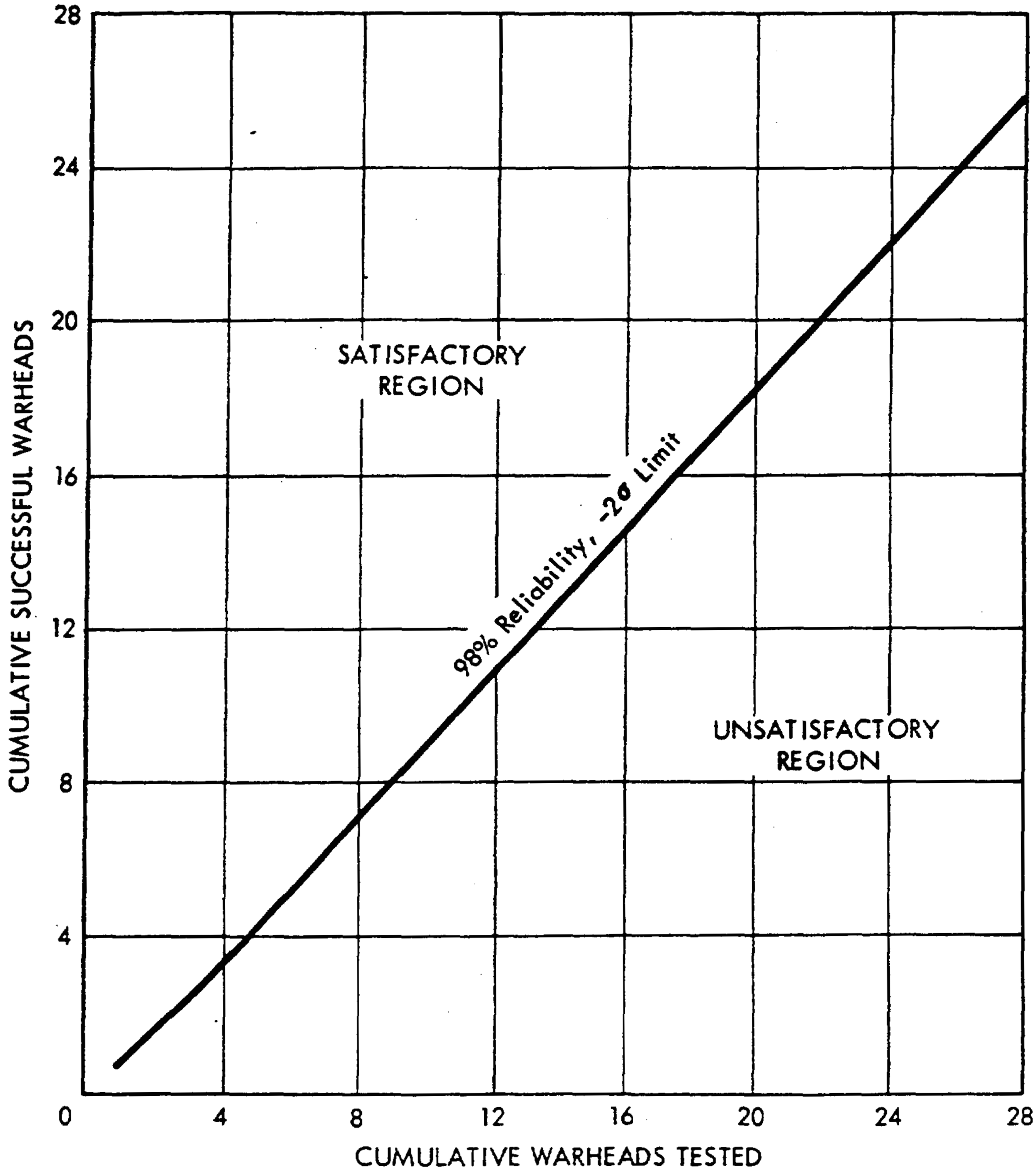

Figure 10. Score Chart for Warhead Inspection and Assembly Mating Checks

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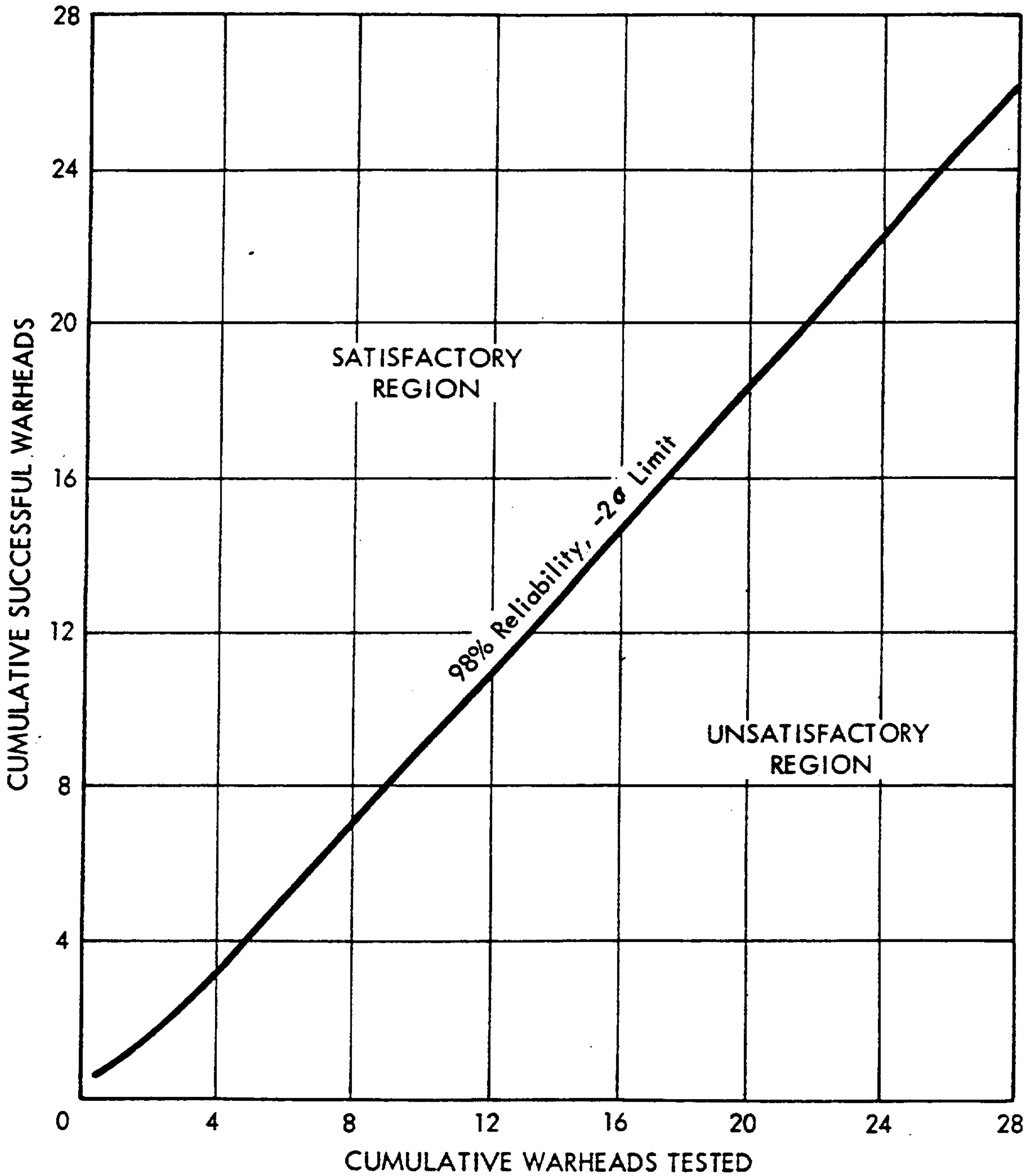

Figure 11. Score Chart for Warhead Performance Tests

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ENVIRONMENTAL TEST PLAN (AIM-9D)

A. INTRODUCTION

1. Background

The AIM-9D SIDEWINDER Missile in service use, particularly in Southeast Asia, has suffered an alarming number of structural failures, many resulting in break up of the missile during captive flight or upon aircraft recovery aboard the carrier. One of the elements determined (by investigation of these failures) to be lacking for thorough engineering evaluation of the problem was a satisfactory definition of the environment seen by the missile under service use conditions.

2. Objective

The general objective of this test plan is to provide the definition of the aircraft missile captive flight environment on the F4 and F8 service aircraft for evaluation of structural, functional and system interface effects on missile system performance.

B. TEST DESCRIPTION

1. Test Objective

Define worst case conditions for normal aircraft missile configuration for the complete captive flight cycle including carrier or shore based take-off and landing, and various flight conditions and maneuvers to which the system is normally subjected in service use.

2. Specific Environmental Objectives

Under various configurations of aircraft launcher and airborne stores, define the following:

(a) The structural loading to which the missile airframe, fins, and rollerons are subjected.

(b) The vibrations to which the missile is subjected.

(c) The temperature environment, including extremes, gradients and heat transfer characteristics to which the missile is subjected.

3. Test Plan

Environmental data is to be obtained on both the F4 and F8 aircraft during captive flight of the AIM-9D SIDEWINDER missile from takeoff to landing. A matrix of aircraft, stores and missile configurations will be examined under various worst case conditions of weight, MACH No., altitude, maneuver and aerodynamic performance to identify the characteristics of the environment to which the missile is subjected. Flight conditions may be modified or added depending upon analysis of data gathered from previous flights. A specific test plan appendix will be provided prior to commencement of the program.

