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NAVAL AIR DEVELOPMENT CENTER

WARMINSTER, PENNSYLVANIA 18974

SYSTEMS DIRECTORATE

SYSTEMS READINESS DIVISION

FLEET READINESS ANALYSIS AND ENGINEERING BRANCH

FINAL REPORT (DRAFT) 22 APRIL 1977

AIR 03 READINESS IMPROVEMENT PROGRAM - PHASE II APPROACH

AIRTASK: A3023021/0018/6F32-311-010

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FOREWORD

This report presents a plan designed to provide the Navy with the in-house capability for ensuring adequate and cost effective readiness in all its advanced technology programs. The plan provides an evolutionary and systematic growth to the highest payoff capability over a four year timeframe. It involves as a minimum technical administratiors, field activity managers lead project engineers. Maximum payoff requires the development and maintenance of a strong in-house readiness technical base located at the laboratory level which is functionally oriented along major weapon subsystem lines (i.e., airframe, power plant, avionics and armament). Until the technology base concept is fully developed, validated and implemented across all AIR 03 technologies, increased awareness, the wider and more intensive application of present assurance disciplines augmented with available quantitative analysis methods are recommended as the primary vehicle for assuring readiness. The concepts recommended in this plan were developed through a qualitative assessment of the present acquisition and management methods used to assure readiness. Several on going and historic technology programs were used in the study. Both in-house and industry perspectives were considered.

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GLOSSARY OF ABBREVIATED TERMS

ADM	Advanced Development Model
AIDS	Advanced Integrated Display System
AN	Airforce/Navy
ASCL	Advanced Sonobuoy Communications Link
ATE	Automatic Test Equipment
BCM	Beyond Capability of Maintenance
CETS	Contractor Engineering and Technical Services
CNO	Chief of Naval Operations
DID	Data Item Description
DOD	Department Of Defense
DSARC	Defense Systems Acquisition Review Council
EDM	Engineering Development Model
ESM	Electronic Support Measures
GSE	Ground Support Equipment
ILS	Integrated Logistic Support
IOL	Initial Outfitting List
JTIDS	Joint Tactical Information Display System
MMH/MA	Maintenance Manhours/Maintenance Action
MTBF	Mean Time Between Failure
MTBMA	Mean Time Between Maintenance Actions
PGM	Program
POL	Petroleum, Oil, and Lubricant
RFI	Ready For Issue
RFQ	Request For Quotation
SPEC	Specification
STD	Standard
TPS	Test Program Set
VAMOSC	Visibility Management Of Support Cost

SECTION I

EXECUTIVE SUMMARY

1.1 INTRODUCTION

The AIR 03 Readiness Assurance Program was initiated at NADC in December 1975 by AIR 03. The program objective was to develop and implement a plan for assuring that adequate and economic readiness would result for future Naval airborne and shipboard weapon system designs conceived and developed by AIR 03. Both AIR 03 and NADC believe this objective can be accomplished by (1) injecting readiness considerations into 6.2 and 6.3 technologies, (2) increasing the transition rate of technologies with built in readiness to 6.4., (3) identifying high-payoff readiness related technologies for application to current Fleet problems.

For the purposes of this study, the type of readiness being assured was assumed to be material readiness. It is defined in OPNAVINST 5444.4C. Material readiness is measured and reported by the Navy's 3-M data system and is considered by many including CNO to be one of the most serious problems in the fleet today. It is a complex,extremely interactive function of R&M, ILS, utilization and the constraints imposed by the operating environments.

A three phase program was developed by NADC in support of the AIR 03 objective. Phase I (Dec 75 - Jan 79) was a low level quick reaction survey of selected AIR 03 technologies designed to define the broad readiness assurance problems and issues. Phase II (Mar 76 - Mar 77) was a slightly larger effort designed to develop the technical approach for overcomming the problems of Phase I. All approved initiative in the approach will be developed, refined and validated in Phase III using several AIR 03 technologies as a test bed. Phase III is expected to take several years to complete. When finished it should result in a proven readiness assurance program which clearly meets the need and is ready for institutionalization across all AIR 03 technologies.

This report summarizes the approach resulting from Phase II effort. The resources and schedules for implementing Phase II recommendations are also presented.

Salient conclusions which emerged from Phase I and provided the basis for initiating Phase II included the following:

a. There is a need for a roadmap or systematic set of events ror designing readiness into 6.2 and 6.3 designs analogus and effective as those used to achieve performance.

b. There is a need for a concise and understandable readiness awareness program for TAs (technical administrators) in NAVAIR and PEs (project engineers) in the laboratories to initially earn and update on a recurring basis the status of fleet readiness, successful readiness assurance methods and effective management methods.

c. There is a need for a greater degree of quantification in the readiness disciplines in order to enhance marketing positions, identify high payoff technologies and single out potential problems with sufficient lead time to effectively deal with the problem.

1.2 APPROACH

1.2.1 Roadmap Development - The approach used was to initially construct a baseline of the 6.2 and 6.3 readiness acquisition process and then develop a set of interactive improvements based on inputs from both industry and government. Information sources used to construct the baseline and develop the improvements consisted of the following:

a) DoD Military Specifications. A list of each reviewed by this study is presented in Figure 1.

b) Discussions with lead R&M system engineers from Hazeltine, Singer, and ITT.

c) Discussions with Air 340, Air 360, and Air 370 TAs and their lead technologists.

d) Discussions with lead project engineers at NADC on LAMPS, ASCL, JTIDS and AIDS.

e) Technical articles on R&M assurance. A list of some of the more relevant articles reviewed by this study is presented in Figure 2.

f) Navy procurements on similar operational equipments to JTIDS and ASCL. A list of each reviewed by this study is presented in Figure 3.

1.2.2 Readiness Awareness Syllabus Development - The approach used was to develop a set of core courses which provided a common understanding of readiness related terminology and principles, illustrated the impact of readiness design decisions in 6.2 and 6.3 downstream through example and finally conveyed the philosophy of the new readiness assurance roadmap. Two separate courses were developed for TAs and PEs because of the vast differences in the day-to-day involvement necessary to implement the roadmap.

1.2.3 Quantitative Methods Expansion - The approach used was to select a readiness related parameter which could be modelled and demonstrated within the time frame of the study as a means of extending the existing quantification capabilities of Air Ø3. Life cycle cost was chosen as the study parameter [illegible] ause it met the above criteria, but also because it was usable by all Air Ø3 technologists, and it generally exhibits a sensitivity between good and poor designs and it is easily understood.

MILITARY SPECIFICATIONS CONSIDERED IN THE DEVELOPMENT OF A READINESS ASSURANCE ROADMAP

	Reference Number	Title
1.	NAVORD OP 39223	Maintainability Eng. Handbook
2.	AR-104	Aeronautical Reqmts
3.	MIL-STD-470	Maint. Pgm Reqmts
4.	MIL-STD-883	Test Methods & Procedures for Microelectronics
5.	MIL-STD-280	Definition of Terms for Equipment Divisions
6.	MIL-STD-781	Reliability Tests, Exponential Distribution
7.	MIL-E-5400	Electronic Equipment, Aircraft, General Specifications for
8.	MIL-T-5422	Testing, Environmental, Aircraft Electronic, Equip.
9.	AR-10A	Maintainability of Avionics Equipment and Systems, General Requirements for
10.	MIL-STD-471	Maintainability Demonstration
11.	MIL-STD-785	Reliability Program for Systems and Equipment Development and Production
12.	AR-30	Integrated Logistics Support Requirements for Aeronautical Systems and Equipments
13.	MIL-STD-DoD	Reliability Program Management (In Process)
14.	MIL-R-27542	Aerospace Systems and Subsystems (Rev. "A" Proposed)
15.	WS-3250	Reliability - General Specification
16.	NPC-250-1	Reliability Program Requirements
17.	MIL-R-26474	Production - Ground Electronic Equipment
18.	MIL-R-27070	Development - Ground Electronic Equipment
19.	MIL-R-27173	Ground Checkout Equipment
20.	MIL-R-26484A	Development - Systems and Subsystems
21.	MIL-R-55231	Production Electronic Equipment
22.	MIL-R-22256	Design - Equipment and Systems

FIGURE 1

Reference Number	Title
23. MIL-R-22732	Shipboard and Ground Electronic Equipment
24. MIL-STD-781	Reliability Test Procedures
25. MIL-R-22973	Index Determination for Avionic Equipment
26. MIL-R-26667A	Demonstration Requirements
27. MIL-STD-441	Military Electronic Equipment
28. MIL-R-23094	Assurance for Prod. Avionic Equipment
29. MIL-M-99331	Quick Reaction Capability Electronic Equipment
30. Spec. Bull. 506	Monitoring
31. MIL-STD-721A	Definitions
32. WR-41	Reliability Evaluation
33. MIL-STD-756A	Procedure for Reliability Prediction
34. MIL-STD-2 CA	
35. MIL-T-152B1	
36. USAF SPEC BLTN 106A	
37. USAF SPEC BLTN 5(1)	
38. USAF SPEC BLTN 523	Environmental Factors
39. ASD-TR-61-363	
40. MIL-Q-9858 (2)	
41. NPC-200-2	
42 NPC 200-3	
43. DCAS EX 62-10	
44. DoD HDBK 110	
45. NAV-P-1034 App "A"	Quality Control
46. MIL-Q-21549A	
47. MIL-STD-202B (3)	
48. MIL-STD-446A	
49. MIL-T-4807A	
50. MIL-E-4970A	
51. MIL-E-5272C (1)	Test Methods
52. MIL-T-5422E (2)	
53. MIL-T-18303	

FIGURE 1 (Cont'd)

Reference Number	Title
54. MIL-STD-439B (1)	Test Methods
55. MIL-E-4158C	
56. MIL-E-5400F	
57. MIL-E-8189B (1)	
58. MIL-W-9411A (2)	Design
59. MIL-E-16400	
60. MIL-E-19600A	
61. ANA BLTN 444	
62. AD114274	
63. AD143556	
64. MIL-T-713A (3)	
65. MIL-W-5088B	
66. MIL-W-8160 D	
67. PD-E-531	Wiring
68. MIL-D-9310B (2)	
69. MIL-D-9412D	
70. MIL-D-26239A	
71. MIL-D-703727 (2)	Data
72. MIL-M-26512B	
73. MIL-M-23313	
74. MIL-M-45765	Maintainability
75. WS-3099-1	
76. SCL-4301B	
77. MIL-STD-415B	
78. MIL-T-945A (2)	
79. MIL-T-18306A (1)	
80. MIL-T-21200 D	Test Equipment
81. MIL-T-4860C	
82. MIL-T-26046	
83. MIL-T-26137	Training
84. MIL-T-27382	

FIGURE 1 (Cont'd)

Reference Number	Title
85. MIL-E-6051C	Training
86. MIL-I-6161D (2)	
87. MIL-I-16919A (3)	Interference
88. MIL-I-266002	
89. PD-R-186	
90. MIL-P-116011)	
91. MIL-P-90248	Preservation and Packaging
92. USAF Spec. Bltn 56E	
93. MCP 71-163	
94. MIL-STD-803	
95. MIL-H-22174	
96. MIL-H-25946	Human Factors
97. MIL-H-26207	
98. ESD 61-99	
99. MIL-B-5005A (2)	
100. MIL-E-171362D	
101. DoD INST 4151	Provisioning
102. MCP 71-550	
103. MCP 71-673	
104. PP-SIG-SE-1A	
105. WR-1	
106. WR-2	
107. MIL-STD-108D	
108. MIL-C-172C (D)	Enclosures
109. MIL-E-2036C (4)	Enclosures
110. MIL-STD-243	Equipment Types
111. MIL-1-8700	Equipment Types
112. MIL-E-25366A	Installation
113. MIL-STD-167	Vibration
114. MIL-R-18301B	Vibration
115. MIL-R-1836A (2)	Reports

FIGURE 1 (Cont'd)

Reference Number	Title
116. MIL-T-9107 (2)	Test Report
117. MIL-STD-105C	Test Report
118. MIL-STD-414	Sampling
119. DoD HDBK-106	
120. DoD HDBK-108	
121. MIL-M-23313	Maintainability Requirements for Shipboard and Shore Electronic Equipment and Systems
122. MIL-M-26512B	Maintainability Requirements for Aerospace and Equipment
123. WR-30	Weapon Readiness Achievement Program
124. MIL-M-26512B	Maintainability Test and Demonstration Requirements for Systems and Equipment
125. MIL-M-26512B	Maintainability Verification of Predictions for Systems and Equipment
126. MIL-M-9933 (1)	Maintainability and Reliability Program-Quick Reaction Capability Electronic Equipment
127. MIL-STD-829	Terms and Definitons for Maintainability
128. WS-3099-1	Maintainability General Specification
129. MIL-STD-778	Definitions for Maintainability Engineering (Orop)
130. SCL-4301B	Maintainability Design

FIGURE 1 (Cont'd)

TECHNICAL ARTICLES CONSIDERED IN THE DEVELOPMENT OF A READINESS ASSURANCE ROADMAP

Title	Author	Source
1. Electronics X	Howard Gates	Final Report of the Joint Logistics Commanders Electronic System Reliability Workshop 1 Oct 75
2. Avionics Reliability Study	L/C. Ben Swett	Final Report of the Joint Logistics Commanders Electronic System Reliability Workshop 1 Oct 75
3. F-15 Reliability Pgm Mgt	Gene Kunznick	Final Report of the Joint Logistics Commanders Electronic System Reliability Workshop 1 Oct 75
4. Industry Viewpoints on the Achievement of Reliability Requirements	James Tamsen	Final Report of the Joint Logistics Commanders Electronic System Reliability Workshop 1 Oct 75
5. Improving the Cost Effectiveness of Military Specifications and Stds.	LaMonte Brown	Final Report of the Joint Logistics Commanders Electronic System Reliability Workshop 1 Oct 75
6. Operational Influences on Reliability	George Kern	Final Report of the Joint Logistics Commanders Electronic System Reliability Workshop 1 Oct 75
7. Long Life Assurance Study for Manned Spacecraft	R.W. Burrows	Martin Marietta Corp Dec 1972
8. A Comparison of Demonstrated and Achieved Equipment Maintainability	Philco-Ford	IEEE R&M Symposium Jan 1974
9. Forcing Functions Integrate R&M into Design	E.G. Metzler	IEEE R&M Symposium Jan 1974
10. Practical R&M Design Techniques	GTE Sylvania	IEEE R&M Symposium Jan 1974

Figure 2

TECHNICAL ARTICLES USED IN THE DEVELOPMENT OF A READINESS ASSURANCE ROADMAP (Continued)

Title	Author	Source
11. Reliability Testing Pitfalls	E. F. Thomas (General Dynamics)	IEEE R&M Symposium Jan 1974
12. Reliability and Choosing the Number of Prototypes	Dept. of Army	IEEE R&M Symposium Jan 1974
13. Application of Life Cycle Costing to the DoD System Acquisition Decision Process	Jacques Gansler	IEEE R&M Symposium Jan 1974
14. Reliability Demonstration Testing Using Failure From Trials	Rockwell International	IEEE R&M Symposium Jan 1974
15. Estimating Life Parameters from Burn In Data	U. S. Army	IEEE R&M Symposium Jan 1974
16. Equipment Procured Reliability and Real Life Survival	Oscar Markowitz	IEEE R&M Symposium Jan 1974
17. Accurate LCC Estimating Early in Program Development	Martin Marietta	IEEE R&M Symposium Jan 1974

Figure 2

PROCUREMENTS REVIEWED IN THE DEVELOPMENT OF A READINESS ASSURANCE ROADMAP

	Nomenclature	Functional Description
1.	AN/ARR-52	Radio Receiving Set
2.	AN/ARR-72	Sonar Radio Receiving Set
3.	AN/ARR-76	Sonobuoy Receiver
4.	R-1047	On Top Position Indicator
5.	AN/ARN-52	Tacan Set
6.	AN/ARN-21	Tacan Set
7.	AN/ASQ-19	Integrated Electronic Control
8.	AN/APX-76	Interrogator Set (IFF)
9.	AN/APX-72	Transponder Set (IFF)
10.	AN/ASW-25	Digital Data Communications Link
11.	AN/ARR-69	UHF Auxiliary Receiver
12.	AN/ARA-50	Direction Finder
13.	AN/APX-64	Transponder Set (IFF)

Figure 3

1.3 SUMMARY OF RESULTS

1.3.1 Roadmap Development

1.3.1.1 Based on a review of the present readiness assurance methods the following conclusions were made:

A. Present methods contain serious deficiencies in nearly all phases of the assurance process. Included are: conceptual design; specification development; DID design for RFP R&M design approach and ADM monitoring framework; RFP source selection; ADM monitoring and ADM transitioning.

B. The result of these deficiencies contribute to an average reliability degradation between original specification and field performance of 6.5[1] with a range between 4. and 9.[2] They also contribute to a near zero treatment of maintainability and supportability issues prior to and during ADM. This lack of emphasis causes the Navy to pay enormous sums during full scale development for quick reaction support systems involving interface units, ATE, TPS programs and special CETS/NETS in order to RFI units after they are pulled from an aircraft. The combination of lower than expected reliability and jury rigged support systems usually results in both low readiness and very expensive operating costs as well as continued get well programs which are also expensive. Marginal conceptual design work prior to ADM also contributes to the fleet readiness problem by not allowing the proper attention to be focused on critical technologies which could benefit from a push for either initiation purposes or momentum continuation.

C. Vendors are capable of developing designs with higher reliability and better testability, repairability, environmental durability and transportability than they are currently doing for the government. Factors cited which limit these benefits are existing environmental control systems from the intended aircraft platforms, component technologies available at or prior to ADM contracting, and/or unit cost constraints imposed by the government. The Navy however, never learns how much better a design they can get beyond the single point performance R&M unit cost design requested by the RFP because it never asks for them.

Notes:

1. Based on values developed by NADC to explain differences between Mil 781 environmental and field as reported in Col. Swetts article "The Avionics Reliability Study."

2. Based on an NADC reliability study for tactical communications systems and sonobuoy receivers reported in Table I of Section 6 of this report.

Under these procurement practices, the vendor is not even slightly motivated to respond. By revising present procurement practices, the government could increase the opportunity for developing designs which have a tremendous payoff downstream in terms of reduced demands for critical fleet resources such as maintenance personnel, OM&N dollars and vessel space. Figures four and five illustrate the wide range in reliability gains which can be realized with typical avionics systems. For example, if a new system is intended to replace an existing fifteen years later without any increase in performance levels, figure four indicates that component technologies alone could result in reliability gains between 8 and 16 depending on whether a unit cost constraint was imposed. If, however, performance levels were allowed to increase at historic growth rates. Figure five indicates that component reliability gains are generally cancelled out resulting in a unity system reliability gain. Clearly a new design with less than historic performace growth will result in a reliability payoff.

D. Navy managers could make more readiness enhancing design decisions if they fully appreciated the impact of design decisions downstream. This forward looking vision can in part be accomplished through training. By and large, however, it is accomplished with credible R&M/ILS readiness/LCC prediction techniques. Up to now there was an excuse for not making sacrifices in ADM for the purposes of readiness and cost because (a) it was believed no single technology could impact readiness on a complex weapon system and (b) believable and accepted operating cost factors were not available. Presently the Navy is capable of (a) relating R&M and ILS design factors to readiness in both an economic and timely manner using NADC's PRISM simulator for fast impact assessments and (b) providing realistic operating cost factors through the Navy's maintenance cost subsystem at NADC. This data bank is updated annually by the NALCOMIS project office in NAVAIR (PMA-270). With both capabilities the Navy can now fully judge the operational impact of new designs. To fully exploit this capability, readiness oriented designs must be encouraged from industry.

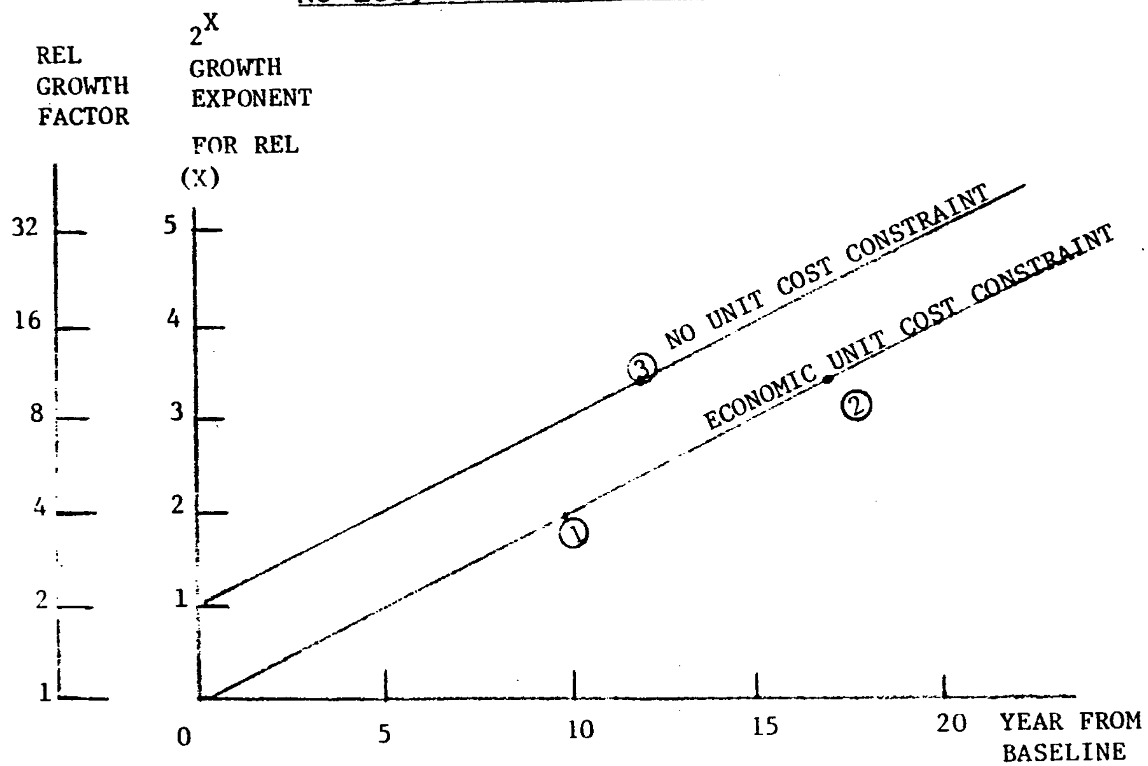
E. Some degree of check and balance system is required of industry if readiness is to be assured. The Navy has to be extremely careful of underlying assumptions concerning a design before it fully accepts and uses operational performance characteristics in its readiness and costing tradeoff considerations. Assumptions which can be extremely critical include parts selection, environmental conditions, and technology breakthroughs.

