

ADA020180

CASE STUDIES OF THE AIR FORCE
AEROSPACE GROUND EQUIPMENT (AGE)
ACQUISITION MANAGEMENT PROCESS

12
B.S.

Task 74-22

See 1473
Theodore R. O'Donnell
John D. Forster

December 1975

DDC
RECEIVED
FEB 6 1976
RECEIVED

Q7 A

Prepared pursuant to Department of Defense Contract No. SD-321. Views or conclusions contained in this document should not be interpreted as representing the official opinion or policy of the Department of Defense. Except for use for Government purposes, permission to quote from or reproduce portions of this document must be obtained from the Logistics Management Institute.

LOGISTICS MANAGEMENT INSTITUTE
4701 Sangamore Road
Washington, D. C. 20016

DISCONTINUED
Approved for public release;
Distribution Unlimited

SUMMARY

This study was undertaken to determine the effectiveness of Air Force policies and procedures for acquiring support equipment, and to develop recommendations for change. The study approach included two principal tasks: 1) the preparation of procedural flowcharts depicting the support equipment acquisition process; and 2) the analysis of a cross-section of support equipment acquisitions against the background of current policies and procedures.

Five flowcharts of the process were prepared and distributed to over 100 Air Force locations during October 1974. Many helpful comments were received, from which the flowcharts were updated. They are republished in Appendix C of this report.

Eight defense systems were selected for study: F-15, A-10, RPV, AIMS, 485L, AF SATCOM, DSP and MMIII. From among those systems, the acquisition of 76 items of support equipment was reviewed in detail. The principle objective of those reviews was to determine 1) the extent to which policy has been implemented and 2) the degree to which policy and implementing procedures are achieving their intended purpose. The 76 items we reviewed are written-up as Case Studies: they are contained in Appendix B.

This study indicates that acquisition policies are sound and comprehensive, and that acquisition procedures are reasonably effective for all types of support equipment except complex electronic test equipment. The Air Force support equipment acquisition process has improved in recent years. Six systems were using similar procedures instead of each having a unique procedure as found in previous studies. The use of similar procedures has improved communications among supporting offices. Some important improvements were noted in drawer/component standardization and in new standardization data bases.

The problems in the complex electronic test equipment area include untimely delivery, high design and acquisition costs, frequent design change activity, low

standardization achievement, and incomplete or weak trade-off analysis. The causes of such problems are normally of a highly technical nature and their solution requires technical expertise and analysis which can be enhanced by greater cross-fertilization among aircraft, space and electronic systems. Complex electronic test equipment both requires and warrants increased management attention and technical analysis. The principal recommendation is to establish a centralized Air Force office to provide technical assistance and guidance for the acquisition of complex electronic test equipment to all System Program Offices.

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
SUMMARY	ii
LIST OF FIGURES	vi
LIST OF TABLES	vii
ABBREVIATIONS	viii
 I. INTRODUCTION	 1
A. Background	1
B. Study Objectives and Approach	2
II. THE AIR FORCE SUPPORT EQUIPMENT ACQUISITION PROCESS	5
A. Support Equipment Policies	5
B. Support Equipment Procedures	6
C. A Composite of the Process	9
III. CASE STUDY SELECTION	13
A. Defense Systems	13
B. Item Selection Criteria	14
C. Case Study Characteristics	14
IV. FINDINGS AND ANALYSIS	17
A. Delivery Performance	17
B. Acquisition Cost	22
C. Trade-off Studies	25
D. Standardization	27
E. Change Impact	32
F. Analysis of Procedures	33
G. Analysis of Problems and Causes	37

TABLE OF CONTENTS (Continued)

<u>Section</u>	<u>Page</u>
V. CONCLUSIONS AND RECOMMENDATIONS	43
A. Conclusions	43
B. Recommendations	44
1. Complex Electronic Test Equipment	44
2. Procedural Improvements in the Total Process	46
BIBLIOGRAPHY	53

APPENDICES

- A. Task Order
- B. Case Study Detailed Data
- C. Flowcharts of the Air Force Support Equipment Acquisition Process