4. Test Method

The following general test methods will be utilized:

Ground Test

(a) Conduct mechanical interface tests with test missile loaded on launch stations.

(b) Checkout and calibrate instrumentation under static load conditions with missile on launcher.

Flight Tests

A flight test appendix will be provided which specifically defines the aircraft, missiles, and stores configuration, the takeoff, flight profile and landing requirements, instrumentation and tracking requirements, as well as all support, data collection and analysis requirements for the test. Requirements for chase plane, photo coverage, voice annotation and time reference information will be specified.

C. TEST REQUIREMENT

1. Test Articles

At a minimum of four current production, AIM-9D Guidance, Control Airframe Groups (GS&A) and inert motors and warhead sections will be required. At least one each service equipped F4 and F8 aircraft will be required.

2. Test Instrumentation

Data will be obtained by means of airborne on-board tape recorder, telemetry units and photographic coverage. The following general instrumentation of the missile will be required:

(a) Structural instrumentation includes strain gages and low frequency accelerometers for obtaining normal forces, bending moments, body bending and torsional stresses.

(b) Vibration instrumentation includes high frequency accelerometers and acoustic transducers with a minimum of 20 to 2000 HZ frequency response.

(c) Temperature will be obtained with thermocouples or thermisters installed in the missile airframe, motor and warhead sections.

D. DATA REQUIREMENTS AND DOCUMENTATION

1. Data Collection

All instrumentation data will be recorded on magnetic tape with voice annotation and time reference information. The following additional sources of data will be utilized:

(a) Aerography data

(b) Flight crew debriefing

(c) Photography - motion picture and still

2. Analysis of Data

Analysis of data collected during the test program will be categorized as follows:

(a) Structural Analysis

Static, dynamics, and combined loading conditions

(b) Vibration analysis

Frequency, amplitude and time domain

(c) Temperature analysis

Extremes, gradients, and heat transfer characteristics

3. Documentation

Interim technical memorandum reports will be provided as the test program progresses. A final technical report will summarize all test results and include recommendations for areas requiring further engineering investigation or corrective action.

Cost Estimates

1. Cost estimates associated with implementation of the recommendations of Task Team One are as follows (Numerals are keyed to sections of the basic report):

I. NAVAIR Air-to-Air Systems Program Management

Cost associated with this portion of the report is internal to NAVAIR and cannot be estimated at this time.

II. Quality Control at the Contractors Facility

Direct costs to NAVAIR to implement this recommendation should be zero, and the cost to NAVAIR Programs for Quality Control should be reduced.

III. Local Contractor Government Representative Actions

Direct cost to NAVAIR to implement this recommendation should be zero.

IV. Quality Control Survey of the Contractors Facility

Action has already been taken on this recommendation. Since costing is internal to NAVAIR it cannot be adequately estimated at this time.

V. Reliability Studies

The AWG-10 reliability program at Westinghouse has an initial cost of $1.5 million and a recurring cost of $0.5 million. The Sparrow III, 7E and 7F reliability programs at Raytheon, have an initial cost of $1.33 million and a recurring cost of $0.32 million. The Raytheon cost would be lower if this recommendation were applied only to the 7E or the 7F, but because of duplication of effort which would be involved between these two missiles, the reduced cost would be considerably less than 50%. The total cost for the Reliability Studies and design margin evaluations is estimated at $3.65 million.

VI. Production Monitoring Tests (PMT)

Assuming the tests will be conducted at Pacific Missile Range, Pt. Mugu, where equipments are currently available, the cost of PMT will become part of the normal programs budget and the additional cost to NAVAIR at this time should be zero.

VII. Missile Systems Environmental Test Plan

Assuming an adequate staff and equipments for the planning, instrumenting, conducting and evaluating of thirty environmental flights, the total cost for the flight portion would be $450,000. The necessary laboratory environmental effort confirmation and to design production evaluation tests will be $600,000. The total cost of the missiles systems environmental tests is estimated at $1,050,000.

VIII. Second Source Considerations

Assuming a reasonable procurement from the second source, that would attract qualified vendors, a minimum of 100 rounds, and assuming the cost for the missile components and assembly would be part of the normal production procurement budget, the only initial cost to NAVAIR would be the tooling and start-up costs. This is estimated to be $400,000.

IX. Change Control Action (ECP)

The cost to NAVAIR to implement this recommendation should be zero.

2. Total estimated cost for implementation of Team One recommendations is $4.28 million initially, and $.82 million recurring. Consultation with Westinghouse, Raytheon, and with Pt. Mugu, was made to assist in the formulation of these estimates.