1.3.1.2 A new 6.2-6.3 roadmap was developed which fully overcomes the deficiencies cited by means of the following special features:

A. Complete Readiness Design Approach by the Navy Prior to Preparation of ADM specifications - The design will be based on technology forecasts for components, ECS, architecture, and test methods, as well as the logistics and operating environments. The design will be used to develop realistic R, M, unit cost and operation cost design goals for inclusion in the RFP. It will also be used to investigate critical readiness related technology issues in the event projected system readiness in the RFP but will be updated periodically and serve as a reference point in evaluating industry's responses.

AVIONICS RELIABILITY PROJECTIONS

EQUAL PERFORMANCE
COMPONENT TECHNOLOGY ADVANCES ONLY
NO ECS, PACKAGING, OR DERATING CONCEPT CHANGES



1	AWG 10 ⟶	AWG 10	1965-1975 (FIRE CONTROL RADAR)
2	ARC 34/37 ⟶	ARC 164	1955-1972 (UHF RADIO)
3	ARC 34/37 ⟶	ULTRA HIGH REL UNLIMITED PROD COST (6 TIMES UNIT COST OF 2)	1955-1967 (VHF RADIO)

FIGURE 4

RADAR COMPONENT TECHNOLOGY, PERFORMANCE AND SYSTEM RELIABILITY TRENDS

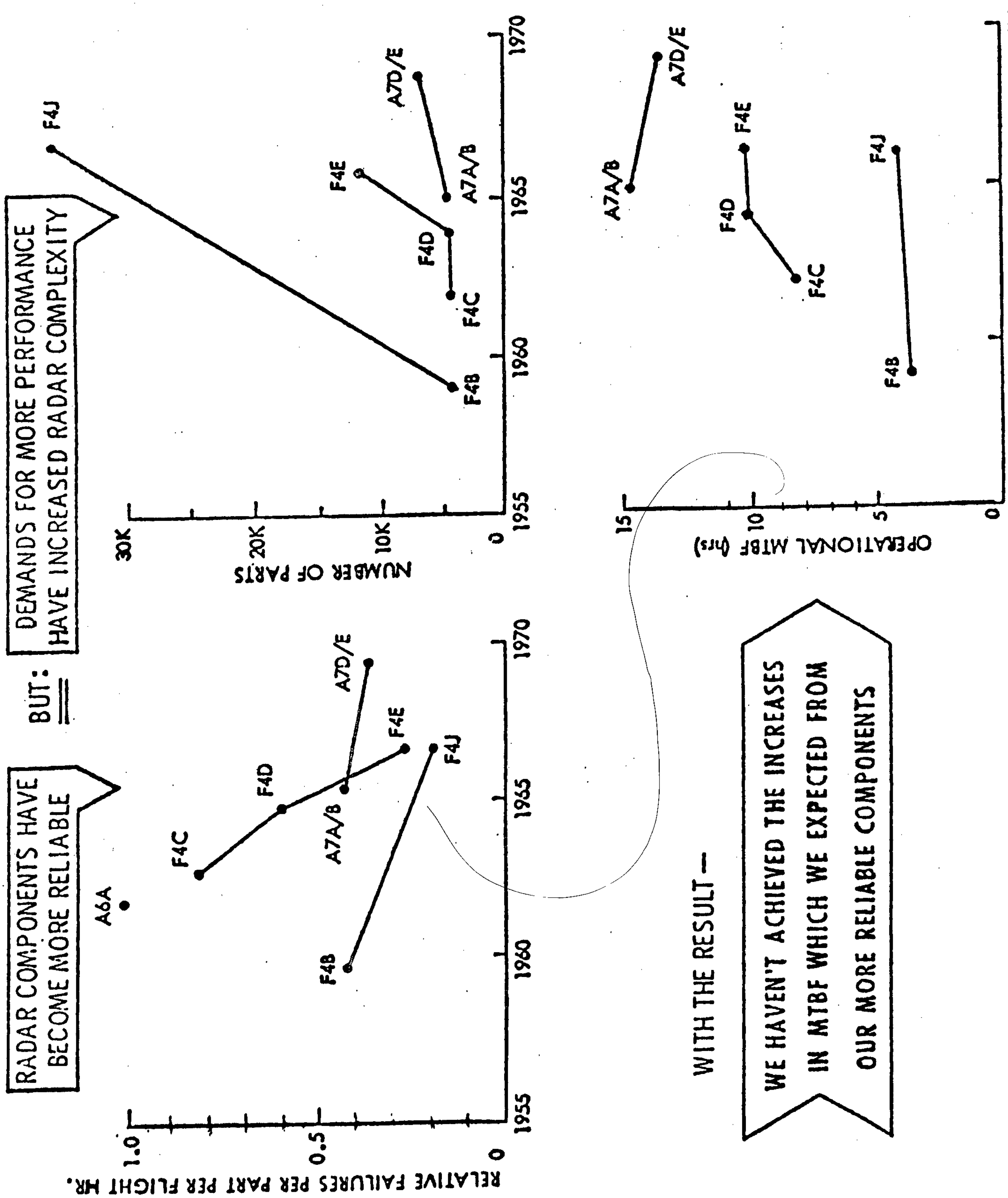


FIGURE 5

B. Complete Vendor Readiness Design Approach in ADM RFP - The vendor will be required to provide inputs which describe his complete maintenance/support system along with his estimates for the cost of each. He will also be required to justify the rationale for the selection of his design and also provide inputs on selected critical issues. He will also be required to submit a sensitivity analysis demonstrating how his recommended maintenance/support system and its costs vary with +100% and -50% changes in reliability, and significant variations to salient performance parameters.

C. ADM Monitoring Framework - Data for performing the independent assessment along with the timeframe and format will be part of the RFP for pricing and become part of the signed contract.

D. Validation of Vendors Readiness Design Approach - All facets of the design including R&M technology projections, cost factors will be verified against the baseline Navy design. Major discrepancies will be investigated by the Navy for uniqueness.

E. Selection of an ADM Vendor Using Readiness and Life Cycle Costs in Addition to Performance

F. Independent Assessment during ADM - The Navy will project system R&M of the ADM design on a periodic basis and compare with the vendors results. Serious differences will be resolved jointly. If they cannot, the Navy will develop the most cost effective design candidates to bring the program back on course.

G. Maintaining a Traceable Path through 6.2 and 6.3 - This documentation will be used to facilitate the transition to 6.4 particularly in the area of incentives and for reference in future developments with the same vendor.

The actual rationale for each feature is discussed in Section II of this report.

1.3.1.3 To implement all aspects of the new roadmap, the Navy must develop and retain a readiness technology base. Personnel within the base must be 1) knowledgeable of the engineering principles for the technology being developed, 2) be equipped with rapid and easy to use technology prediction and design assessment methods and 3) capable of trading off performance for readiness. The first criteria suggests that at least four distinct bases must be developed following a vehicle subsystem approach - i.e. airframes, power plants, avionics, and armaments. Personnel and their technical tools within each base will probably develop along functional lines (ie. radar ESM, computer, displays, etc.) initially as the funding for specific readiness assurance programs will likely come from individual Air Ø3 programs. Eventually however personnel in the technical base will be capable of supporting any function in the base equally well through cross training provided the technical tools have been developed and maintained.

1.3.1.4 It is estimated that a minimum of one year will be required to develop the readiness technical base capable of implementing the readiness roadmap philosophy for a single aviation function. About 2-1/2 people will be required during this time frame to develop the necessary data bases and engineering/analysis tools. After startup, it is estimated that 1 man year per year will be required to maintain the technical tools and 1 man year per year will be required to apply the developed capability to a given program. Economies due to commonality of up to 50%, should be realized in startup costs for each additional function developed in the same technology base. These economies should also apply to the annual maintenance costs appointed with maintaining the data base and tools but not for applications.

1.3.1.5 Partial implementation of the roadmap has merit and is probably the best way to proceed until the full readiness technology base is completed. Through the use of a short training program, project managers and engineers with minimal skills in R&M and ILS techniques can be instructed to use part 2 (complete Vendor design approach in the ADM RFP) and part 5 (selection of vendor using readiness and LCC considerations in addition to performance) of the roadmap. The degree of improvement from partial implementation over today's methods is highly a function of the quality of the vendor's inputs. With realistic inputs the Navy should realize tremendous benefits. If the vendor takes a license to make brash assumptions, partial implementation is probably no better off than today's methods. The mere possibility of doing better than today's methods gives a slight edge to partial implementation.

1.3.1.6 Implementation of roadmap part 7 (independent assessment) was attempted in Phase II of this study for two designs already in 6.3. The effort was purely exploratory in nature. Its objective was to gage the significance of the monitoring framework and the technical base in the performance of part 7. The JTIDS and ASCL programs were selected as test cases for the study. Neither had much of a monitoring framework set up outside the standard Navy 3 day design reviews. The assessment was attempted with electrical engineers possessing an extensive background in roadmap principles, few technology base tools, and only limited experience with the hardware. The results of their assessments are presented in Section 6 of this report. In brief, it was found that without the monitoring framework no critical independent assessment was possible without payments for data in the neighborhood of $120K. The only assessment which could be accomplished was a comparison of the vendor's prediction with the specification in the area of reliability. Similar assessments were possible for organizational maintainability in only one of the two cases considered. The second one had a prediction but no specification. Sample assessments for intermediate maintainability were not possible at all as there was no specification or prediction. Where assessments were possible, the contractors prediction always equalled or exceeded the specification, thereby indicating no problem.

This conclusion can be extremely misleading if the vendors predictions were based on a whole series of incorrect assumptions such as 1) the use of gold parts instead of aluminum or 2) the use of an inhabited environment in lieu of an uninhabited environment. While no specific design or assumption data was provided by the vendors, they did give out samples of what they could provide. Based on these inputs the two NADC engineers concluded that if the vendor data were available, the assessment tools and work around methods characteristic of the technology base would be required to perform the assessment in a timely manner to effect the design.

1.3.2 Awareness Syllabi

1.3.2.1 The resulting syllabi for TAs is a one day course. It concentrates heavily on the features of the new roadmap, the implementation requirements for the readiness technology base, and the type of problems which are likely to result from using the full or partial roadmap, and the type of options available for each class of problem. The course is not R&M or ILS engineering oriented. Details are presented in Section 3 of this report.

1.3.2.2 The resulting syllabi for PEs is a three day course. The course features an in depth treatment of the new roadmap's methods as well as the means of implementing and interpreting each element. The PE course deals with the situations which might occur at each junction from both the vendor's and readiness assurance engineer's point of view. The course also addresses the options open for each situation along with the types of factors which should be considered in making representative decisions. Details of the course are presented in Section 4 of this report.

1.3.2.3 Implementation Requirements per syllabi

A. Startup (1st year only)

a. preparation time - 6 man months

b. Implementation time - 2.5 man months

B. Annual recurring

a. preparation update time - 3 man months

b. implementation time - 2.5 man months

1.3.3 Quantitative Methods Extension

1.3.3.1 A computerized costing model called PAYOFF 3 was developed for translating design improvements in terms of R&M weight volume, and unit cost into LCC savings. The payoffs are time phased in the sense they are limited to the percent completion of the R&D program. Therefore if the R&M program changes in length, funding, or expected design benefits, the LCC will also change. Weapon system planning data along with their expected ADM and R&M windows are inputs to the model. Baseline cost factors are also inputted. These are obtained automatically from the VAMOSC cost data bank at NADC.

1.3.3.2 The model was exercised for three Air Ø3 technologies to demonstrate its capabilities. Technologies considered include light weight hydraulics, ring laser gyro and advanced modular radar. The range of aircraft considered for application included VSTOL A, F18, VSTOL B, VPX, OVX, and A-18. Results from PAYOFF 3 for a representative R&D funding profile are tabulated in figure 6.

1.3.3.3 A more in depth description of the model and the three technologies considered is presented in Section 5 of this report.

1.3.3.4 Implementation Requirements

A. 1 man year per year would be required to operate and maintain the model to support all Air Ø3 technologies with a reasonable number of parametric studies. This estimate assumes there are no charges the baseline cost factors from the VAMOSC data bank and the model is run by NADC personnel. The estimate is location and computer independent.

B. In order for NAVAIR personnel to access the model, a detailed user manual would have to be written and the model and its data bases transferred to NAVAIR's computer. This would require about a .5 man years of work to complete on a one shot basis.

TYPICAL RESULTS FROM
PAYOFF 3 FOR A
SINGLE R&D FUNDING PROFILE

Technology	25 Yr. Baseline Costs $M	Representative R&D Pgm					
		$ M	Δ Rel	Δ Wt	Δ Maint	LCC $M	Savings $M
Lt Wt Hydraulics	1023	17.3	20%	-50%	-10%	849	$174
Ring Laser Gyro	621	24.6	900%	-50%	+100%	235	$386
Advanced Mod Radar	615	28.7	100%	-50%	-50%	240	$375

Figure 6

1.4 CONCLUSIONS

1.4.1 Roadmap and Syllabi

A. Consistent cost effective readiness can not be achieved using present 6.2-6.3 acquisition methods. A major overhaul across the board is needed. Small adjustments to any part alone will not bring about improvement because of the highly interactive nature of the process.

B. Readiness assurance can be realized through the application of the 7 readiness roadmap principles as they tend to close the gap between perceived problems in today's system and an ideal check and balance system between industry and government.

C. The roadmap principles of specification selection, monitoring and parallel design are not revolutionary - they just make good management sense. These same principles are applied on a routine basis by technologists when they acquire performance.

D. The Navy can not implement all of the roadmap concepts overnight on all functional programs in Air Ø3. They must develop the necessary technology base in terms of skills and capabilities before the roadmap can be applied successfully and routinely.

E. Until a total technology base is developed in airframes, power plants, avionics, and armaments, the implementation of the syllabi has the potential for providing low cost immediate relief across all technologies by educating TAs and PEs in the partial use of readiness roadmap.

F. Partial roadmap implementation with its inherent risks of optimistic vendor design responses to the RFP appears to be far superior than present methods of no design at all. The Navy can minimize this risk somewhat by using baseline design data on today's systems and allowing for modest technology growth factors.

1.4.2 Quantitative Methods Extension

A. Life cycle costs capability of the PAYOFF 3 has the potential to aid program management to investigate options from a more rationale point of view rather than a speculative one.

B. Care must be taken to verify the design goal payoff before use of the model otherwise erroneous results will occur and Navy may be no better off than it was before PAYOFF 3.

C. Due to the spontaneous nature of management queries, the PAYOFF 3 model would probably be of more use to the Navy if it were installed in NAVAIR rather than at NADC.

1.5 RECOMMENDATIONS

1.5.1 Air Ø3 adopt a time phased program to develop, test and scope the roadmap implementation concepts proposed with the intention of full implementation on all Air Ø3 technologies in four years. The following would constitute a minimum program between now and then:

		MY
a) 1st year		
	1) publish and distribute the 7 roadmap features to all technologists	.15
	2) implement TA and PE syllabi	1.5
	3) develop technology base for a single function in avionics, power plants, and airframes.	7.5
		9.15
b) 2-4th years		
	1) update and implement TA & PE syllabi	1.0 /yr
	2) update technology base & roadmap as required	3.00/yr
	3) apply full roadmap principles on three 6.2 programs with support of the technology base.	3.00/yr
		7.00/yr

A maximum program would involve 2 functions in each technology base (avionics, power plants, and airframes) instead of one in the minimum case. Either program would provide some payoff to all technologies primarily through the use of the syllabi. The maximum program would provide a greater short term payoff during years 2 through 4 than the minimum (six 6.2 programs with a technical base support vice three) plus a data base for determinimg the full scale implementation requirements based on the benefits of functional commonality within a technology base.

1.5.2 Air Ø3 continue to support the LCC benefits analysis capability on an annual basis for its rapid easy to use credible responses on critical program issues such as schedule, cost, and payoff.

1.5.3 Air Ø3 develop a roadmap for transferring high payoff readiness technologies to Air Ø5 for inclusion in today's systems.

1.5.4 Air Ø3 develop strategy for pushing readiness related technologies outside Air Ø3 particularly in the area of supportability so that aviation designs can be optimized.

SECTION II

Air-Ø3 READINESS ASSURANCE ROADMAP
FOR
AVIONICS SYSTEMS IN 6.2/6.3

2.1 Roadmap Objective

2.1.1 General

Provide a sequential set of events (a traceable path) for assuring the development of cost objective readiness, reliability and maintainability into AIR-03 Avionics Systems from a Navy technical point of view.

2.1.2 Specific

Readiness

- o Prevent errosion of present fleet performance through R&M degradation.
- o Ensure adequate mission success rates.
- o Identify R&M/ILS/operational technologies which must be pushed to ensure readiness bojectives.

Reliability and Maintainability

- o Close the gap between specified values and fleet performance.
- o Improve the level of fleet R&M performance values.
- o Ensure equipment can operate in the most demanding logistics/ operating environment.
- o Ensure that latest technologies are fully exploited.

COST

- o Minimize the cost of design, acquisition, and operations while insuring that fleet readiness requirements are met.

2.1.3 Approach

The approach for developing the required roadmap consisted of an assessment of the present readiness milestones from both a Navy and industry perspective, the formulation of viable alternatives and the selection of a recommended method considering effectiveness, feasibility and implementation costs.

Salient READINESS ASSURANCE MILESTONES

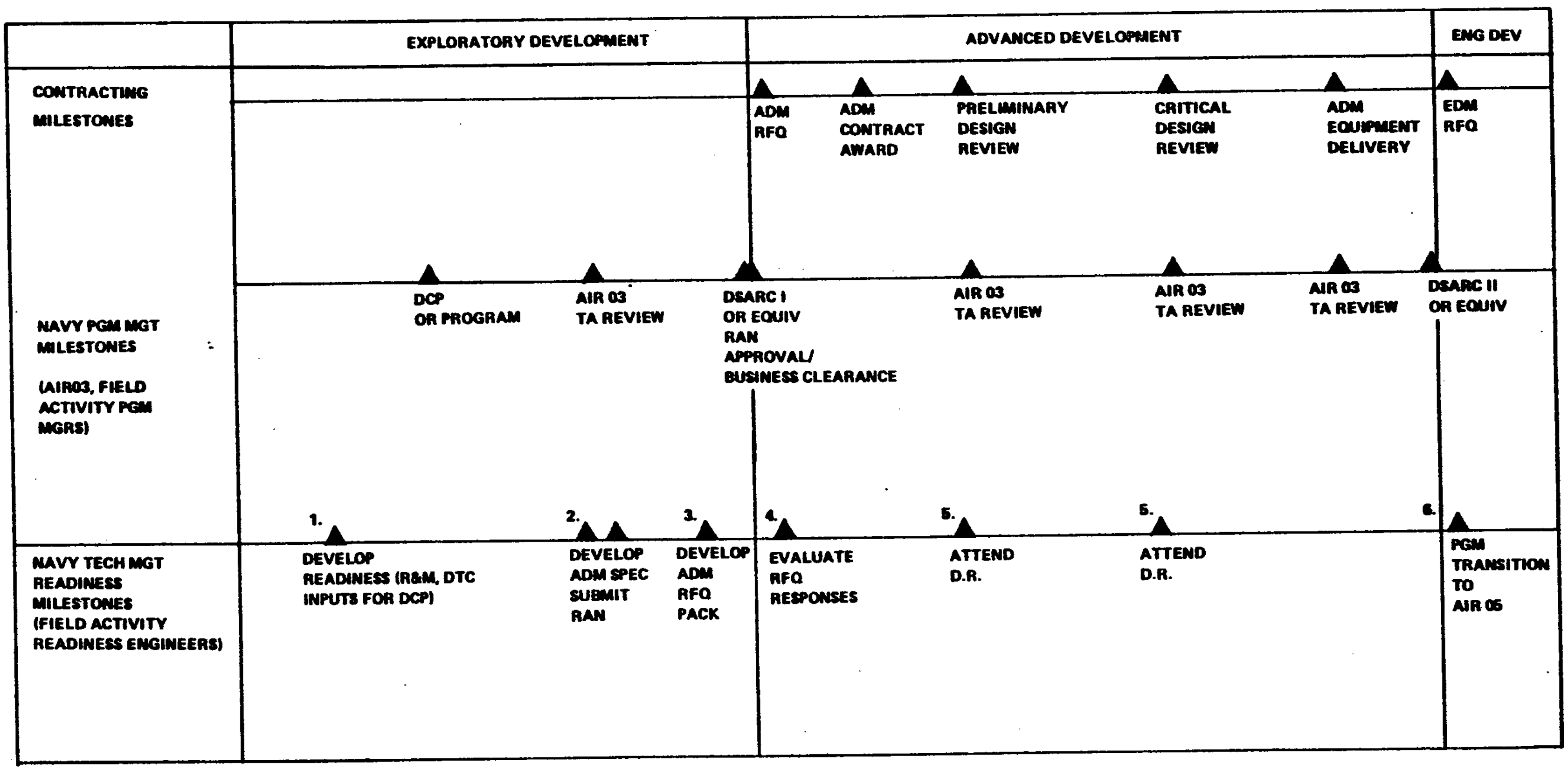


FIGURE 7

2.2 Salient Readiness Assurance Milestones - Present assurance milestones for both NAVAIR and field activity project engineers are summarized in Figure 5 for a typical advanced technology.

2.3 Technical Management Milestones Assessment

2.3.1 Milestone 1 - Readiness Inputs to DCP

2.3.1.1 DEFICIENCY

Reliability and Maintainability goals and requirements do not necessarily reflect the needs of the fleet, the existing R&M status in the fleet, or advances in technology.

2.3.1.2 PROPOSED CORRECTIVE ACTION

Systematize the development of R&M goals and requirements for the ADM DCP.

- o Insure that operational requirements for MTBF and MTTR at the "O" level are considered.
- o Develop the best possible representation of the environemnt to which both the ADM and the production equipments will be exposed.
- o Incorporate the best estimate of the specification MTBF to fleet MFHBF degradation factors.
- o Insure that the Navy requirements and goals for R&M are provided to AIR-03 along with the anticipated uses and technical requirements for the ADM equipment developments.
- o Insure that the latest technologies in R&M and ILS are considered.