LIST OF FIGURES

<u>Figure</u>		<u>Page</u>
1	Case Study Delivery Performance by Percent of Items	18
2	Case Study Delivery Performance by Percent of Acquisition Cost	19
3	Why Support Equipment Was Late	20
4	Distribution of Case Study Acquisition Costs	23
5	Case Studies Cost Distribution	24
6	A-7D Unit Cost Distribution	24
7	Unit Cost History of One ATE Case Study	25
8	Case Study Trade Study Activity	26
9	Case Study Change Impact	32

LIST OF TABLES

<u>Table</u>		<u>Page</u>
1	Defense Systems Selected for Study	4
2	Principal Air Force Support Equipment Documents	5
3	Summary of Principal Functions Required in the Air Force Support Equipment Acquisition Process	10
4	Case Study Characteristics	15
5	Acquisition Cost of Case Studies by Category	22
6	Standardization Tools	28-a
7	Percent of Case Study Affected by Data Quality Control Problems	35
8	Support Equipment Acquisition Problems and Causes	40
9	Support Equipment Problem Summary	41

LIST OF ABBREVIATIONS

AFAD	- Air Force Acquisition Document
AFLC	- Air Force Logistics Command
AFLCM	- Air Force Logistics Command Manual
AFLCR	- Air Force Logistics Command Regulation
AFPRO	- Air Force Plant Representative's Office
AFSC	- Air Force Systems Command
AFSCM	- Air Force Systems Command Manual
AFSCP	- Air Force Systems Command Pamphlet
AFSCR	- Air Force Systems Command Regulation
AGE	- Aerospace Ground Equipment
AGEI	- Aerospace Ground Equipment Illustration
AGERD	- Aerospace Ground Equipment Recommendation Data
AIS	- Avionics Intermediate Shop
ALC	- Air Logistics Center
ASD	- Aeronautical Systems Division
ATE	- Automatic Test Equipment
CAGEL	- Consolidated Aerospace Ground Equipment List
CDR	- Critical Design Review
CFE	- Contractor Furnished Equipment
DIDS	- Defense Integrated Data System
DLSC	- Defense Logistics Service Center
ECP	- Engineering Change Proposal
ESD	- Electronic Systems Division
FACI	- First Article Configuration Inspection
FIIG	- Federal Item Identification Guide
FSC	- Federal Stock Classification

ABBREVIATIONS (Continued)

GFE	- Government Furnished Equipment
IM	- Item Manager
INC	- Item Name Code
IOC	- Initial Operating Capability
LMI	- Logistics Management Institute
LRU	- Line Replaceable Unit
MIL-HDBK	- Military Handbook
MIL-STD	- Military Standard
NSN	- National Stock Number
ORLA	- Optimum Repair Level Analysis
PAGEL	- Priced Aerospace Ground Equipment List
PMEL	- Precision Measurements Equipment Laboratories
SAMSO	- Space and Missile Systems Office
SERD	- Support Equipment Recommendation Data
SM	- System Manager
SPD	- System Program Director
SPO	- System Program Office
TO	- Technical Orders
UMR	- Unsatisfactory Materiel Report

I. INTRODUCTION

A. Background

The development and acquisition of Support Equipment (formerly called Aerospace Ground Equipment or AGE) are integral parts of a defense system acquisition program. The types of items classified as support equipment are extremely diverse, ranging from slightly modified hand tools to multi-million dollar automatic test systems. The cost of developing and acquiring support equipment ranges from 5% to 15% of the development and acquisition cost of the system to be supported. In the aggregate, the acquisition cost of all Air Force support equipment currently in use is approximately \$4.5 billion. In addition, support equipment impacts the operational and maintenance costs required to support Air Force defense systems. Thus the development and selection of the appropriate type of support equipment is a critical process and may be more significant than indicated by the ratio of support equipment acquisition costs to system acquisition costs.

The Air Force recognizes the importance of the support equipment acquisition process and has established a broad range of policies and regulations to control its development and acquisition. However, there are many problems with deployed support equipment and with the methods for evaluating alternatives.

A previous LMI study (LMI Task 72-1 Rev.) was undertaken at the request of the Air Force during 1972. That study examined the AGE acquisition process and found the basic policies and regulations then in existence to be generally sound and comprehensive. However, LMI found that implementing procedures applied by the various System Program Offices (SPOs) in the support equipment acquisition process varied from program to program. LMI concluded that the Air Force support equipment development and acquisition process could be strengthened by initiating a more systematic approach and

providing more intensive management through 1) the development and control of the support equipment Acquisition Plan; and 2) the identification and analysis of support equipment alternatives. Some general recommendations aimed at strengthening the acquisition process were presented. The study did not, however, develop detailed implementing procedures. During 1974 the Air Force incorporated the principal concepts advanced in the 1972 LMI study into an Air Force Regulation on acquisition of support equipment.¹

To further facilitate the cost/effective development and acquisition of support equipment, the Air Force has decided to prepare a support equipment acquisition guide which will set forth principles, procedures and actions which should be considered in the acquisition process. Pursuant to that objective the Air Force requested LMI to undertake an additional task to determine the effectiveness of current policies and procedures as affected by detailed implementing actions applied by various System Program Offices, and as applied to various types of defense systems and support equipment. The Air Force believed that through a case study approach, appropriate differences in acquisition of various types of support equipment for various types of systems could best be identified. In addition, it was believed that the detailed case study approach would serve to highlight the relative significance of support equipment problems emanating from various implementing actions, and thus provide System Program Directors insight into those areas which require more intensive management for their specific type of system.

B. Study Objectives and Approach

The purpose of this task² is to determine the effectiveness of currently prescribed Air Force policies and procedures for acquiring support equipment in terms of stated

¹ Air Force Regulation 800-12, "Acquisition of Support Equipment," 20 May 1974.

² The objective and approach of LMI Task 74-22 are detailed in the Task Order and memorandum of understanding which are included as Appendix A of this report.

objectives. By an analysis of the process, the study determines those areas that have not been implemented or are not achieving their intended purpose and recommends changes that will permit objectives to be obtained.

The study approach includes two principal sub-tasks which are briefly described below.

1) Prepare procedural flowcharts of the current support equipment acquisition process.

This sub-task was designed to bring together a detailed description of the current process for the acquisition of support equipment as described in Air Force documentation.

Air Force support equipment policies and procedures were assessed by reviewing Air Force regulations, manuals, pamphlets, and guides applicable to the subject and through interviews with Air Force personnel. The review led to the development of the procedural flowcharts of the Air Force support equipment acquisition process. The five procedural flowcharts are included in this report as Appendix C. Approximately 100 sets of these flowcharts were initially distributed to Air Force personnel in October 1974 when completed. Appropriate revisions from comments received from numerous sources have been incorporated into the flowcharts shown in Appendix C.

The procedural flowcharts provide a basis for examining the case studies described below and serve as a tool for analysis.

2) Case Studies and Analysis.

The case study sub-task was designed to illustrate typical acquisition history including how the regulations were interpreted, problems encountered, tools used, and resulting experiences. A number of the case studies are made in-depth to assure adequate coverage. The case study approach provides a data base of practical experience encompassing support equipment items of all types. From these data a prioritized list of problems is identified which aids in determining the nature of required solutions.

Eight defense systems were selected for study. These are listed in Table 1 below:

Table 1. DEFENSE SYSTEMS SELECTED FOR STUDY

System	Size	Phase	Type
F-15	Large	Production	Single Aircraft Project
A-10	Medium	Development	Single Aircraft Project
RPV	Medium	Multiple	Multiple Aircraft Project
AIMS	Large	Deployment	Joint Services Electronics
485L	Small	Multiple	Multiple Electronics Projects
AF SATCOM	Small	Development	Satellite Joint Commands
DSP	Large	Deployment	Satellite Multiple Projects
MMIII	Large	Deployment	Single Missile Project

The systems selected are diverse and represent almost all types of Air Force program offices.