2.3.1.3 IMPLEMENTATION REQUIREMENTS

- o Generate and maintain a data base of the R&M parameters for existing AN equipments. Include cost elements, specification requirements, test plans and results, and a history of fleet experience. Develop a data base management system to access the information in an economic/timely manner and pertinent format.
- o Generate and maintain a data base of R&M and cost parameters pertinent to the electronic component environmental interface and support technologies assembly. Develop a data base management system to access the information in an economic and timely manner and pertinent manner.
- o Generate and maintain a data base of expected operating and logistics envoronments. Develop a data base management system to access the information in an economic and timely manner and pertinent format.
- o Develop a comprehensive methodology for the selection of R&M goals and minimum acceptable requirements for all stages of development.

2.3.2 Milestone 2 - Develop ADM Specification

2.3.2.1 DEFICIENCY

ADM specifications do not necessarily reflect realistic or complete readiness goals or the expected logistics/operation environment.

2.3.2.2 PROPOSED CORRECTIVE ACTION

- o Insure that the R&M and DTC requirements in the DCP are included in the ADM specification.
- o Insure that the operating and logistics environment in the DCP are included in the ADM specification.

2.3.3.
2.3.3 Milestone 3 - Develop ADM RFQ Package

2.3.3.1 DEFICIENCY

- o Necessary R&M goals and adequate monitoring requirements are not always included in the specification and contract.
- o R&M design and production data necessary to select the most cost effective design is not always requested.
- o Readiness and life cycle cost are not poart of the evaluation criteria.
- o Development of the most cost effective readiness design approach which capitalizes on the latest technologies is not encouraged via prompt R&M design goal method.

2.3.3.2 PROPOSED CORRECTIVE ACTION

- o Insure specific R&M and cost criteria are included in the RFP evaluation criteria.
- o Insure required R&M activities and date are procured with appropriate delivery schedules.
- o Insure delivery of specific R&M data necessary for evaluation prior to design reviews (i.e., schematics, parts lists, thermal analysis, reliability predictions, cost estimates, etc.)
- o Insure that necessary funds to procure the required R&M activities, both in house Navy and contractor efforts, and the data are specifically ear-marked for R&M purposes.
- o Request multiple R design data along with complete M approach for each R design.
- o Request complete set of cost data for each R&M zesign approach.
- o Request management assurance plan.
- o Request detailed comments on critical technology issues.
- o Request status on tradeoff methodologies and data bases used to select readiness design approach.

2.3.4 Milestone 4 - ADM RFQ Evaluation

2.3.4.1 DEFICIENCY

Primary emphasis is presently on the technical aspects of the contract, with contract price driving the final selection in case of more than one technically acceptable response.

2.3.4.2 PROPOSED CORRECTIVE ACTION

- Utilize R&M critiera as major factors in selecting the ADM contractor.
- Utilize Life Cycle Cost for selecting the final R&M design parameters for each vendor being considered.
- Investigate the possibility of using Life Cycle Cost as a final selection criteria, rather than only ADM contract price, in case of more than one technically acceptable response.

2.3. 4.3 IMPLEMENTATION REQUIREMENTS

- The data bases required for milestone 1 are required.
- Contractural feasibility study for using LCC in lieu of ADM contract price.

2.3.5 Milestone 5- Design Reviews

2.3.5.1 DEFICIENCY

The data necessary to accomplish and independent Navy evaluation of R&M is frequently not available prior to the design review.

2.3.5.2 PROPOSED CORRECTIVE ACTION

- Insure the use of standard Data Item Descriptions and Contract Data Requirement Lists for the R&M data requirements. Require NAVAIR approval for reduction of the requirements of the standard data package.
- Perform an independent assessment of the contractor's R&M activities prior to attending the design reviews.
- Develop/evaluate corrective actions as required.

2.3.5.3 IMPLEMENTATION REQUIREMENTS

- Establish procedures with AIR-03 for reporting anticipated and discovered R&M problems. Include suggested corrective actions and anticipated funding requirements. A candidate format is presented in Section VI.
- Develop a data book of standard work accounts for common reliability & maintainability problems experienced in design.

2.3.5.6 Milestone 6 - Transition to AIR-05

2.3.5.6.1 DEFICIENCY

Data is not necessarily presented to AIR-05 in an optimum manner for improving the Navy contracting activity during EDM.

2.3.5.6.2 PROPOSED CORRECTIVE ACTION

Insure that a coherent total package of data is provided to AIR-05, including:

- History of ADM development
- Operational Requirements
- Assumptions
- R&M goals selected, with rationale
- Progress toward reaching goals
- Problems encountered and status of action items
- Recommendations and Conclusions
- Draft EDM Specification
- Draft R&M Development Plan
- Draft Test Plan
- Draft Incentive Plan

2.4 Proposed AIR 03 Roadmap - A summary of the recommended set of activities consistent with existing readiness assurance milestones and designed to correct the deficiencies of present acquisition methods is presented in Figure 9

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Conceptual Phase

Prior to DCP

- Determine readiness state of equivalent systems and/or functions in the fleet.
- Determine operational requirements for Maintainability at "0" level and for Reliability.
- Develop best possible representation of the operational logistics support environment, both for ADM and production equipments.
- Generate the MTBF requirements for operational equipment, and the expected values at various stages of development. Incorporate specification MTBF to fleet MFHBF degradation factors.
- Verify technical feasibility of R&M requirements, via technology assessments of components, environmental control systems, ILS, packaging installation etc.
- Highlight critical R&M/ILS technologies which design is dependent on to meet its design goals.
- Generate the maintainability requirements for the operation of equipment. Incorporate the best estimate of the maintenance and support policy for the operational equipment.
- Develop unit cost and operating cost estimates guidelines.
- Insure that firm R&M guidance is provided to the Laboratories via the DCP.

Develop ADM Specification

- Insure that the following elements from the DCP are incorporated in the specification.
  - R&M requirements and goals
  - design to cost objectives
  - planned operating and logistics environment

(may be multiple) ADM Phase

Prior to Design Reviews

- Perform an independent assessment of the reliability status.
- Compare the independent assessment with the contractors predictions and the specification, and generate action items based on discrepancies, if any.
- Perform an independent assessment of the maintainability status.
- Compare the independent assessment with the contractors predictions and the specification, and generate action items based on discrepancies, if any.

(may be multiple)

Design Reviews

- Attempt resolution of action items generated by independent assessment.
- Generate suggested corrective actions for unresolved action items and submit to project management.

Develop ADM Specification

- Insure that the following elements from the DCP are incorporated in the specification.
  - R&M requirements and goals
  - design to cost objectives
  - planned operating and logistics environment

ADM RFQ Package

- Insure that responses are sought for a nominal MTBF equipment and also for equipments with higher MTBF and lower MTBF.
- Insure specific R&M and cost criteria are included in the RFP evaluation criteria.
- Insure required R&M activities and data are procured with appropriate delivery schedules.
- Insure the use of standard Data Item Descriptions and Contract Data Requirement Lists for the R&M data requirements. Require NAVAIR approval for reduction of the requirements of the standard data package.
- Insure delivery of specific R&M data necessary for evaluation prior to design reviews (ie; schematics, parts lists, thermal analysis, reliability predictions, maintainability predictions, cost estimates, etc.)
- Insure that necessary funds to procur[e] required R&M activities and the data [...] in house Navy and contractor efforts [...] specifically earmarked for R&M purp[oses]
- Insure resonances contain complete [...] approach and cost data for each relia[bility ap]proach considered.
- Insure responses are sought in critic[al] technical issue.
- Insure that responses are sought in a[...] methodologies and data bases used to R&M and ILS design approaches.
- Insure that responses are sought in th[e ...]ment of R&M achievement during AD[M]

(may be multiple)

Design Reviews

- Attempt resolution of action items generated by independent assessment.
- Generate suggested corrective actions for unresolved action items and submit to project management.

Prior to Transition to AIR-05

Insure that a coherent total package of data to be provided to AIR-05 is generated, including:

- History of ADM development
- Operational Requirements
- Assumptions
- R&M goals selected, with rationale
- Progress toward reaching goals
- Problems encountered and status of action items
- Recommendations and Conclusions
- Draft EDM Specification
- Draft R&M Development Plan
- Draft Test Plan

ADM Phase

ADM RFQ Package

- Insure that responses are sought for a nominal MTBF equipment and also for equipments with higher MTBF and lower MTBF.
- Insure specific R&M and cost criteria are included in the RFP evaluation criteria.
- Insure required R&M activities and data are procured with appropriate delivery schedules.
- Insure the use of standard Data Item Descriptions and Contract Data Requirement Lists for the R&M data requirements. Require NAVAIR approval for reduction of the requirements of the standard data package.
- Insure delivery of specific R&M data necessary for evaluation prior to design reviews (ie; schematics, parts lists, thermal analysis, reliability predictions, maintainability predictions, cost estimates, etc.)
- Insure that necessary funds to procure the required R&M activities and the data for both in house Navy and contractor efforts are specifically earmarked for R&M purposes.
- Insure resonances contain complete maintenance approach and cost data for each reliability approach considered.
- Insure responses are sought in critical results technical issue.
- Insure that responses are sought in all, tradeoff methodologies and data bases used to develop the R&M and ILS design approaches.
- Insure that responses are sought in the management of R&M achievement during ADM.

ADM RFQ Evaluation

- Utilize Life Cycle Cost for selecting the final R&M design parameters for each vendor being considered.
- Utilize R&M criteria as major factors in selecting the ADM contractor.
- Investigate the possibility of using Life Cycle Cost as a final selection criteria, rather than only ADM contract price, in case of more than one technically acceptable response.

EDM Phase

Prior to Transition to AIR-05

Insure that a coherent total package of data to be provided to AIR-05 is generated, including:

- History of ADM development
- Operational Requirements
- Assumptions
- R&M goals selected, with rationale
- Progress toward reaching goals
- Problems encountered and status of action items
- Recommendations and Conclusions
- Draft EDM Specification
- Draft R&M Development Plan
- Draft Test Plan

Transition to AIR-05

- Transmit total data package (Final Report) to AIR-05.

Proposed AIR-03 Roadma

FIGURE 8

3

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SECTION III

AIR 03 READINESS ASSURANCE SYLLABUS FOR NAVAIR TECHNICAL ADMINISTRATION

3.1 General. This section presents a syllabus for a course designed to the readiness awareness of technological administrators in the AIR 03 community.

The resultant syllabus reflects the findings of a readiness technical team which surveyed a sampling of TSa and their staff prior to development to assess the current level of awareness.

The syllabus achieves increased awareness by (a) generating a confidence with the termonology and standard assurance methods, (b) demonstrating a need for readiness assurance through the consequences of near readiness and the emerging challenges of a smaller, austere and distributed Navy and (c) presenting an effective methodology for achieving readiness through design.

The syllabus motivates the use of increased readiness awareness by (a) illustrating how readiness will be monitored and rewarded within the AIR-05 management system, (b) demonstrating how readiness can be used to retain on-going programs and market new ones and (c) outlining the availability and use of data bases within the NAVAIRSYSCOM to facilitate the use of the new readiness assurance roadmap.

The syllabus is not oriented around a mathematical treatment on the subject of ADM, ILS or life cycle cost.

Implementation of the proposed syllabus will require research on each topic delineated as well as packaging into both presentation and booklet formats. It is estimated that three (3) man-months are required for initial preparation and 2.5 man-months for initial implementation. Annual preparation updates and implementations are estimated to require 3 and 2.5 man-months respectively.

3.2 Recommended Syllabus

TITLE:

SYLLABUS OUTLINE FOR READINESS AWARENESS

OBJECTIVE:

To help Technological Administrators within NAVAIRSYSCOM gain an increased understanding for the need for readiness awareness and its vital importance to the Navy and the management methods and controls which facilitate the achievement of readiness in the most cost effective manner.

CONTENT:

The course will consider key dimensions of readiness in order to increase the awareness of the importance of readiness and identify potentials for further work and study by the participants.

METHODS:

The course can be implemental in either of two ways:

1. A one-day workshop utilizing lecture, simulation and discussion
2. A printed self-instruction program in the form of a booklet.

SALIENT TOPICS:

1. What is readiness?
2. Why is readiness assurance important in the development of NAVAIR programs?
   - 2.1 Present Fleet readiness trends
   - 2.2 Changing threat
   - 2.3 Changing political envoronment
   - 2.4 DoD budget considerations
   - 2.5 Capabilities and limitations of MIL STD's and MIL SPECs for assuring readiness
   - 2.6 Cost Study with present readiness assurance methods
3. A roadmap for readiness assurance in 6.2/6.3/6.4
4. Conceptual phase readiness assurance activities amplified
   - 4.1 R&M/readiness goals
   - 4.2 Operating/Logistics Operating Environment
   - 4.3 R&M/ILS Design Approach
   - 4.4 Critical R&M/ILS Technologies
   - 4.5 Contracting for maximum industry R&M creativity
   - 4.6 Contracting for total system readiness
   - 4.7 Contract awards based on LCC considerations
   - 4.8 Contracting for R&M monitoring
5. ADM phase readiness assurances activities amplified
   - 5.1 Continual exchange of R&M/ILS data
   - 5.2 Independent R&M assessment
6. How readiness can be used to advantage in marketing 6.2 and 6.3 programs
7. How to initiate critical readiness assurance technologies
8. Summary of benefits and costs of implementation of the new readiness assurance roadmap and how to budget for the costs.

SECTION IV

AIR 03 READINESS ASSURANCE SYLLABUS FOR PROGRAM MANAGERS AND PROJECT ENGINEERS

4.1 General. This section presents a syllabus for a course designed to increase the readiness awareness of project engineers within NAVAIRSYSCOM and the Navy field activities.

The resultant course reflects the findings of a readiness technical team which surveyed a sampling of PEs and their staff prior to development to assess the current level of awareness.

The syllabus achieves increased awareness by (a) generating a confidence with the termonology and standard assurance methods, (b) demonstrating a need for readiness assurance through the consequences of poor readiness and the emerging challenges of a smaller, austure and distributed Navy and (c) presenting and illustrating an effective methodology for achieving readiness through design.

The syllabus motivates the use of increased readiness awareness by (a) illustrating how readiness will be monitored and reworded by the field activity managmeent, the AIR 03 sponsors, and Fleet review teams at COMOPTEVFOR, and (b) outlining the availability and use of data bases and technical support personnel skilled in the new readiness assurance roadmap techniques.

The syllabus is not oriented around a mathematical treatment on the subject of R&M, ILS, or life cycle costs.

The primary difference between the PE course and the TA course is depth. The PE course demonstrates more of the day to day mechanics of the implementation of the readiness assurance roadmap whereas the TA course does not.

Implementation of the proposed syllabus will require research on each topic delineated as well as packaging into both presentation and booklet formats. It is estimated that 6 man-months are required for initial preparation and 2.5 for initial implementation at each Navy laboratory. Annual preparation updates and implementation are estimated to require 3 and 2.5 man-months respectively.

4.2 RECOMMENDED SYLLABUS

TITLE:

SYLLABUS OUTLINE FOR READINESS AWARENESS

OBJECTIVE:

To help PMs and PEs within NAVAIRSYSCOM and its field activities to become more aware of the importance and potential for incorporating readiness concerns in the conceptual and advanced development design stages through the contractural processes and available data banks and methodologies.

CONTENT:

This course will consider key dimensions of readiness in order to increase awareness of the importance of readiness and identify potentials for further work and study by the participants.

METHODS:

This course will utilize: lectures, class notes, and discussions to present concepts; and problem-solving simulations to engage participants in the use of those concepts and involve them in relating readiness to the kind of issues they face on their jobs. The course is expected to take three 8 hour sessions to complete.

OVERVIEW:

SESSION	TOPICS	CLASS TIME (Hrs)
I	Orientation and Importance of Readiness.	4
II	Readiness Assurance Methodology.	4
III	Implementation Requirements for Contractual Phase Readiness Assurance Methods.	4
IV	Implementation Requirements for Assuring Readiness via the ADM Contractual Process.	8
V	Implementation Requirements for Assuring Readiness During ADM.	4
		24

SESSION 1

1. Introduction & Orientation
   1.1 Definition of readiness
   1.2 Readiness reporting
   1.3 Current fleet readiness and costs
   1.4 Readiness data banks
   1.5 Future threat
   1.6 DoD budget levels
   1.7 Impact of acquisition process on readiness

2. Team competition on problem solving with data from case study on "Retrofit" for Readiness (e.g., Airborne Fire Control Radar Set - AWG 10); Given this equipment with its known readiness problem, develop an approach and suggest a corrective action to ease the problem.
   2.1 Divide group into teams.
   2.2 Each team prepares a solution
   2.3 Teams report and critique each others' work.
   2.4 Teams compare their solutions to solution actually adopted in case study.

3. Discuss problem-solving experience
   3.1 Identification of principles used by the teams in developing their approaches
   3.2 Identification of applications to participants' jobs.

4. Present and discuss material relating to:
   4.1 Why readiness is important in the development of NAVAIR programs.
   4.2 Where readiness fits in the DOD Procurement cycle.
   4.3 Whose attention is required for readiness development.

5. Identify potentials for further information (papers, courses, and related issues)
   5.1 Current Fleet Problems
   5.2 Current AIR 03/05 Readiness Programs
   5.3 Readiness Data Sources

SESSION 2

1. Capabilities and limitations of MIL STDs and MIL SPECs for readiness assurance

2. A new roadmap for readiness assurance in 6.2/6.3/6.4

3. Conceptual Phase readiness assurance activities amplified

    2.1 R&M/readiness goals

    2.2 Operating/Logistics environments

    2.3 R&M/ILS design approach

    2.4 Critical R&M/ILS Technologies

    2.5 Contracting for maximum industry R&M creativity

    2.6 Contracting for total system readiness

    2.7 Contract awards bond on LCC consideration

    2.8 Contracting for continual R&M monitoring

4. ADM phase readiness assurance activities amplified

    3.1 Independent R&M assessment

    3.2 Implementing R&M design changes

5. Navy requirements for implementation

    5.1 Prediction methods

    5.2 Data bases

    5.3 Fund analysis

SESSION 3

1. Development of R&M/readiness goals
   - 1.1 R&M/readiness defined
   - 1.2 Differentiation between specification, laboratory values and fleet values
2. Development of operational/logistics environments
   - 2.1 Task force mix
   - 2.2 Planned utilization
   - 2.3 Available support platforms/bases
3. Development of R&M/ILS Design approach
   - 3.1 R&M/ILS technology assessment
   - 3.2 Synthesis of alternatives
   - 3.3 Evaluation of alternatives in terms of readiness, cost, turnaround time, space requirements, skill level requirements, etc.
4. Critical R&M/ILS technologies
   - 4.1 Readiness parametric analysis
   - 4.2 R&M/ILS technology advancement studies

SESSION 4

1. Preparation of the readiness specification
   - 1.1 R&M/readiness goals and thresholds.
   - 1.2 Design to cost goals
   - 1.3 Logistics/operating environment
   - 1.4 Applicable MIL STDs and SPECs and cost implications

2. Preparation of the RFQ for total systems readiness responses
   - 2.1 Rel approach format
   - 2.2 Maintenance approach format
   - 2.3 Maintenance concept format
   - 2.4 ICS approach format
   - 2.5 Cost elements
   - 2.6 Sources of data
   - 2.7 Tradeoff methodologies

3. Preparation of the RFQ for maximum industry R&M creativity
   - 3.1 Range of R&M within SOA
   - 3.2 Cost vs number of R&M design approaches

4. DIDS required for effective contract monitoring
   - 4.1 R&M design data and timing
   - 4.2 MO for affecting proposed dsigns

5. Evaluation Criteria for ADM awards
   - 5.1 ADM development costs
   - 5.2 Readiness, availability, R&M
   - 5.3 LCC
   - 5.4 Quality of management plan
   - 5.5 Credibility of readiness inputs

6. Navy requirements for implmentation
   - 6.1 Assessment methods
   - 6.2 Data bases

SESSION 5

1. Methodology for an independent R&M assessment
   - 1.1 MIL STD 217 B
   - 1.2 In house skills required for implementation
2. Methodology for Impacting the design
   - 2.1 Requirements development
   - 2.2 Benefits analysis
   - 2.3 Adjusting planned budgets

SECTION V

PAYOFF 3, A READINESS ECONOMCTRIC MODEL FOR ADVANCED TECHNOLOGIES

5.1 OVERVIEW

PAYOFF 3 is a computerized model designed to project the life cycle cost savings of expected reliability, maintainability, weight, and unit cost improvements which characterize advanced technology designs in 6.2 or 6.3. The model is also structured to permit the rapid evaluation of a variety of sensitivity analyses such as the impact on savings due to reduced/accelerated funding, program slippage, and/or partial readiness benefits.

The PAYOFF3 model calculates life cycle savings in two steps. First it computes the life cycle costs assuming no changes to present day technology. This is the baseline. It then computes the life cycle costs with the new technology. The life cycle savings is the difference between the baseline and improved case.

Life cycle costs in PAYOFF3 are computed by summing the individual life cycle costs for a fixed set of existing and proposed aircraft over the same life cycle. Aircraft in the set are all likely candidates for the technology being evaluated.

Life cycle cost elements in PAYOFF3 include R&D costs to develop the new technology, acquisition costs to install the new technology, initial outfitting costs (ie pipeline spares, special support equipment, publications, etc) and operating costs.

There are four primary inputs which control the amount of savings projected by PAYOFF3. They are 1) the degree of R&M, unit cost, and weight improvements, 2) the timing of the ADM/EDM windows on each weapon system application relative to the completion of the technology, 3) the quantity of aircraft receiving the technology, and 4) the technology funding profile which controls the rate of benefit growth.

Outputs from PAYOFF3 are both tabular and graphic. Cost tables are generated for baseline and new technology cases by individual aircraft and life cycle year. A graph of total costs by year for both baseline and new technology is also generated.

PAYOFF3 is written in FORTRAN and is currently operational on NADC's CDC 6600. It automatically interfaces with NADC's Fleet readiness data bank for realistic cost and R&M factors which are functionally equivalent to the advanced technology being evaluated. The data bank is updated annually through an AIRTASK with Air 4105.

5.2 INPUTS

- Future Aircraft Procurement

Aircraft	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97
A				ADM		EDM		30	70	150	150	150	150	150	150	150	150	70	30		
B																					
A																					
C																					
.																					
.																					
n																					

- Baseline Aircraft Properties

  A. Physical

    1. empty wt
    2. ratio of subsystem wt to total
    3. fuel consumption (barrels/hour).

  B. Acquisition Costs

    1. unit technology cost
    2. slope for airframe \$/lb learning curve
    3. offset for airframe \$/lb learning curve
    4. slope for unit cost curve
    5. offset for unit cost curve

  C. Operational

    1. monthly utilization

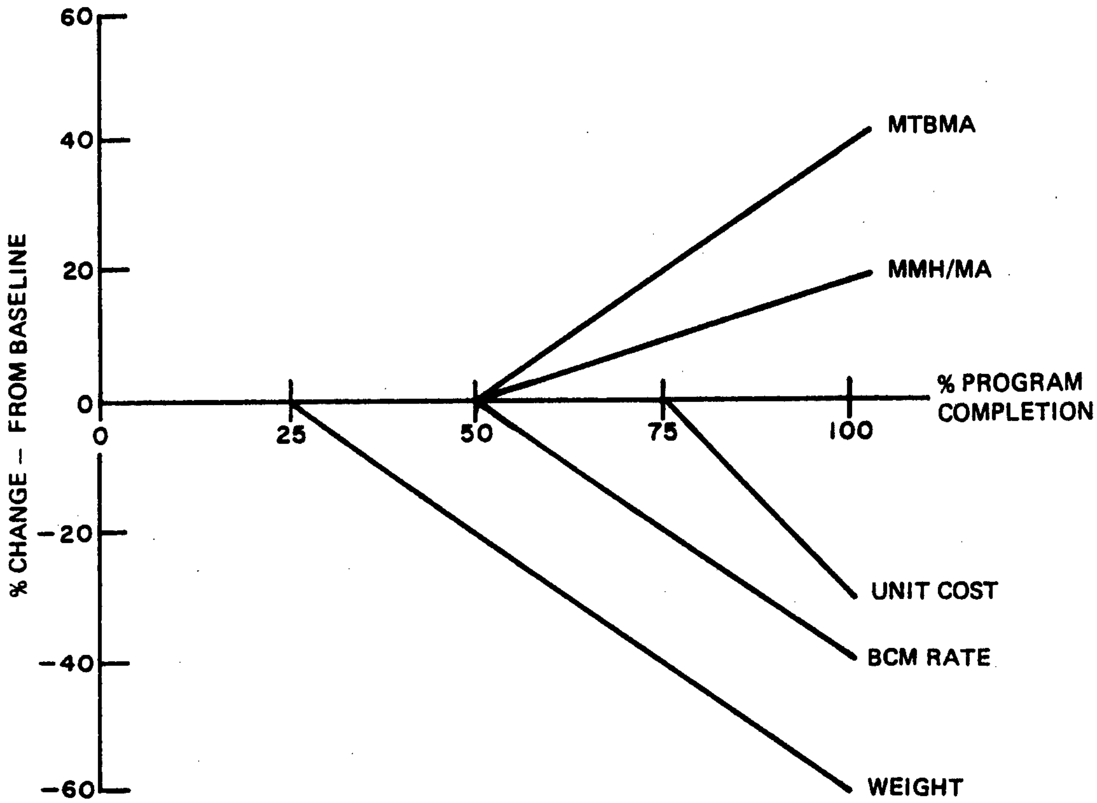
D. R&M

1.	MTBMA	
2.	MMH/MA @ 0 Level	(K_1)
3.	MMH/MA @ I Level	(K_2)
4.	MMH/repair @ D Level	(K_3)
5.	0 Level MA/total MAs	(K_4)
6.	0 Level repairs/total MAs	(K_5)
7.	I Level MAs/total MAs	(K_6)
8.	I Level repairs/total MAs	(K_7)
9.	I Level attritions/total MAs	(K_8)
10.	NARF repairs/total MAs	(K_9)
11.	Commercial repairs/total MAs	(K_{10})
12.	Depot surveys/total MAs	(K_{11})

E. R&M Cost Factors

1.	Matl \$/0 Level repair	(C_1)
2.	Matl \$/I Level repairs	(C_2)
3.	Matl \$/I Level attrition	(C_3)
4.	Matl \$/NARF repair	(C_4)
5.	Matl \$/D Level survey	(C_5)
6.	Matl \$/commercial repair	(C_6)
7.	Labor \$ per direct hour for O&I maintenance	(C_7)
8.	Labor \$ per direct hour for D maintenance	(C_8)
9.	Labor \$ per direct hour for commercial maintenance	(C_9)

- **TECHNOLOGY GROWTH FACTORS**



- **FUNDING PROFILES**

A. ADM R&D

77	78	79	80	81	82	Σ
1M	2M	2M	2M	1M	.5M	8.5M

B. PECULIAR GSE & TRAINING

82	83	84	85	86	87	88	89	90	91	Σ
.2M	.2M	.4M	.4M	.4M	.6M	.6M	.4M	.4M	.2M	3.8M

5.3 OUTPUTS

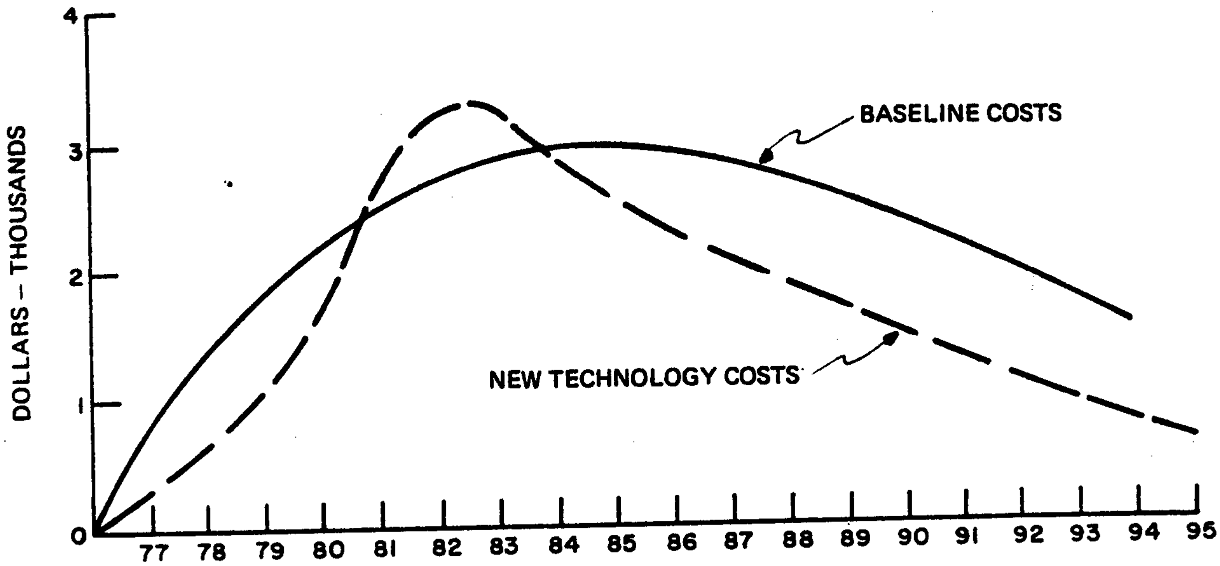
- Baseline Life Cycle Costs

Aircraft	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	
A																						
B																						
C																						
D																						
n																						
	b1	b2	b3	b4	b5	b6	b7	b8	b9	b10	b11	b12	b13	b14	b15	b16	b17	b17	b19	b20	b21	TOTAL

- Technology Growth Life Cycle Costs

Aircraft	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	
A																						
B																						
C																						
D																						
n																						
	g1	g2	g3	g4	g5	g6	g7	g8	g9	g10	g11	g12	g13	g14	g15	g16	g17	g18	g19	g20	g21	TOTAL

- Overall savings graph



5.4 EQUATIONS

- LCC = R&D + Acquisition + IOL + Operating
- Acquisition = unit price x quantity x Learning Factor
- IOL = GSE + training + pipeline spares

GSE + training (input)

pipeline spares = site + depot

$$\text{site spares} = \left\{ \sum_{\text{all sites}} (\text{daily removal rate} \times 3) \right\} \text{unit price}$$

$$\text{depot spares} = \left\{ \sum_{\text{all sites}} (\text{daily BCM rate} \times 120) \right\} \text{unit price}$$

- Operating = maintenance + POL

  - maintenance $= \dfrac{12X \text{ utilization} \times \sum_{i=1}^{n \text{ years}} (AC)_i}{\text{MTBMA}} \left\{ \dfrac{K_1 C_1}{K_4} + \dfrac{K_1 C_1}{K_4} + \dfrac{K_3 C_8}{K_9} + \dfrac{C_1}{K_5} + \dfrac{C_2}{K_6} + \dfrac{C_3}{K_8} + \dfrac{C_4}{K_9} + \dfrac{C_5}{K_{11}} + \dfrac{C_6}{K_{10}} \right\}^{(1)}$

  - POL $= \dfrac{\text{subsystem net}}{\text{total wt}} \times \dfrac{\text{barrels}}{\text{hr}} \times 12X \text{ utilization} \times \sum_{i=1}^{\underline{n} \text{ years}} \times \dfrac{\$}{\text{barrel}}$

Notes

1. See input section for an explanation of the C_i and K_j.

5.5 HYDRAULIC TECHNOLOGY APPLICATION

5.5.1 Objective - To investigate the cost savings for three different hydraulics technologh programs for a set of weapons systems over the next 25 years.

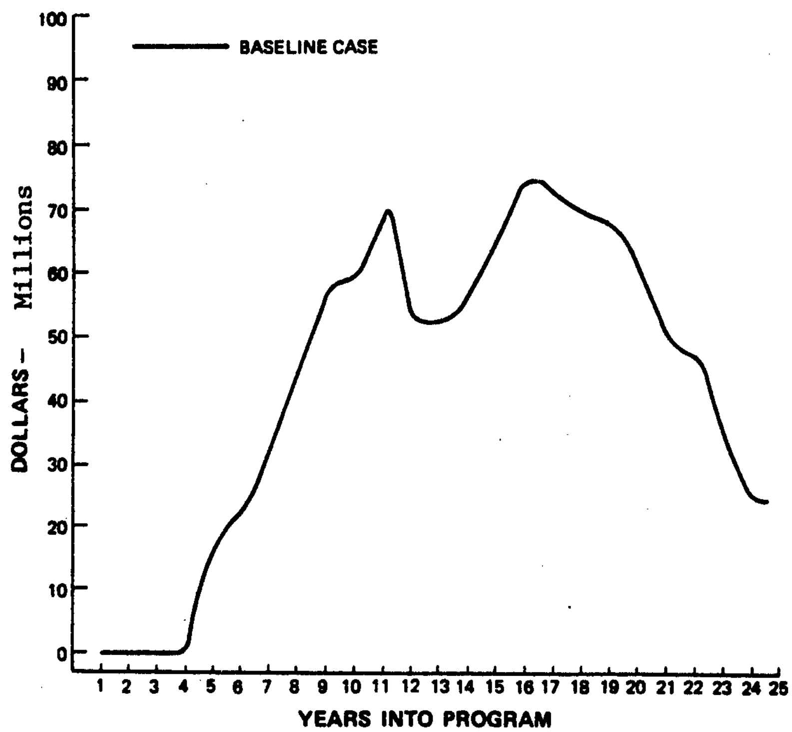
5.5.2 Approach - A baseline case consisting of no advance in technology and three cases investigating the sensitivy to various level of improvement and funding rates were evaluated using the PAYOFF 3 model. The weapons systems considered are the A-18, AHX, CVHSL, F-18, HXH, HXM, KAX, KCX, OVX, VAMX, VPX, VSTOL-84, VSTOL A and VSTOL B.

5.5.3 Summary of Results

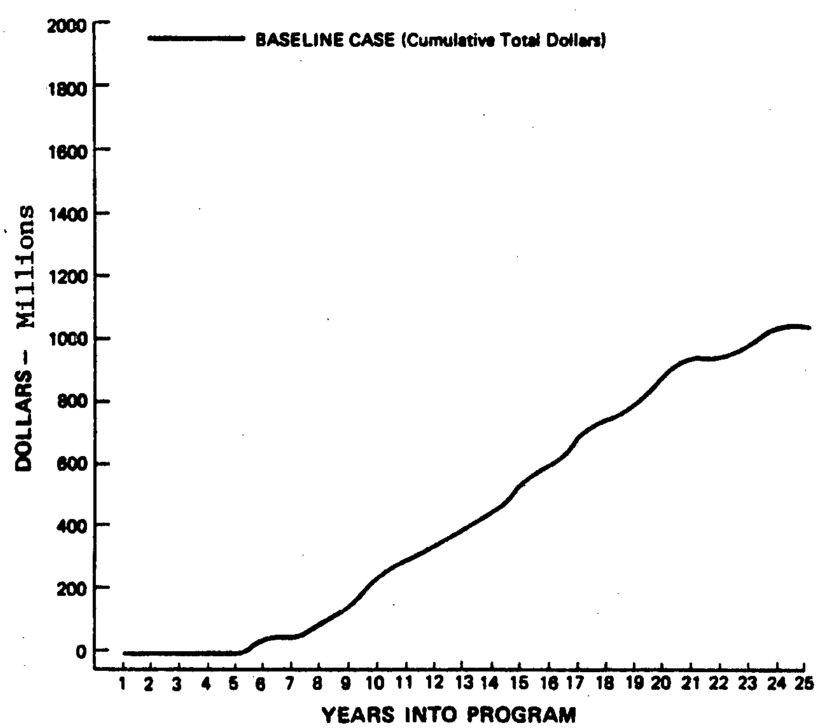
	Baseline	Case I	Case II	Case III
Life Cycle Cost ($ FY-75)	$1023 M	$ 849 M	$1049 M	$1198 M
R&D Funding	NONE	$17.3 M	$21.5	$38.4
System Weight	No Change	- 50%	- 50%	- 50%
MTBMA	No Change	+ 20%	_ 40%	_ 40%
MMH/MA	No Change	- 10%	- 20%	- 20
BCM Rate	No Change	- 5%	- 10%	- 10

5.5.4 Baseline Costs

5.5.4.1 Per Year

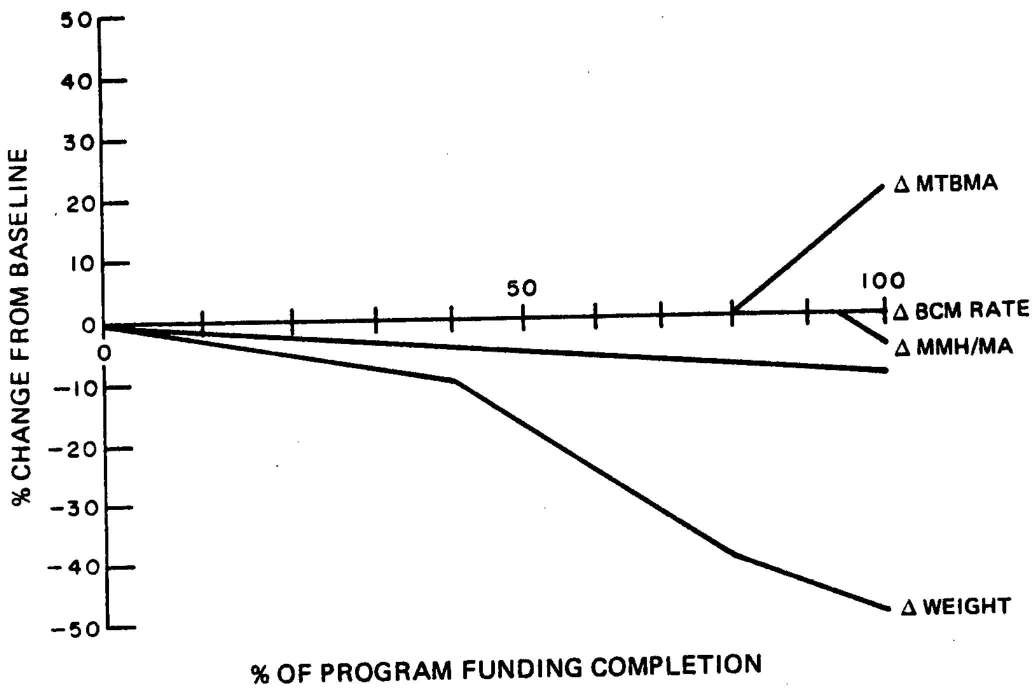


5.5.4.2 Cumulative



5.5.5 Case 1 - Description

5.5.5.1 o HYDRAULICS TECHNOLOGY GROWTH FACTORS - CASE 1

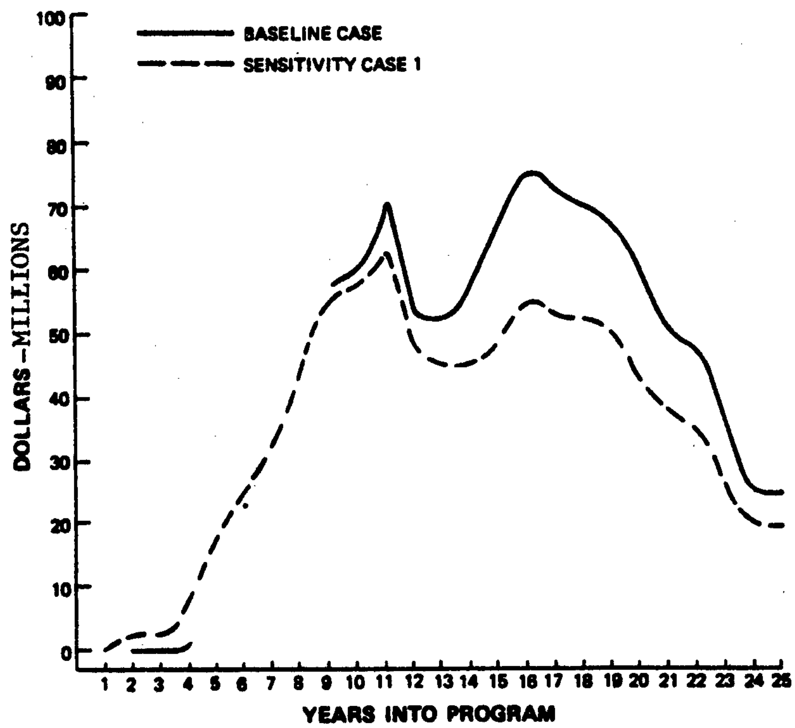


5.5.5.2 o R&D FUNDING PROFILE - CASE 1

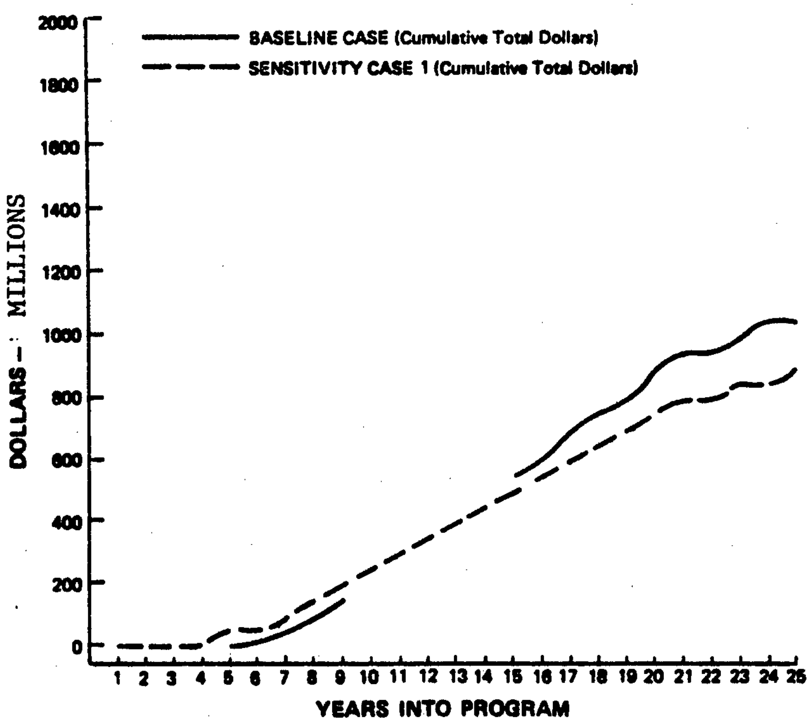
FY	77	78	79	80	81	82
$M	.4	1.4	3.5	7.0	2.5	2.5