From among the defense systems, 76 specific items of support equipment were chosen for case studies. Appendix B contains the detailed data gathered about those items. Initial attempts at random selection of case studies failed to produce an acceptable variety of types of equipment desired to be represented in the sample. Therefore, a list of selection criteria was formulated and selections made to achieve an appropriate sample. LMI believes the resulting case study items are a valid sample from which to draw inferences about the Air Force support equipment process.

From the 76 case studies data a matrix of 17 problems correlated with 20 causes was developed. This interrelation among problems and causes contributes to the analysis and recommended solutions that follow.

II. THE AIR FORCE SUPPORT EQUIPMENT ACQUISITION PROCESS

This section summarizes the policies and procedures used by the Air Force in acquiring support equipment. First, the policies of the Air Force as documented in Air Force literature are reviewed. Second, implementing procedures are examined. Finally, a composite is presented of the interfaces among policies, procedures, required functions, implementing organizations and input/output data.

A. Support Equipment Policies

Documentation of Air Force policies and procedures in the acquisition of support equipment is extensive at all levels. The principal documents and their primary content are listed in Table 2.

Table 2. PRINCIPAL AIR FORCE SUPPORT EQUIPMENT DOCUMENTS

Document	Title	Primary Content
1. AFR 800-12	Acquisition of Support Equipment	Establishes Policy. Enumerates Trade-off Studies
2. AFR 800-8	Integrated Logistics Support (ILS) Program for Systems & Equipment	Includes Support Equipment as one of ten elements
3. AFSCR/AFLCR 800-5	AGE Acquisition Management	Implements Policy. Delineates Responsibilities for Engineering, Funding, Quantities, and Procurement, by category
4. AFLCM 65-3/ AFSCM 65-2	Air Force Provisioning Policies and Procedures, Part 10 Aerospace Ground Equipment	AGERD procedures and time standards
5. AFAD 71-685	Aerospace Ground Equipment Identification/Acquisition/Provisioning Document for USAF Contracts	Data Items with time standards. Interim Release Provisions
6. AFM 28-40	Mobility of Tactical Air Forces	Mobility Quantity Requirements
7. AFM 67-1	USAF Supply Manuals, Vol. 1, Part 1, Chap. 21 - Time Phasing of Aerospace Ground Equipment Deliveries	Delivery Requirements
8. AFLCM 57-16	AGE Acquisition Control System	Data Recording and Reporting Procedures
9. SAMSO Exhibit 68-62	System Requirements Analysis Program for Minuteman	Minuteman III Policies and Procedures
10. AFLCR 66-37	Management of Automated Test Systems	ATE Management System
11. San Antonio ALC/MMID	Automatic Test Equipment Acquisition Planning Guide	Extensive ATE Acquisition Guidance
12. AFLCM/AFSCM 800-4	Optimum Repair Level Analysis	Trade-off Study Influencing Need for and Location of Support Equipment

The complexity of the interface of support equipment with other areas in Air Force acquisition is illustrated in Appendix 3 of the ATE Acquisition Planning Guide (item 11, Table 2). That appendix contains 789 references to Air Force support equipment documentation in 23 categories. Readers interested in specific support equipment interfaces with other areas are referred to that appendix.³

In consonance with the DoDD 5000.1, Air Force System Program Directors (SPD) have final authority and responsibility for the support equipment acquisition process to be used for their system. Support equipment is clearly defined as inseparable from the prime system: it is required to be delivered with the prime system in order to assure that operational requirements can be met. Support equipment decisions are required to be based on cost-benefit trade-off studies during all phases of system acquisition.

Numerous such trade-off studies are specifically identified in Air Force documentation. These include the built-in test trade-off study, the Optimum Repair Level Analysis (ORLA) trade-off study, the automatic versus manual test system trade-off study, standardization trade-off studies, production line test equipment for depot use trade-off studies, contractor versus military initial support studies and depot manufacture studies. Only the ORLA trade-off study is required of all systems by AFSCM/AFLCM 800-4. The other trade-off studies may be made at the discretion of the SPO.

The support equipment acquisition policies are sound, contain sufficient flexibility to be structured to fit individual systems, and are comprehensive in that they address all pertinent areas of support.