5.5.5.3 <u>LCC Profile</u>

5.5.5.3.1 <u>Cost per year</u>



5.5.5.3.2 Cumulative Costs

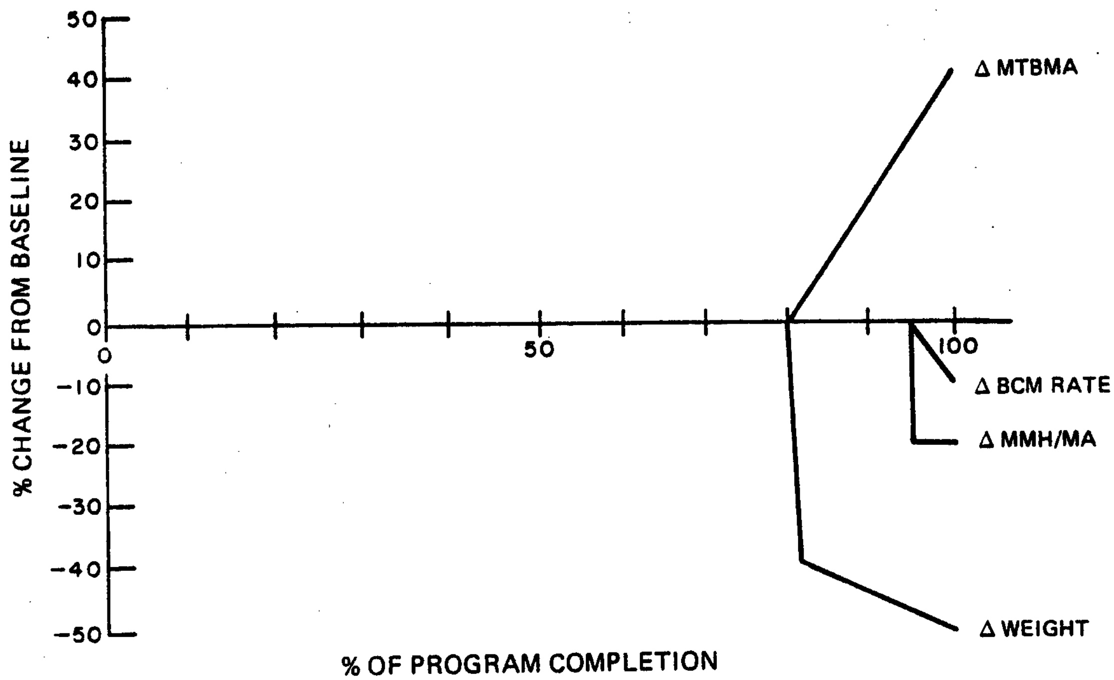


5.5.6.4 Cost Summary

TOTAL R&D FUNDING	LIFE CYCLE COST	NET SAVINGS
$21.5 M	$1049 M	- $29 M

5.5.6 Case II - Description

5.5.6.1 o HYDRAULICS TECHNOLOGY GROWTH FACTORS - CASE 11

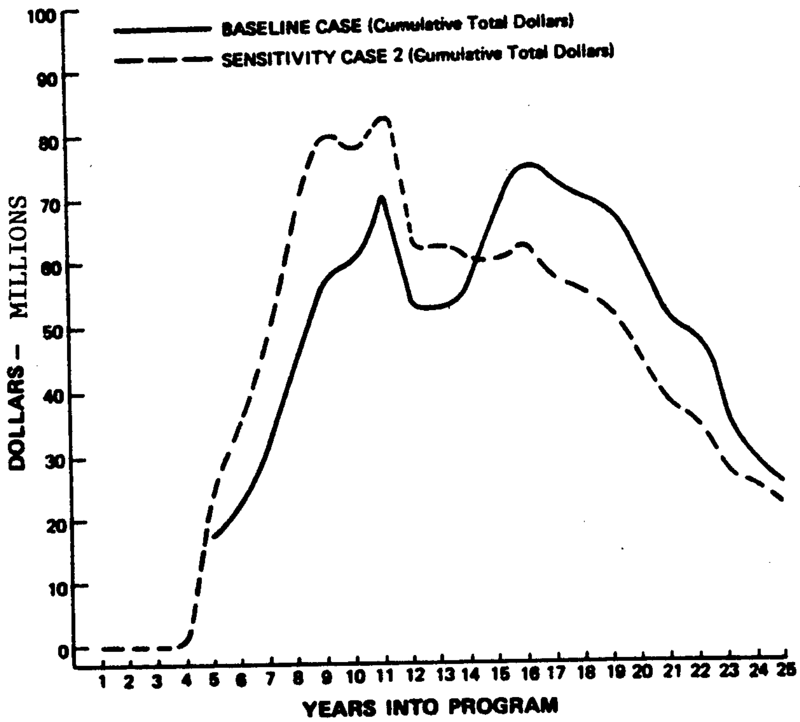


5.5.6.2 o FUNDING PROFILE - CASE 11

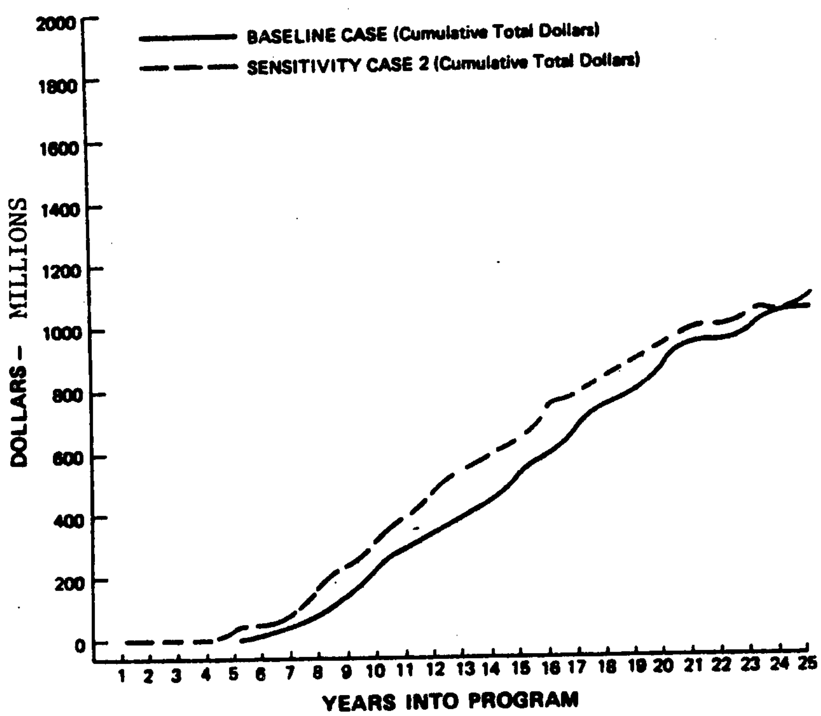
FY	79	80	81	82	83	84	85
$M	.5	.5	3.5	6.0	4.5	4.5	2.0

5.5.6.3 LCC Profile

5.5.6.3.1 Cost Per Year



5.5.6.3.2 Cumulative Cost Per Year

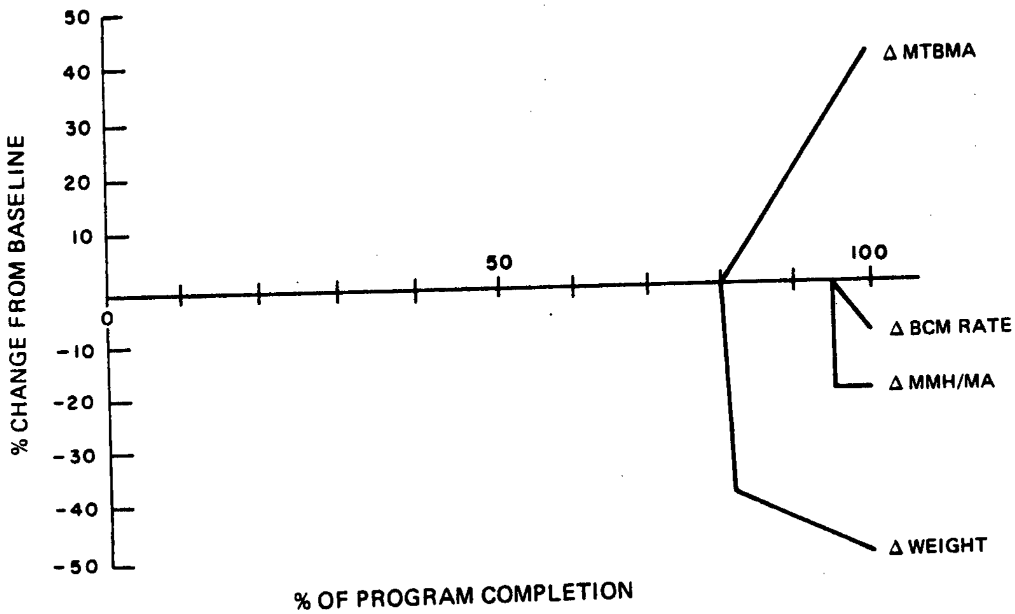


5.5.6.4 Cost Summary

TOTAL R&D FUNDING	LIFE CYCLE COST	NET SAVINGS
$17.3 M	$849 M	$174 M

5.5.7 Case III - Description

5.5.7.1 o HYDRAULICS TECHNOLOGY GROWTH FACTORS - CASE 111

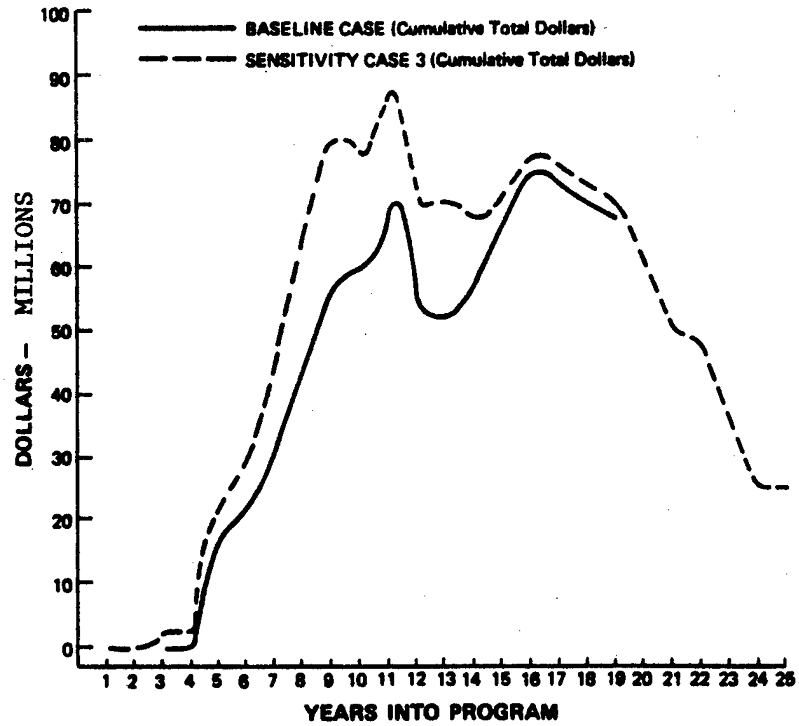


5.5.7.2 o FUNDING PROFILE - CASE 111

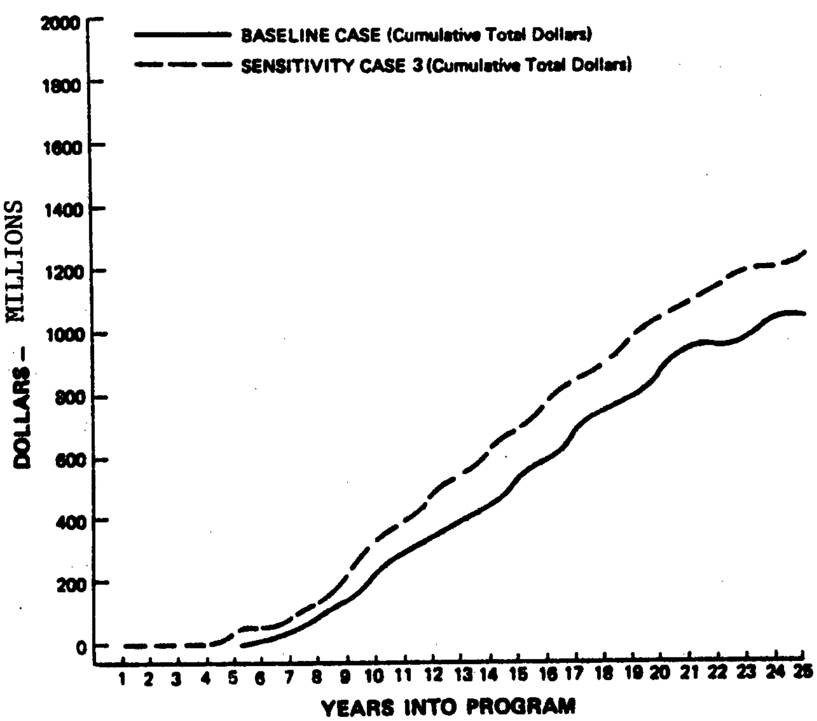
FY	78	79	80	81	82	83	84	85	86	87	88	89	90
$M	.4	1.5	1.5	2.5	2.5	2.5	2.5	2.5	1.5	6.0	6.5	7.0	1.5

5.5.7.3 LCC Profile

5.5.7.3.1 Cost Per Year



5.5.7.3.2 Cumulative Cost Per Year



5.5.7.4 Cost Summary

TOTAL R&D FUNDING	LIFE CYCLE COST	NET SAVINGS
$38.4 M	$1198 M	- $175 M

5.6 MODULAR RADAR APPLICATION

5.6.1 Objective - Investigate the cost savings for four different programs for a set of weapon systems over the next 25 years.

5.6.2 Approach - A baseline case consisting of no advance in technology and four cases investigating the sensitivity to various levels of improvement and funding rates were evaluated using the PAYOFF 3 mode.

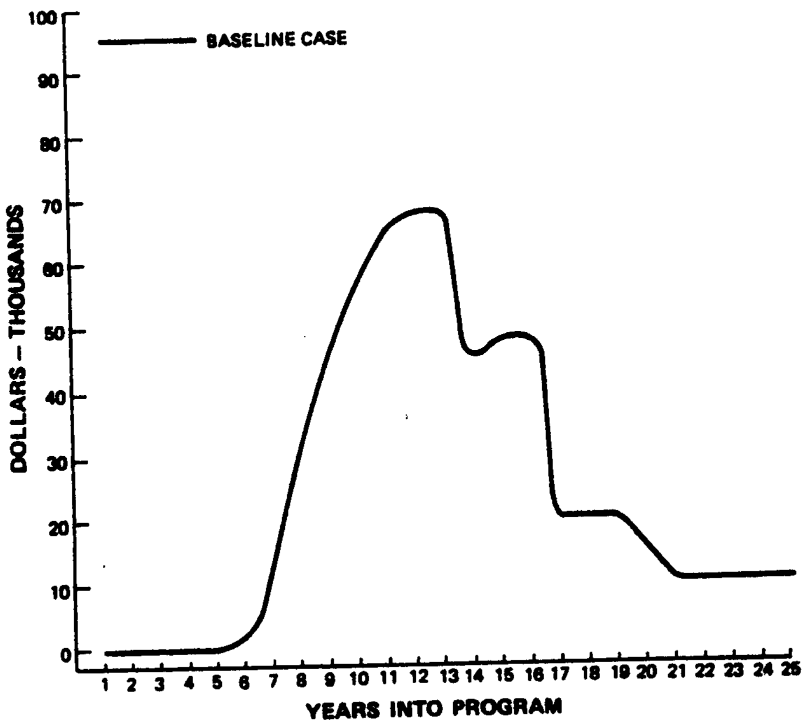
The weapon systems considered are the A-18, VAMX, and VSTOL B.

5.6.3 Summary of Results

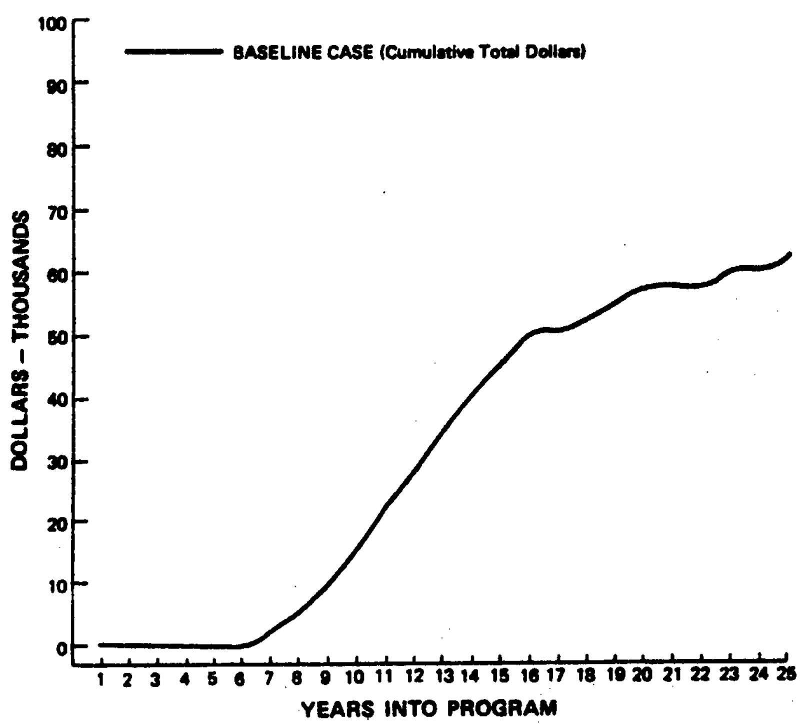
	Baseline	Case I	Case II	Case III	Case IV
Life Cycle Cost ($FY-75)	$615.3 M	$239.6 M	$381.8 M	$307.4 M	$440.1 M
R&D Funding	NONE	$ 28.7 M	$ 28.7 M	$ 28.7 M	$ 28.7 M
Sys Weight	No Change	- 50%	- 50%	- 25%	- 25%
MTBMA	No Change	+100%	+100%	+ 50%	+ 50%
MMH/MA	No Change	- 50%	- 50%	- 25%	- 25%
BCM Rate	No Change	-	-	-	-

5.6.4 Baseline Costs

5.6.4.1 Per Year

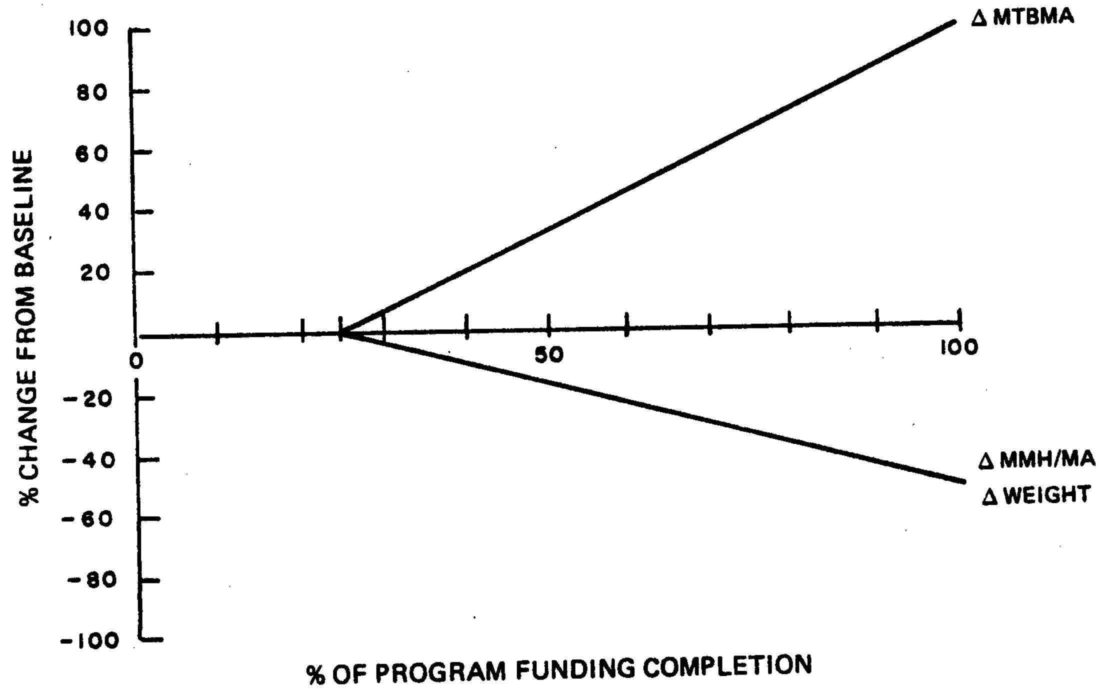


5.6.4.2 Cumulative



5.6.5 Case 1 - Description

5.6.5.1 o MODULAR RADAR GROWTH FACTORS - CASE 1

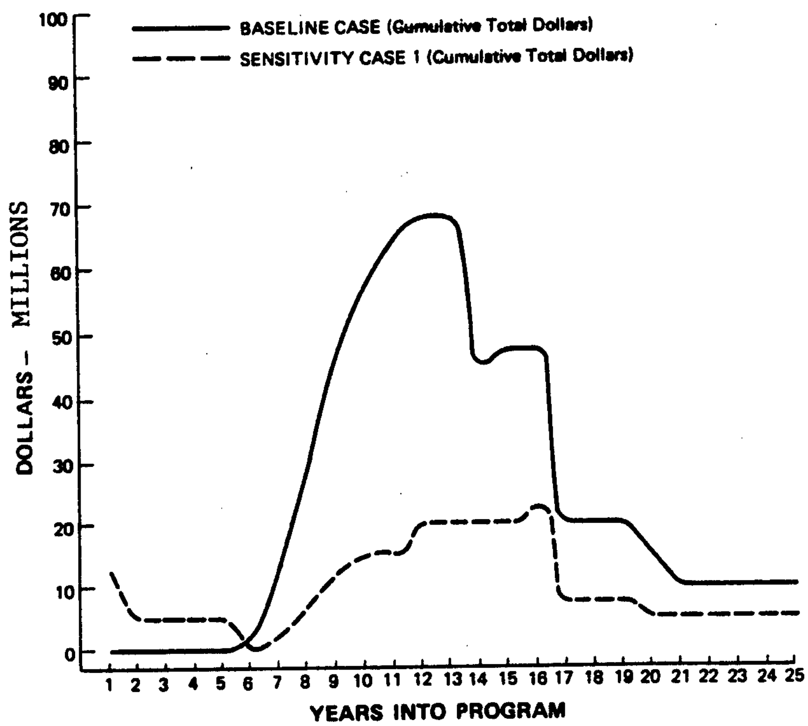


5.6.5.2 o R&D FUNDING PROFILE - CASE 1

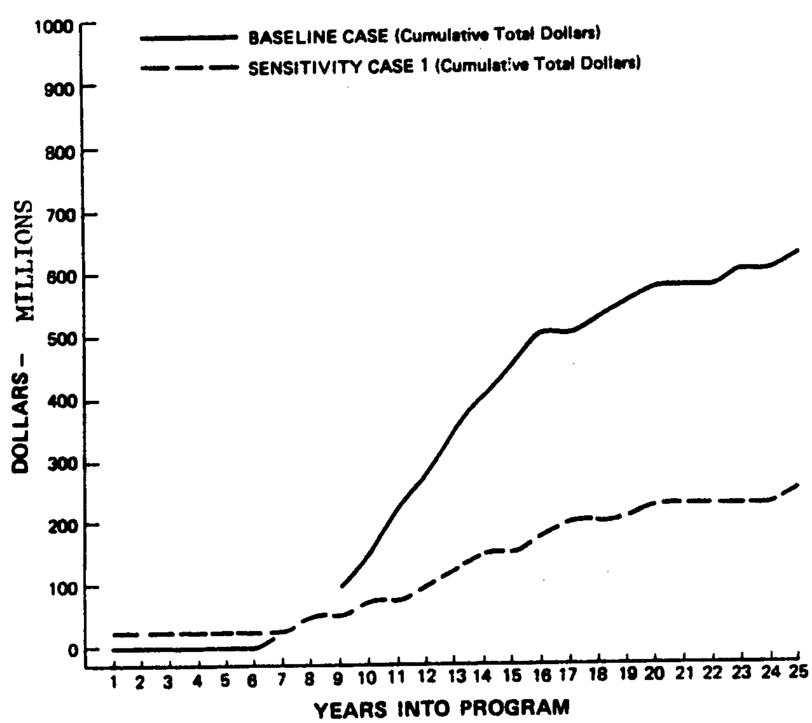
FY	77	78	79	80	81
$M	12.7	4.0	4.0	4.0	4.0

5.6.5.3 LCC Profile

5.6.5.3.1 Cost Per Year



5.6.5.3.2 Cumulative Costs

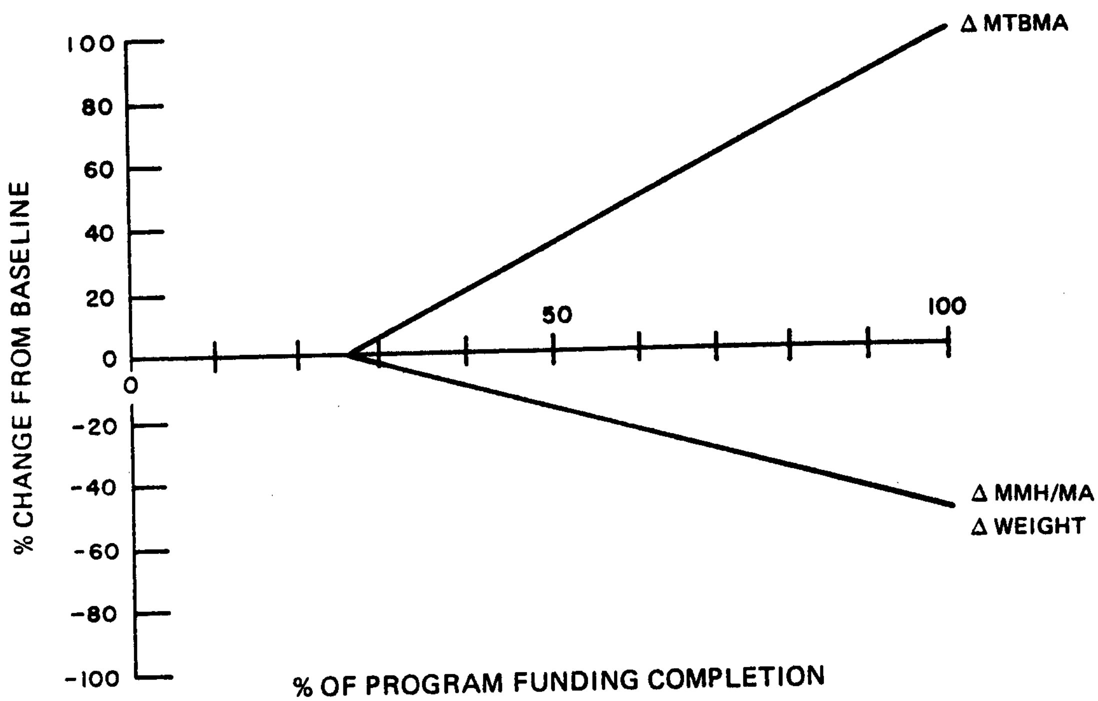


5.6.6.4 Cost Summary

TOTAL R&D FUNDING	LIFE CYCLE COST	NET SAVINGS
$28.7 M	$239.6 M	$375.7 M

5.6.6 Case 11 - Description

5.6.6.1 o MODULAR RADAR GROWTH FACTORS - CASE11

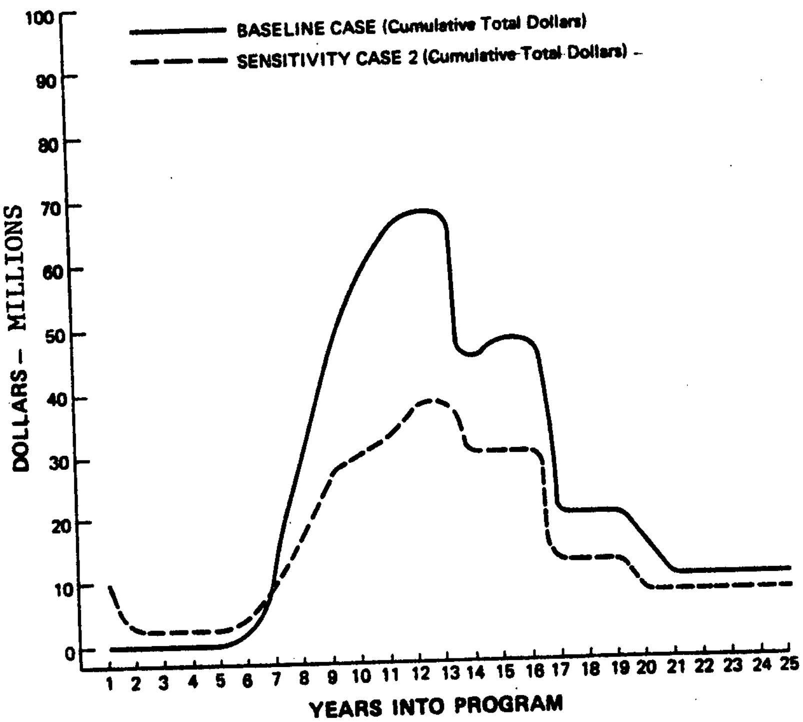


5.6.6.2 o FUNDING PROFILE - CASE 11

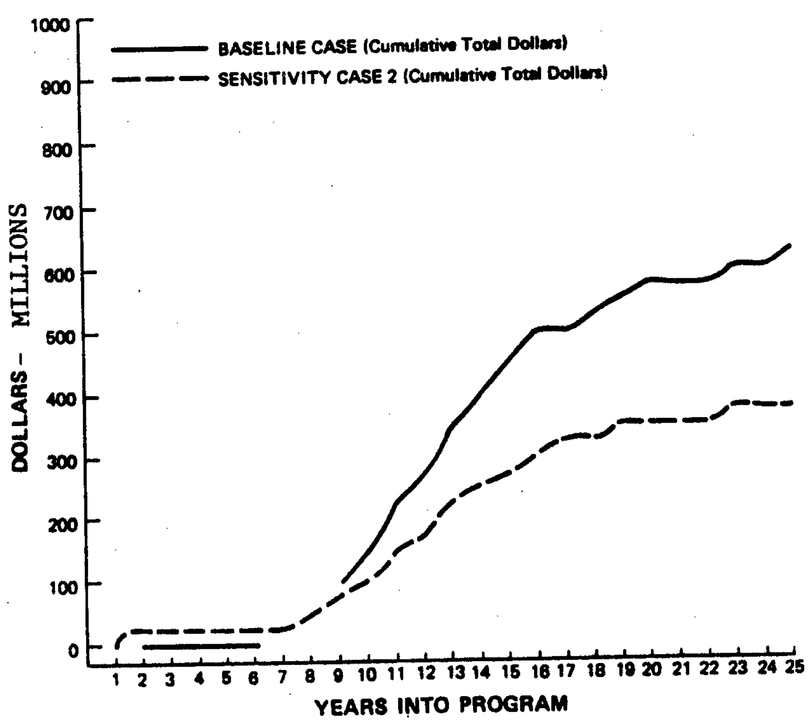
FY	77	78	79	80	81	82	83	84	85	86
$M	9.5	3.2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

5.6.6.3 LCC Profile

5.6.6.3.1 Cost Per Year



5.6.6.3.2 Cumulative Costs Per Year

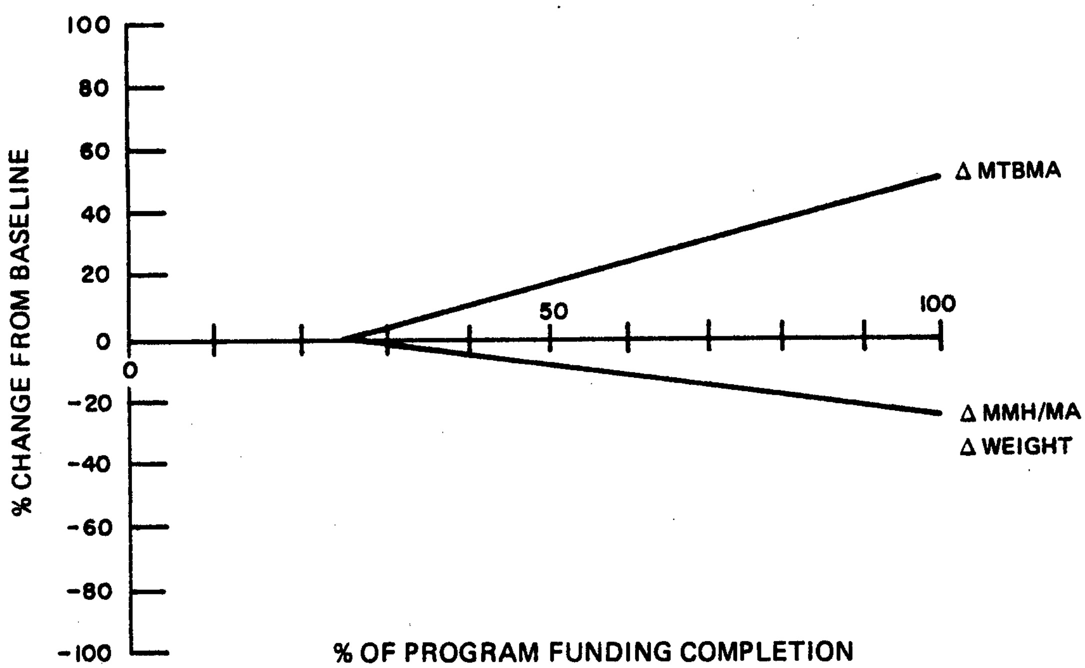


5.6.6.4 Cost Summary

TOTAL R&D FUNDING	LIFE CYCLE COST	NET SAVINGS
$28.7 M	$381.8 M	$233.5 M

5.6.7 Cast 11 - Description

5.6.7.1 o MODUMLAR RADAR GROWTH FACTORS - CASE 111

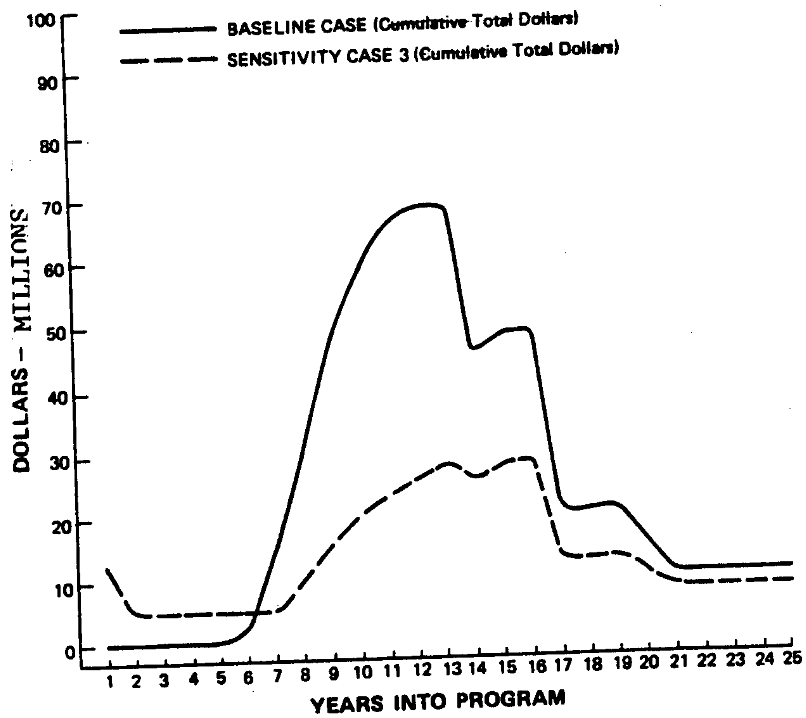


5.6.7.2 o FUNDING PROFILE - CASE 111

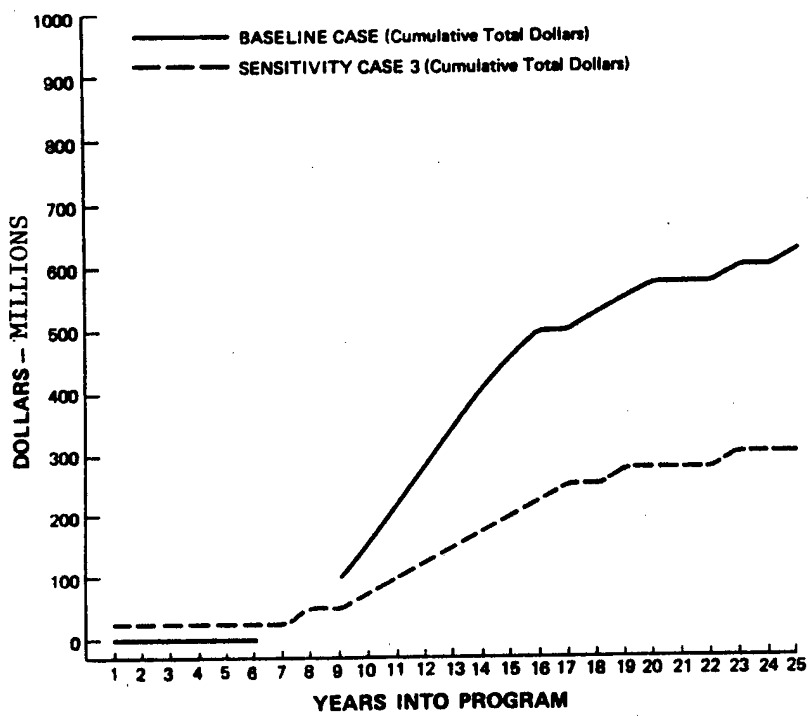
FY	77	78	79	80	81
$M	12.7	4.0	4.0	4.0	4.0

5.6.7.3 LCC Profile

5.6.7.3.1 Cost Per Year



5.6.7.3.2 Cumulative Costs Per Year

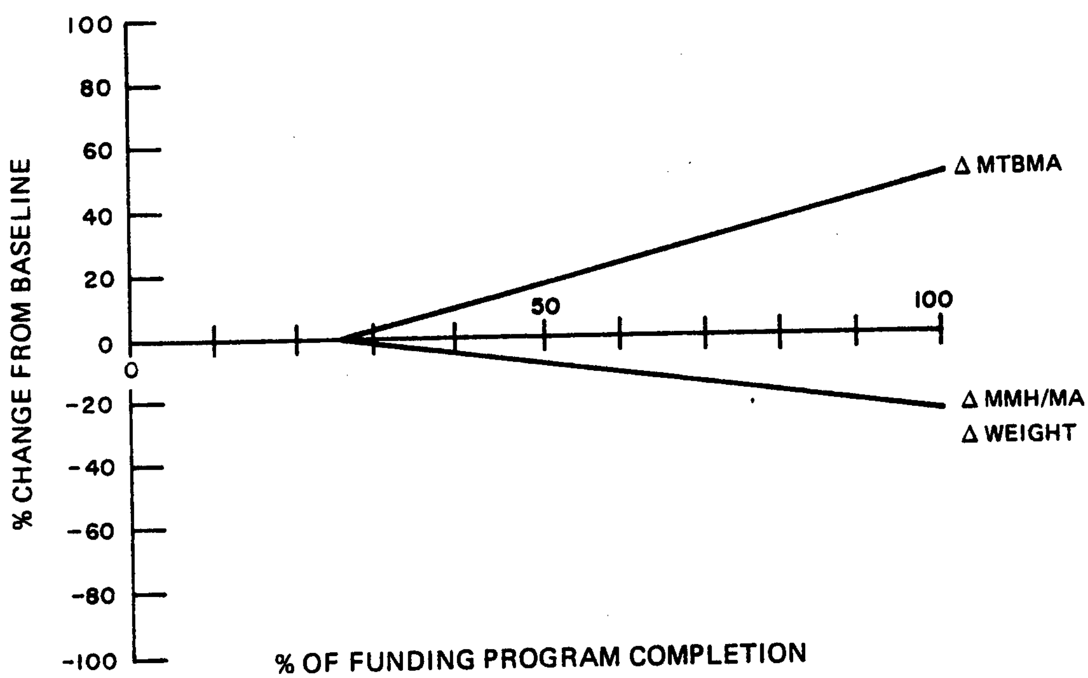


5.6.7.4 Cost Summary

TOTAL R&D FUNDING	LIFE CYCLE COST	NET SAVINGS
$28.7 M	$307.4 M	$307.9 M

5.6.8 Cost IV - Description

5.6.8.1 o MODULAR RADAR GROWTH FACTORS - CASE IV

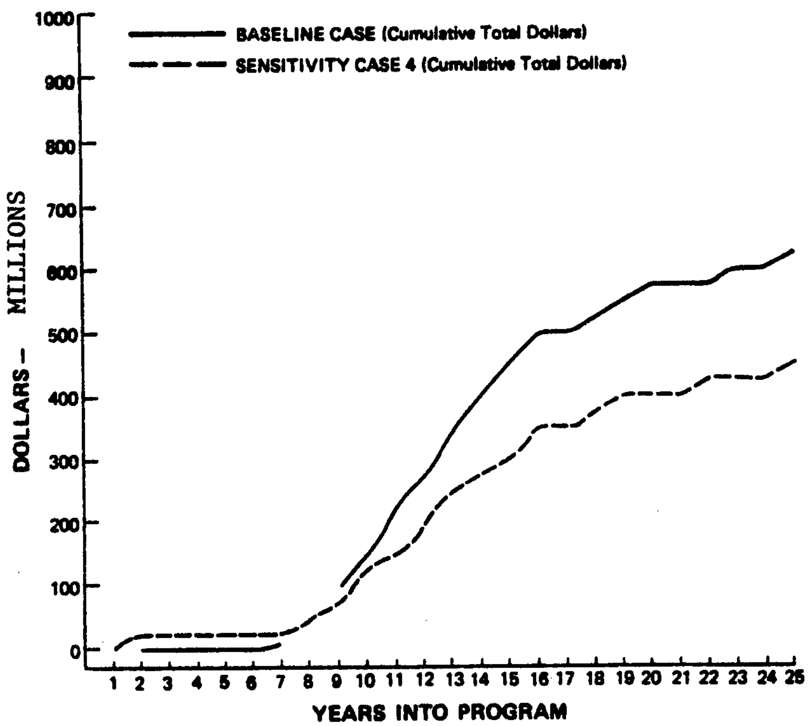


5.6.8.2 o FUNDING PROFILE - CASE IV

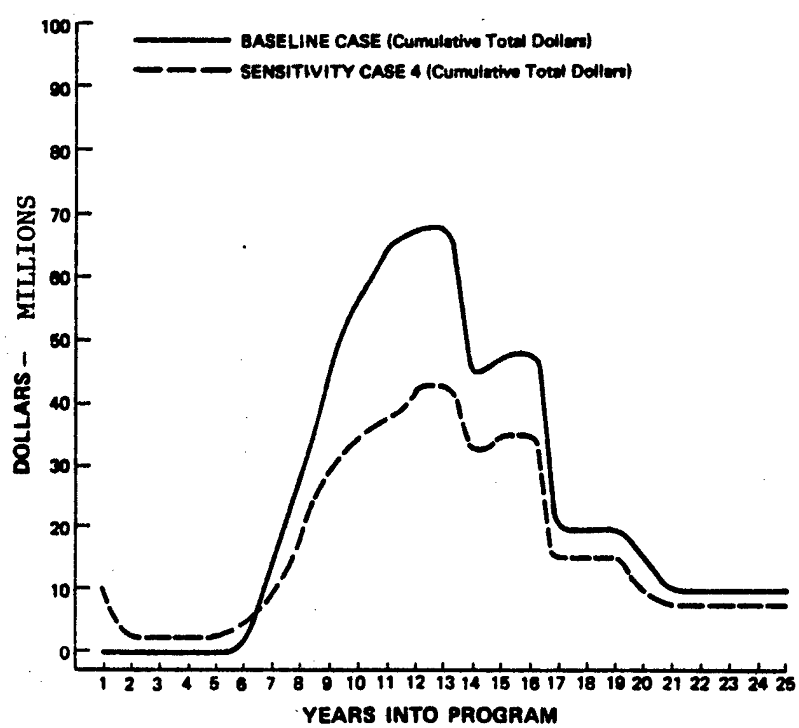
FY	77	78	79	80	81	82	83	84	85	86
$M	9.5	3.2	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

5.6.8.3 LCC Profile

5.6.8.3.1 Cost Per Year



5.6.8.3.2 Cumulative Costs



5.6.8.4 Cost Summary

TOTAL R&D FUNDING	LIFE CYCLE COST	NET SAVINGS
$28.7 M	$440.1 M	$175.2 M

5.7 RING LASER GYRO APPLICATION

5.7.1 Objective - To investigate the cost savings for four different ring laser gyro technology programs for a set of weapons systems over the next 25 years.

5.7.2 Approach - A baseline case consisting of no advance in technology and four cases investigating the snesitivity to various levels of improvements and funding rates were evaluated using the PAYOFF 3 model.

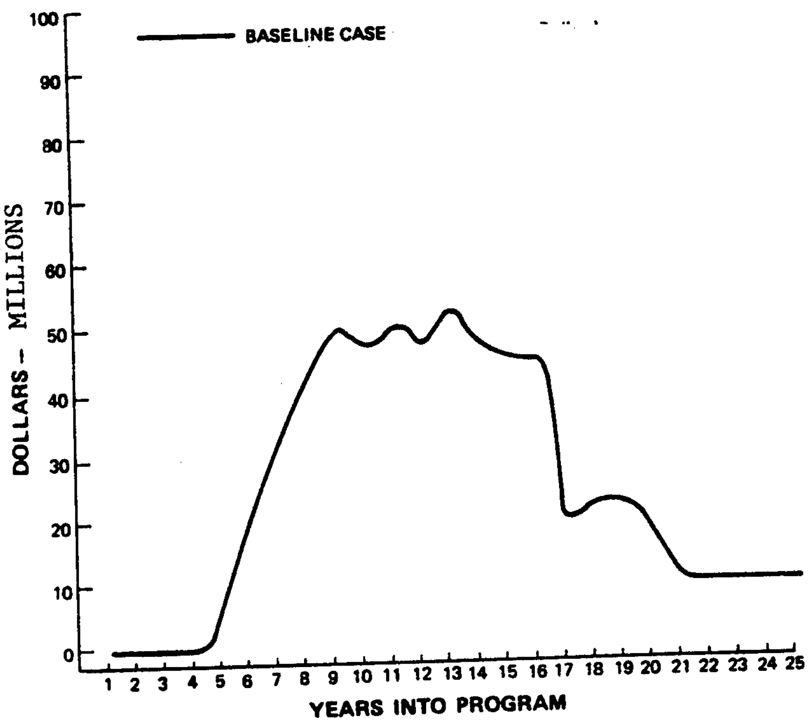
The Weapons systems considered are the A-18, AHX, CUHSK, F-18, HXH, HSM, KAX, KCX, OVX, VAMX, VPX, VSTOL-84,VSTOL A and VSTOL B.