B. Support Equipment Procedures

Because Air Force policy leaves final determination of the support equipment acquisition process to the SPO, great diversity in Air Force procedures could be expected. However, six of the eight defense systems studied by LMI used remarkably similar support

³The Appendix also is reproduced in Appendix 3 of "Procedural Flowcharts of the Air Force Support Equipment Acquisition Process," LMI, Oct. 1974.

equipment acquisition processes, all based on the Aerospace Ground Equipment Recommendation Data (AGERD) process⁴ recommended in AFSCR/AFLCR 800-5 and defined in AFLCM 65-3/AFSCM 65-2, (item 4, Table 2). The high degree of uniformity in support equipment acquisition procedures is an encouraging note. As recently as 1972, at least five unique sets of procedures were in use in the acquisition of Air Force support equipment.

Several of the systems we reviewed (Table 1) had individually tailored the AGERD process to their own needs. All systems of the Aeronautical Systems Division (ASD) use an approval form entitled ASD Form 170 (formerly ASD Form 169). This form was significantly beneficial in communications and record keeping at all levels. Two systems had replaced the Consolidated Aerospace Ground Equipment List (CAGEL) data item with other forms. The replacement of the CAGEL, however, restricted communication and record keeping by eliminating information which occasionally became necessary.

The placement of responsibility for the final decision on an item of support equipment varied from system to system. Some used the Engineering Division while others used the Integrated Logistics Support (ILS) Division, while still others used the AGE Projects Division as their responsible focal point within the SPO. The placement of responsibility within the SPO appeared to make no difference in the effectiveness of the final product.

A set of five procedural flowcharts depicting the AGERD process was published by LMI during October 1974. The flowcharts are reproduced in Appendix C of this report. The complexity of the process is illustrated by the fact that the principal flowchart (Flowchart 1) contains 81 functional blocks. The flowcharts represent an intermediate level of detail. For example, for more detail on the AFLC funding cycle one should refer to the joint AFSC/AFLC Joint Task Force Report.⁵

⁴AGERD procedures are contained in the flowcharts, Appendix C.

⁵Study of Aerospace Ground Equipment Acquisition Policies AFSC/AFLC Task Group, Oct. 1972.

The next set of procedures examined by LMI during the study was the systems engineering concept in use by the Minuteman III program. The concept is explained in detail in SAMSO Exhibit 68-62 (item 9. Table 2). The set of procedures clearly implements the policy of inseparability of prime system and support equipment by treating the two exactly alike. Exhibit 68-62 constructs a single logical flow of documents illustrating the use and maintenance of both types of equipment. From this, requirements for support equipment are identified clearly by the function they fulfill. The requirements, thus generated, lead to identical flows of documents for the support equipment use and maintenance until all requirements have been satisfied.

The principal form in the Minuteman III process which defines the specific item of support equipment is entitled Figure A, End Item Design Requirement Form. The figure combines in short form the essential ingredients of the AGERD. In addition, the terminology, "Technical Requirements," replaces the AGERD terminology, "Functional Analysis." This pinpoints for the contractor the most useful information to the Air Force.

The Minuteman III process does not contain specific provisions for searching the Air Force inventory by Air Force personnel for location of a common item as a check on the contractor. It does, however, fit well into the scheme of MIL-STD 499, Systems Engineering Management Plan, for integration with other efforts in design and support areas.

The final procedures studied was the identification of all support equipment required in the technical statement of work prior to final contract-negotiation. This technique was in use by the Remotely Piloted Vehicle (RPV) SPO. This approach was possible only because of the limited number of support equipment items required by RPV projects: clearly, systems with thousands of support equipment items could not use the procedure. However, other systems have used the procedure for large complex pieces of support equipment on an individual basis (for example case studies 1, 22, and 60 in Appendix B.) This procedure normally results in little formal search of the inventory for existing items to accomplish requirements.

As RPV projects have grown larger, the SPO has attempted to use the AGERD process. Case Study 18, for example, shows that one AGERD was abandoned when the contractor estimated the price of preparing an AGERD to be \$11,500. The RPV SPO expects to use the AGERD process exclusively on future large programs.