5.7.3 Summary of Results

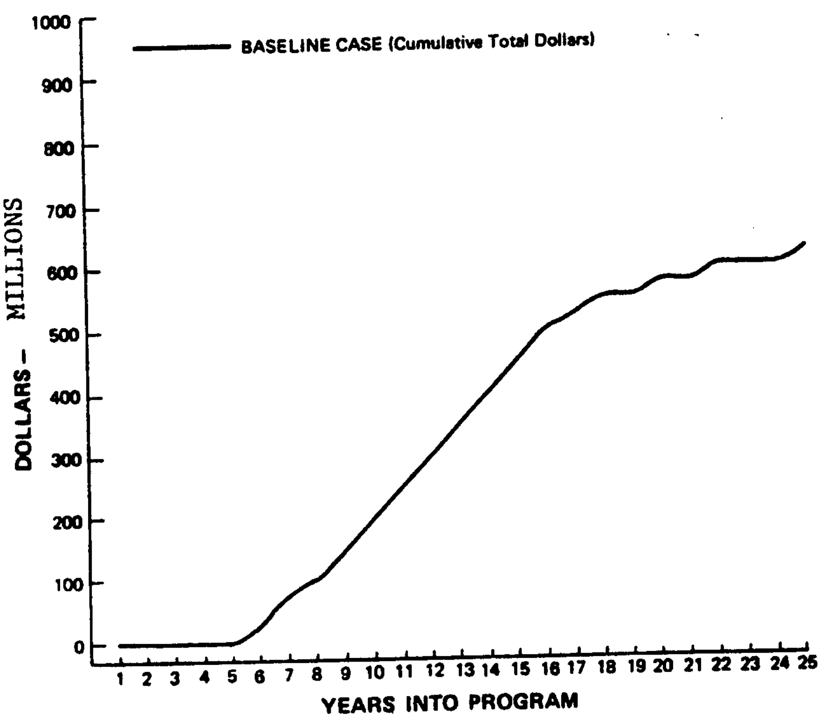
	Baseline	Case I	Case II	Case III	Case IV
Life Cycle Cost	$620.9 M	$235.3 M	$330.8 M	$285.6 M	$389.4 M
R&D Funding	NONE	$ 24.6 M	$ 24.6 M	$ 24.6 M	$ 24.6 M
Sys Weight	No Change	- 50%	- 50%	- 25%	- 25%
MTBMA	No Change	+900%	+900%	+450%	+450%
MMH/MA (I)	No Change	+150%	+150%	+150%	+150%
MMH/MA (O)	No Change	- 50%	- 50%	- 25%	- 25%
BCM Rate	No Change	+ 50%	+ 50%	+100%	+100%

5.7.4 Baseline Costs

5.7.4.1 Per Year

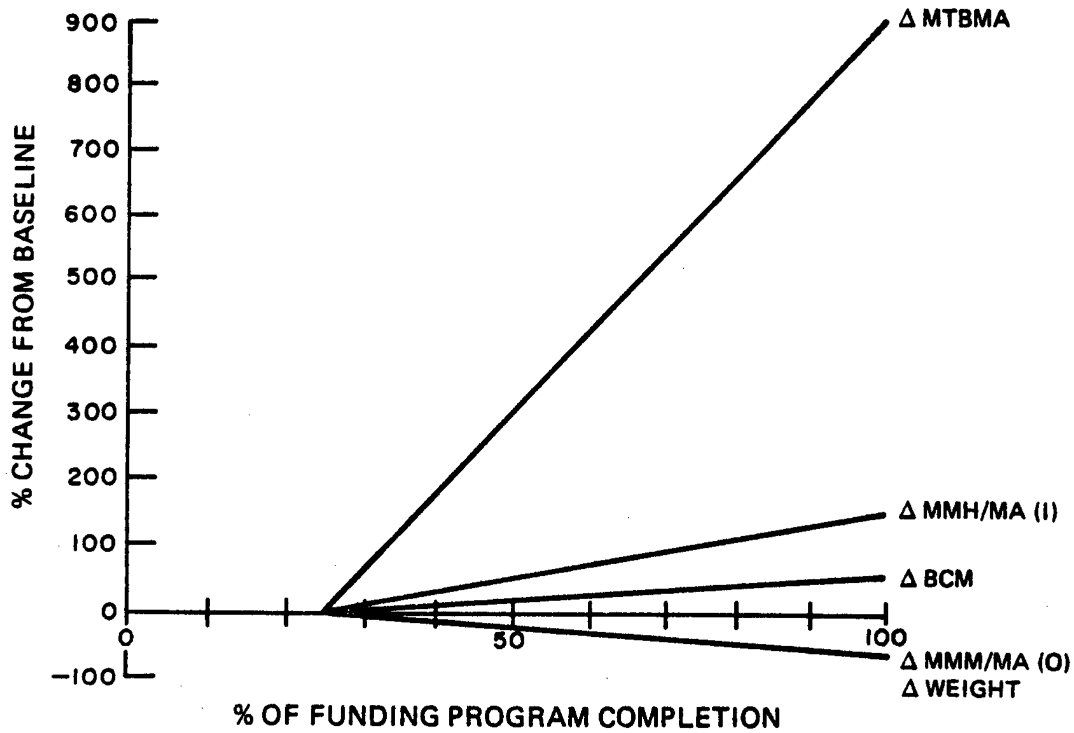


5.7.4.2 Cumulative



5.7.5 Case 1 - Description

5.7.5.1 o RING LASER GYRO GROWTH FACTORS - CASE 1

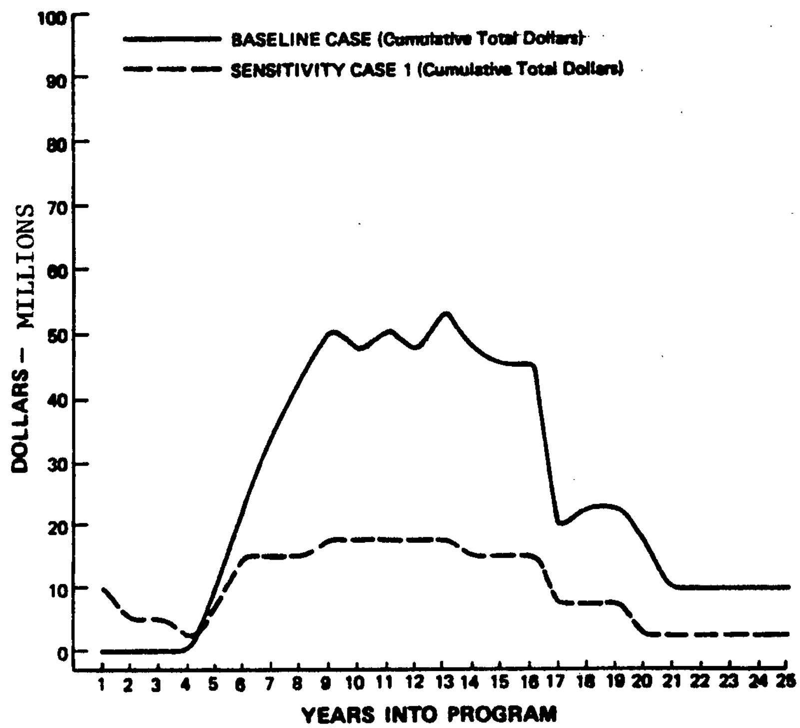


5.7.5.2 o FUNDING PROFILE - CASE 1

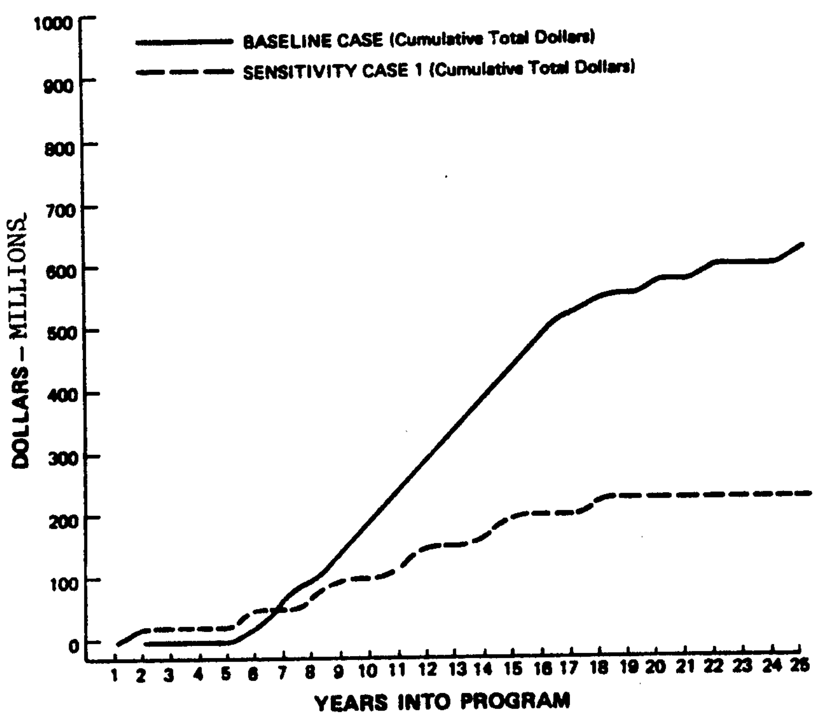
FY	77	78	79	80	81	82
$M	10	4.5	4.0	3.5	1.3	1.3

5.7.5.3 LCC Profile

5.7.5.3.1 Cost Per Year



5.7.5.3.2 Cumulative Costs

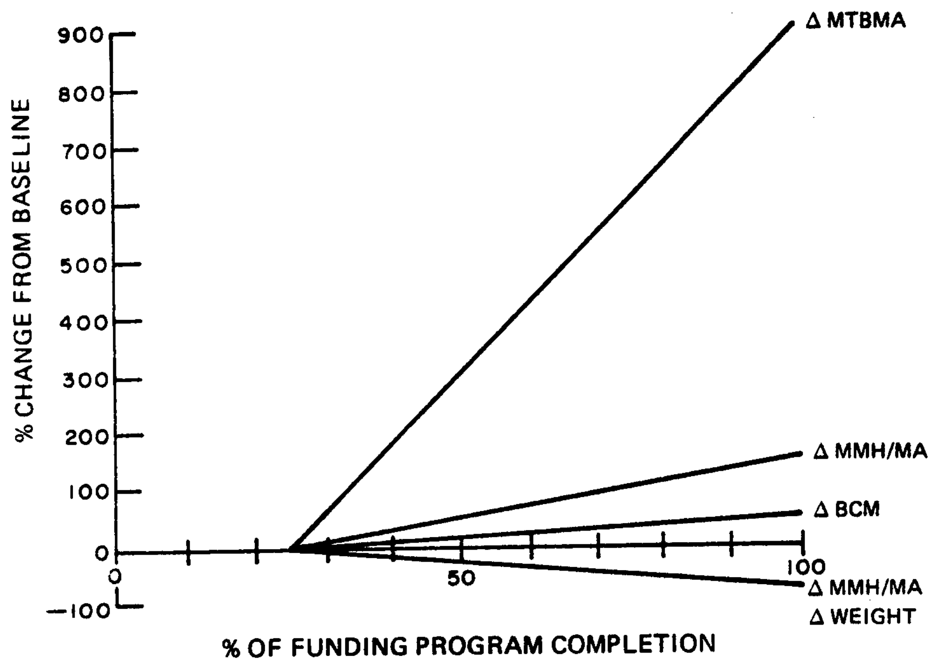


5.7.5.4 Cost Summary

TOTAL R&D FUNDING	LIFE CYCLE COST	NET SAVINGS
$24.6 M	$235.3 M	$385.6 M

5.7.6 Case 11 - Description

5.7.6.1 o RING LASER GYRO GROWTH FACTORS - CASE 11

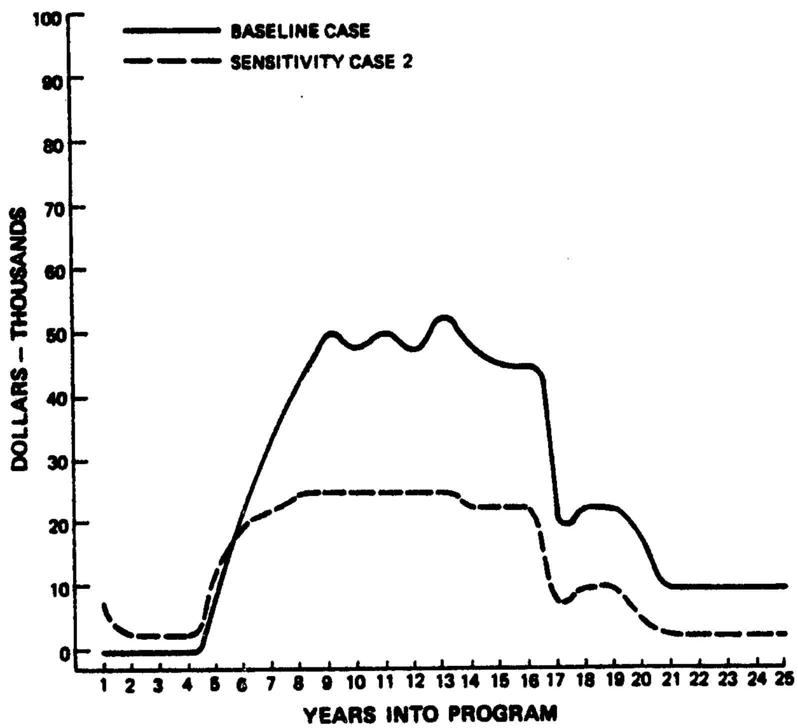


5.7.6.2 o FUNDING PROFILE - CASE 11

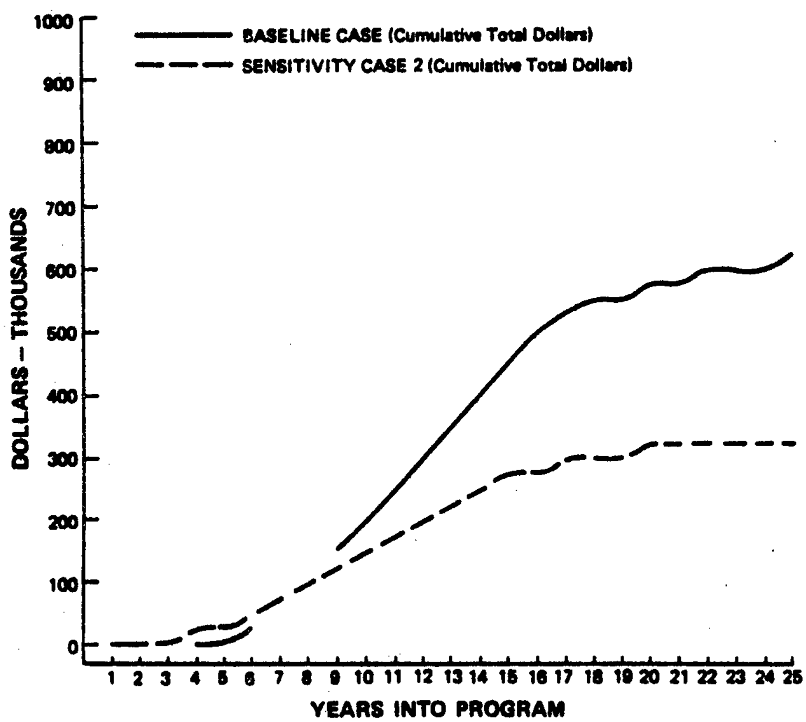
FY	77	78	79	80	81	82	83	84	85	86	87	88
$M	7.8	2.2	2.2	2.2	2.0	2.0	1.8	1.8	.6	.7	.6	.7

5.7.6.3 LCC Profile

5.7.6.3.1 Cost Per Year



5.7.6.3.2 Cumulative Costs

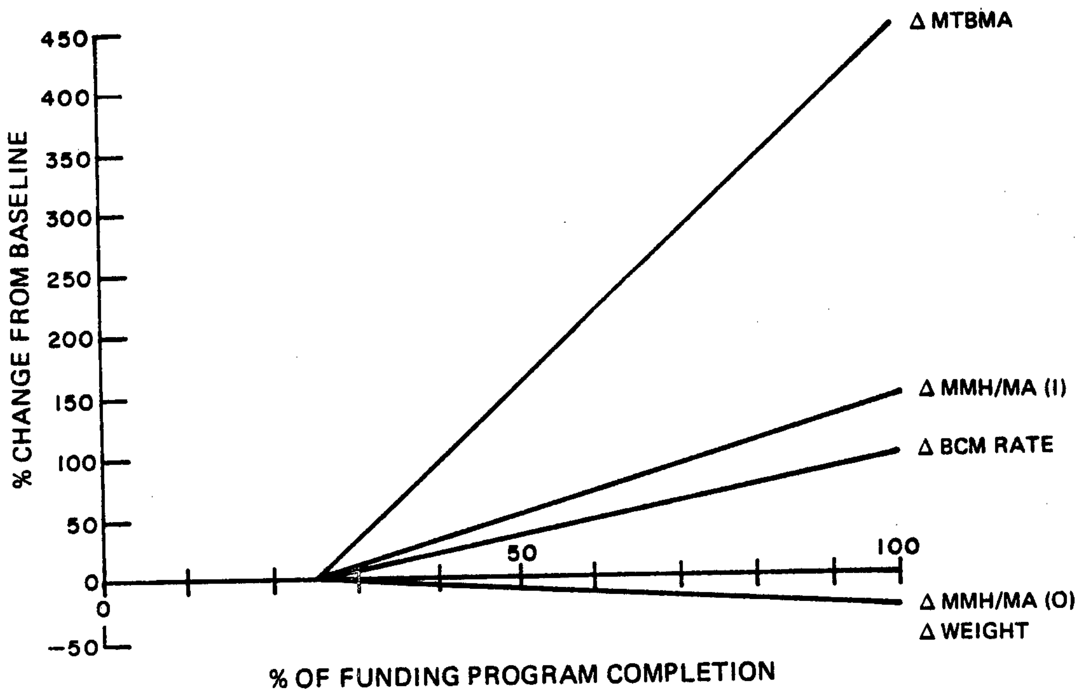


5.7.6.4 Cost Summary

TOTAL R&D FUNDING	LIFE CYCLE COST	NET SAVINGS
$24.6 M	$330.8 M	$290.1 M

5.7.7 Case 111 - Description

5.7.7.1 o RING LASER GYRO GROWTH FACTORS CASE 111

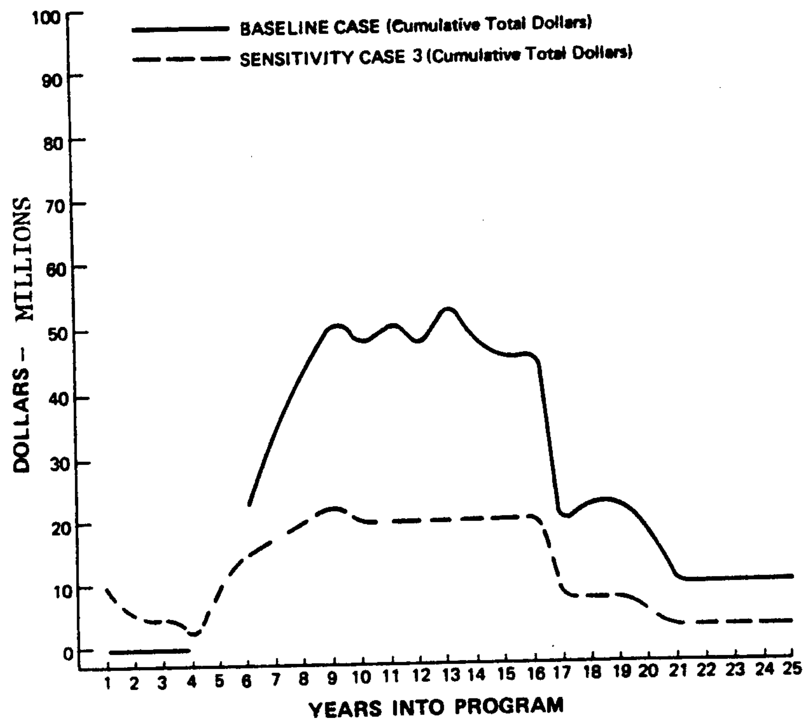


5.7.7.2 o FUNDING PROFILE - CASE 111

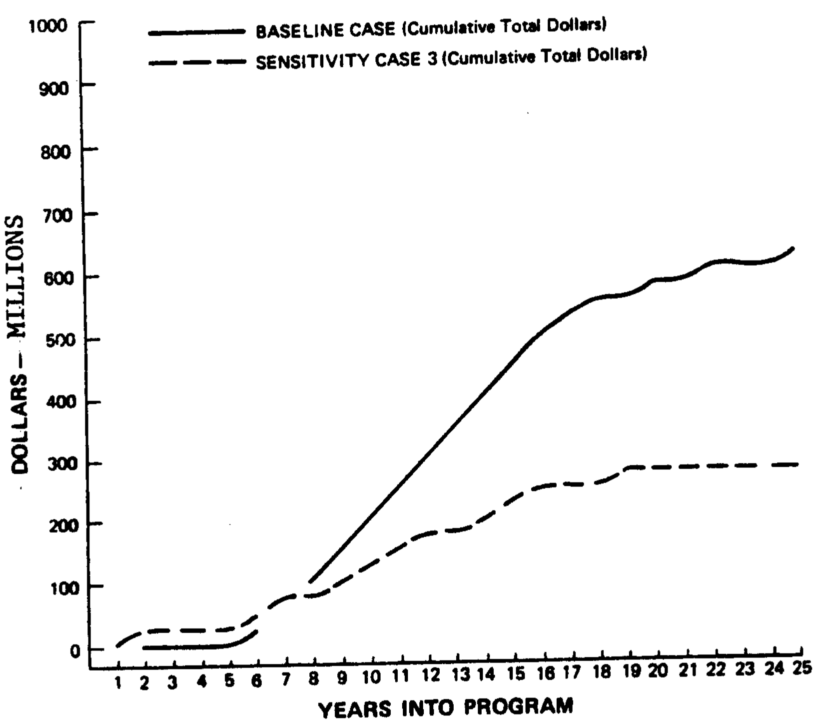
FY	77	78	79	80	81	82
$M	10	4.5	4.0	3.5	1.3	1.3

5.7.7.3 LCC Profile

5.7.7.3.1 Cost Per Year



5.7.7.3.2 Cumulative Costs

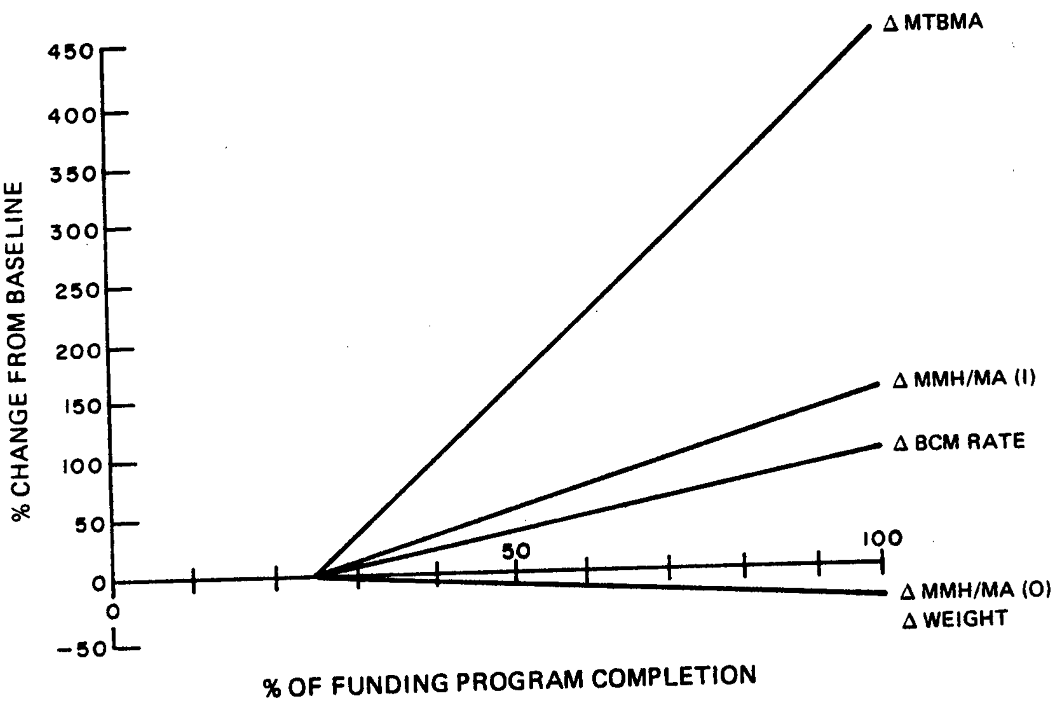


5.7.7.4 Cost Summary

TOTAL R&D FUNDING	LIFE CYCLE COST	NET SAVINGS
$24.6 M	$285.6 M	$335.3 M

5.7.8 Case IV - Description

5.7.8.1 o RING LASER GYRO GROWTH FACTORS CASE - IV

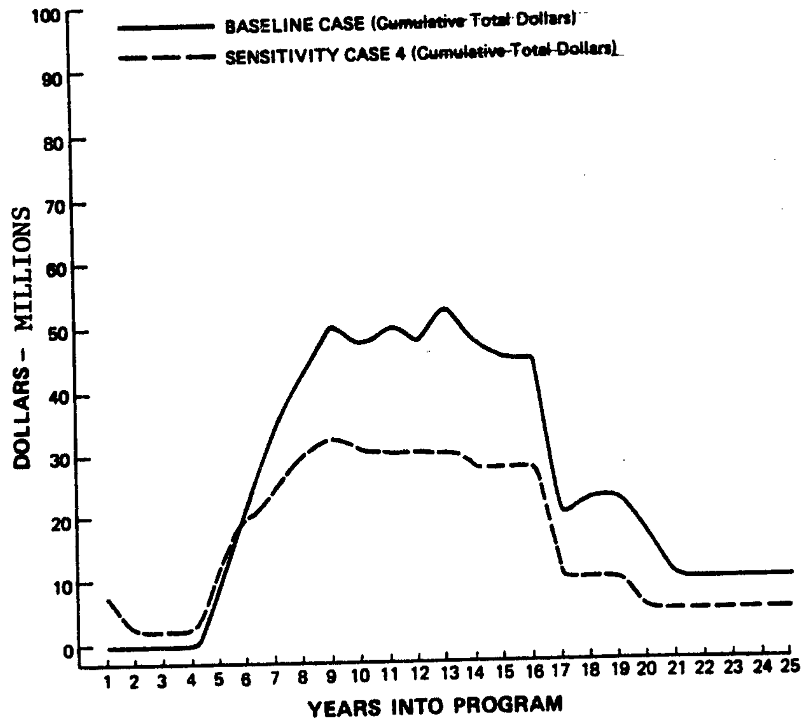


5.7.8.2 o FUNDING PROFILE - CASE 11

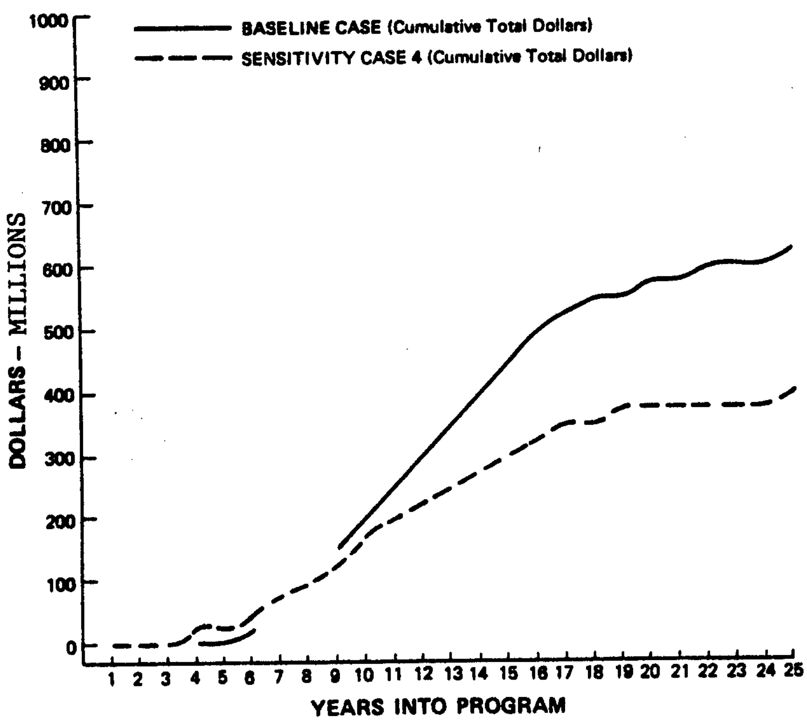
FY	77	78	79	80	81	82	83	84	85	86	87	88
$M	7.8	2.2	2.2	2.2	2.0	2.0	1.8	1.8	.6	.7	.6	.7

5.7.8.3 LCC Profile

5.7.8.3.1 Cost Per Year



5.7.8.3.2 Cumulative Costs



5.7.8.4 Cost Summary

TOTAL R&D FUNDING	LIFE CYCLE COST	NET SAVINGS
$24.6 M	$389.4 M	$231.5 M

SECTION VI

AIR 03 READINESS ASSURANCE ROADMAP APPLICATIONS

6.1 General. This section summarizes the results of attempting to implement the readiness assurance roadmap developed in Section 2 for two on-going AIR 03 ADM programs - ASCL and JTIDS. For the ADM stage of development, roadmap implenentation requires an independent government assessment and correction actions. In both test cases the independent assessment was being attempted without the benefit of performing any conceptual design work or establishing the goals and monitoring framework for the contract. The purpose of the exercise was to (a) establish a format for presenting results and conclusions to AIR 03, (b) uncover design deficiencies, and (c) determine implementation requirements for future indeavors. The technical base supporting the effort consisted of a single electrical engineer per program each familiar with the functional performance of the system of interest as well as an in depth understanding of the disciplines of R&M, ILS and LCC. Neither engineer had access to any automated R&M/ILS/LCC methods. Each was given a total of 2 months to acquire the appropriate background on each particular system and implement the roadmap concept.

6.2 Summary of Results Based on ASCL and JTIDS Evaluation. A summary of attempting to implement the roadmap for ASCL and JTIDS is presented in Figure 9 and 10 respectively.

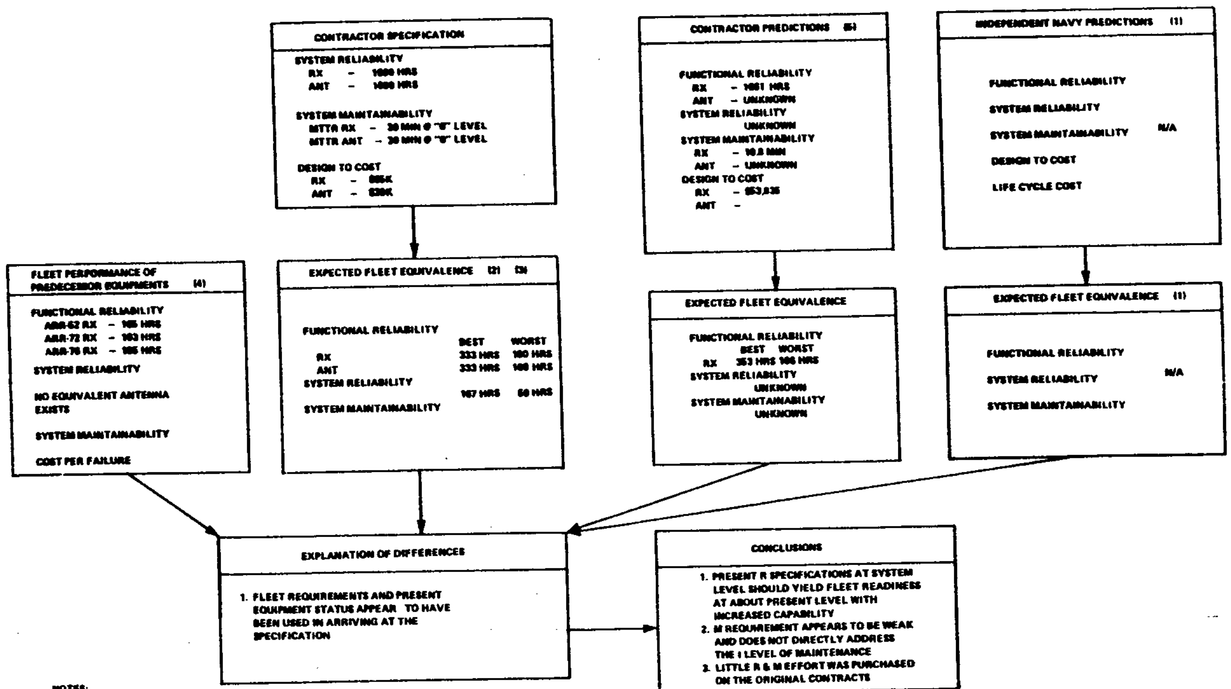
In general the technical base employed found it difficult to independently assess the readiness status relative to the contract for one or more of the follows reasons:

a. Contract specifications were incomplete in the areas of R&M and no justification could be found connecting the four R&M parameters to an operational need. Therefore if the design could be assessed it would be impossible to establish whether they were deficient from a Navy point of view.

SUMMARY OF RESULTS

PARTIAL IMPLEMENTATION OF THE READINESS TECHNOLOGY ROADMAP DURING ADM

ASCL ARR-78



RECOMMENDATIONS

ACTIONEE	DESCRIPTION	FUNDING
AIR-370	1. DETERMINE VALIDITY OF VENDOR'S R PREDICTIONS SO THAT ANY REQUIRED ADDITIONAL WORK MAY BE PLANNED FOR WITH SUFFICIENT LEAD TIME. 2. DETERMINE EFFECTIVITY OF BIT AND ESTABLISH "I" LEVEL MAINTENANCE POLICY ASAP FOR THE SAME REASONS.	2 TECHNICAL MAN YEARS IF PERFORMED AT NADC
AIR-03	3. IMPLEMENT NADC ROAD MAP CONCEPTS ON FUTURE DESIGNS PRIOR TO DCP TO AVOID COSTLY DESIGN MODIFICATIONS IN EDM AND POSSIBLE SCHEDULE SLIPPAGES	WORK UNIT PLAN HAS BEEN SUBMITTED TO AIR-03.

NOTES:

1. IMPLEMENTATION WITHOUT BENEFIT OF REQUIRED EXPLORATORY DEVELOPMENT ROADMAP AND DATA BANK. THE CONTRACTOR WAS NOT FUNDED TO PROVIDE DATA NECESSARY FOR EFFECTIVE MONITORING DURING ADM.

2. DUE TO DESIGN OF ANTENNA, A DEGRADED MODE EXISTS WITH PRESENT FLEET CAPABILITIES HAVING FAILURE MODES OF RX ONLY AFFECTING R.

3. ASSUMES DEGRADATION FACTORS BETWEEN SPEC AND FIELD OF 1/3 BEST CASE AND 1/10 WORST CASE. AN NADC SAMPLE OF 25 AVIONICS SYSTEMS INDICATES A 70% BIAS TOWARD BEST CASE. SEE TABLE I.

4. BASED ON NAVY WIDE APPLICATION AND FLIGHT HOUR AVERAGING.

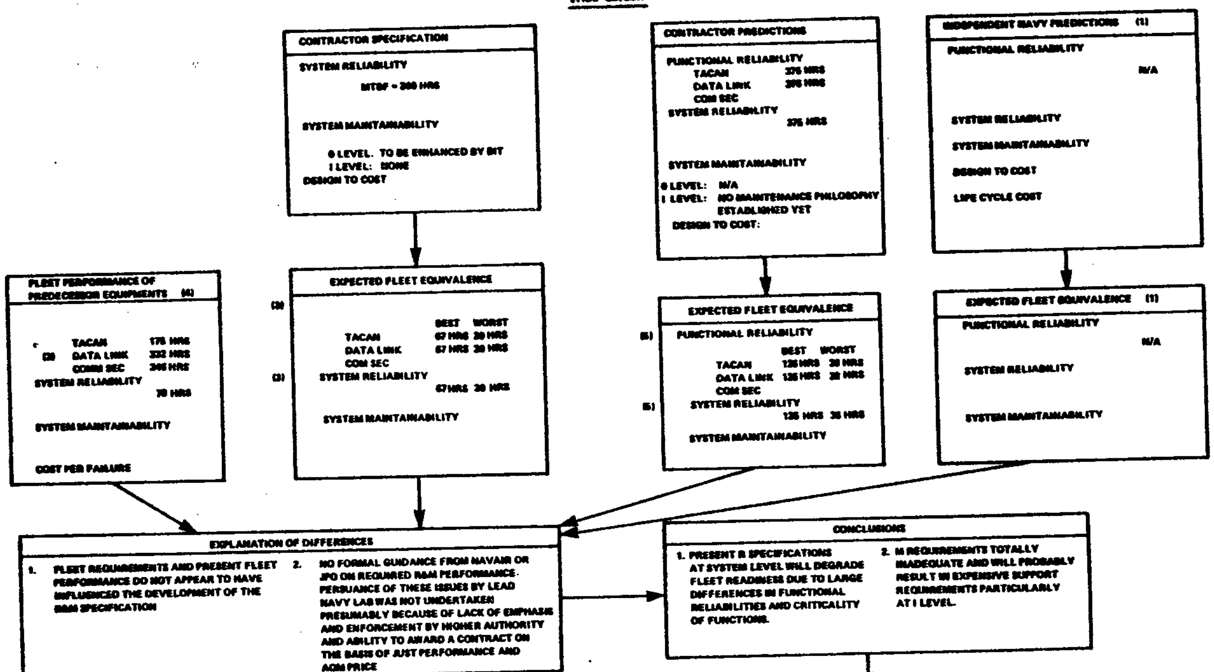
5. NO PREDICTIONS ARE AVAILABLE AT THIS TIME FOR THE ADAPTIVE ANTENNA, THEREFORE SYSTEM PREDICTIONS ARE NOT POSSIBLE.

FIGURE 9

SUMMARY OF RESULTS

PARTIAL IMPLEMENTATION OF THE READINESS TECHNOLOGY ROADMAP DURING ADM

JTIDS—SINGER



	RECOMMENDATIONS	
ACTIONEE	DESCRIPTION	FUNDING
AIR 360/JPO	1. ESTABLISH R GOALS BASED ON FLEET NEEDS AND DETERMINE THE VALIDITY OF VENDOR'S R PREDICTIONS ASAP SO THAT EXTENT OF ADDITIONAL R WORK MAY BE ESTABLISHED AND PLANNED FOR WITH SUFFICIENT LEVEL TIME. 2. DETERMINE EFFECTIVITY OF BIT AND ESTABLISH I LEVEL MAINTENANCE POLICY ASAP FOR THE SAME REASON	$120K FOR CONTRACTOR DATA 2 TECHNICAL MAN YEARS IF PERFORMED AT NADC
AIR 03	3. IMPLEMENT NADC ROADMAP CONCEPTS ON FUTURE DESIGNS PRIOR TO DCP TO AVOID COSTLY DESIGN MODS IN EDM AND POSSIBLE SCHEDULE SLIPPAGES	WORK UNIT PLAN HAS BEEN SUBMITTED TO AIR 03 FOR IMPLEMENTATION

NOTES:
1. IMPLEMENTATION WITHOUT BENEFIT OF REQUIRED EXPLORATORY DEVELOPMENT ROADMAP AND DATA BANK. THE CONTRACTOR WAS NOT FUNDED TO PROVIDE DATA NECESSARY FOR EFFECTIVE MONITORING DURING ADM.
2. ASSUMES IFF TRANSPONDER APX 76 IS THE RELIABILITY EQUIVALENT OF COMM SEC; ARN-84 THE EQUIVALENT FOR TACAN AND ASW-25 THE EQUIVALENT FOR THE DATA LINK.
3. ASSUMES DEGRADATION FACTORS BETWEEN SPEC AND FIELD OF 1/3 BEST CASE AND 1/10 WORST CASE. AN NADC SAMPLE OF 25 AVIONICS PROCUREMENTS INDICATED A 75% BIAS TOWARDS BEST CASE. SEE TABLE I.
4. BASED ON NAVY WIDE APPLICATION AND FLIGHT HR AVERAGING
5. BASED ON NOTE 3 AND THE ASSUMPTION THAT PREDICTIONS ARE GENERALLY SIMILAR TO THE SPECIFICATION.

FIGURE 10

TABLE 1 FLEET/SPECIFICATION RELIABILITY RATIOS FOR SELECTED AVIONICS EQUIPMENT

COMMON EQUIPMENTS

EQUIPMENT NOMENCLATURE	MTBF		TEST PLAN	FLEET MFHBF						NAVY	FLEET MFHBF/ SPEC MTBF
	SPEC	PRED		A	F	P	E	S	H		
ARR-72	500	395	781-V			193				193	.386
ARR-76	500	600	781-IV					185		185	.370
R-1047	400		MIL-R 23394			339			418	355	*
ARR-52	200		MIL-R 23094*						165	165	*
ARN-52	150		MIL-E 26669A	33		58	51		48	44	*
ARN-84	500	1000	781-III	124	115	355		223		175	.350
ARN-21	12		NONE			44			79	75	*
ASQ-19	50		MIL-R 23094		10					10	*
APX-76	225		781-III		123	123	369	243		129	.573
APX-72	300	450	781-I	159	136	330	141	418	332	241	.803
ASW-25	1000		781-III	237						237	.237
ARR-69	1000		781-III	548	617					568	.568
ARA-50	1000	1200	MIL-R 26667	657		605				630	*
APX-64	300	400	781-II	76						76	.253

* TEST DATA NOT RELATABLE TO MIL-STD-781

TABLE 1. FLEET/SPECIFICATION RELIABILITY RATIOS FOR SELECTED AVIONICS EQUIPMENT (cont'd)

S-3 PECULIAR EQUIPMENTS

EQUIPMENT NOMENCLATURE	M T B F		TEST PLAN	MFHBF						NAVY	FLEET MFHBF/ SPEC MTBF
	SPEC	PRED		A	F	P	E	S	H		
AYK-10	350		IV					100		100	.286
ARC-153	1300		IV					130		130	.100
ARC-156	2000		IV					90		90	.450
AYN-5	2080		IV					125		125	.060
APN-200	1000		IV					200		200	.200
ASN-107	1400		IV					127		127	.091
OL-82	100		IV					30		30	.300
ASQ-147	413		IV					90		90	.218
ASA-82	150		IV					30		30	.200
ARS-2	2650		IV					380		380	.143

AIRCRAFT TYPE ABBREVIATIONS

A - Attack
F - Fighter
P - Patrol
E - Electronic Picket
S - Surveillance
H - Helicopter

b. The technical monitoring framework was incomplete. As a result the Navy's engineers were not allowed access to the approrpiate engineering drawings without incurring a cost to the program. Under these conditions, it was not possible to assess the R&M status of either ASCL or JTIDS ADM design. The vendors did however provide a summary of the results of their own R&M assessment at the organizational level. Neither vendor has made an "I" level maintainability assessment. In spite of the inability to fully implement the roadmap for either the ASCL or JITIDS equipments, several conclusions were established which made the effort worthwhile:

   a. The Navy can realize tremendous savings in development and maintenance money by attempting to establish their R&M requirements based on an operational need. Without hard argurments the vendor is given the opportunity to establish them in his best interests which could result in considerable expense to the government. In the area of reliability the vendor can sell a lengthy test program to demonstrate a high reliability in a laboratory which may not be needed.

   b. The Navy can realize a tremendous savings in development money by providing a facsimile operational and intergation environment for testing. Without the true environmental profiles the vendors generally select a weak facsimile because it enables him to demonstrate a higher reliability with a high degree of confidence. To the Navy a weak facsimile translates directly into a large variance between factory and field reliability. This results in lower than expected readiness due to a higher failure rate, increased down times and longer queries in the IMS for a higher than expected work load. Maintenance costs are also higher than expected for repair and pipeline sizes.

c. The Navy can realize a tremendous savings in maintenance dollars by considering a complete maintenance concept in ADM and not just the organizational level maintenance concepts. Without any specifications for "I" level maintainability, the ADM design is not optimized for test points which are necessary for ATE type testing in the IMA. As a result lengthy test programs and complex interface devices are required to compensate for a lack of adequate test points for isolation below the WRA.

Based on (a) and (b) above it can be considered that a partial impact can be made on a program already underway in ADM by means of thr readiness assurance roadmap. The level of effort required is greater than two man months in order to develop the R&M goals and establish the operating and integration stress levels for testing. In general however the fullest readiness assurance impact can not be achieved without either (a) active participation prior to the ADM period (i.e., during concept formulation and ADM contract negotations), or (b) significant monies are made available for obtaining the necessary documentation for in-depth independent assessment and the corresponding corrective action efforts necessary to bring a design into specification or modify the original specifications.