C. A Composite of the Process

Regardless of the formal procedures used, an underlying set of functions are required for the successful acquisition of support equipment by the Air Force. In the early stages concepts must be formulated and trade-off studies executed so that a plan can be formulated for the acquisition of support equipment. In the Full-Scale Development phase specific items must be named and approved by the Air Force before they can be developed or procured. Pre-delivery reviews such as the Preliminary Design Review (PDR) and the Critical Design Review (CDR) must be accomplished. Inspections such as First Article Configuration Inspection (FACL), acceptance tests and data acquisition must be managed. In the Production and Deployment phases delivery and price negotiations must be settled with the contractor and any changes arising from system changes or from test findings must be incorporated into the system.

The support equipment acquisition process has been divided by LMI into 18 functional areas, illustrated in Table 3. Table 3 lists the organizations, time standards, documents, inputs, outputs, uses of outputs, and the authenticating agency for each of the 18 functional areas. This table integrates the support equipment acquisition policy with its implementation by Air Force offices. Taken together, this matrix of principal functions and the flowcharts appearing in Appendix C contain the basic information required for guidance of the Air Force support equipment acquisition process as it is currently prescribed.

TABLE 3 SUMMARY OF PRINCIPAL FUNCTIONS REQUIRED IN THE AIR FORCE SUPPORT EQUIPMENT ACQUISITION PROCESS

Principal Function	Responsible Organization	Time Standard Or Requirement	Principal Regulatory Documents	Input Required To Perform Function	Source Of Inputs	Output(s)		Authentication Of Output
						From Performance Of Function	Recipient(s) Use Of Output	
1 Determine Support Concept	AFSC, AFSC, Using Com-mand	None	AFR 57-1, AFR 800-8, AFLCMC/AFSC 400-10, AFM 28-40	Mission Rmt. Support Exp. Concept Altns. Env. Regs. Mobility Regs.	Draft ROCs, Reported Data	Support Con-cept, Sec-tions of ROC ILS Plan, & DCP	SPO, HqUSAF, DSARC	AFSC, AFSC, Using Com-mand
2 Identify Support Equip-ment Trade-Off Studies	AFSC, AFSC, AFSC, AFSC	None	AFR 800-8, AFR 800-12, AFLCMC/AFSC 400-10	Support Con-cept, Subsystem Determination	ROC, ILS Plan, PMP, Field Experience	Selected Trade-Off Studies for Performance	Contractors AFSC, AFSC	SPO
3 Perform Sup-port Equip-ment Trade-Off Studies	Contractors AFSC, AFSC	None	AFLCMC/AFSC 800-4, MIL-STD 1513, AFR 800-12	List of Trade-Off Studies, Field Experi-ence Data, Support Concept	SPO, Reported Data, Using Command, Con-tractor Files, ROC, ILS Plan	Definition of Support Equipment Alternatives	SPO, AFSC	AFSC, AFSC
4 Develop Support Equipment Plan	Contractor	60 Days After Latest of Guidance Meet-ing or Contract Award	AFAD 71-685, AFLCMC 65-3/AFSC 65-2, DI-A-3014	Support Concept Operation and Maintenance Tasks, Inven-tory Items	SPO, Field Experience, MIL-HDBK 300	AGE Plan DI-A-3014	SPO, AFSC	SPO
5 Review Support Equipment Plan	SPO	Return Com-ments 30 Days After Submittal	AFLCMC 65-3/AFSC 65-2	AGE Plan, Support Concept Field Experi-ence	Contractor, MIL-HDBK 300	Approval of AGE Plan	Contractor	AFSC
6 Identify Specific Items of Support Equipment	Contractor	Continuously with first AGED by 30 Days from AGE Plan Approval	AFAD 71-685, DI-S-3596, AFLCMC 65-3/AFSC 65-2	Support Func-tions, Inven-tory Capabili-ties	System Design, MIL-HDBK 300, Fed. Stock Catalogues, Commercial Catalogues	AGERD	SPO, AFSC Using Command	SPO, AFSC
7 Review Spe-cific Items of Support Equipment	AFSC, AFSC, Using Com-mand	AFSC 45 Days Total 60 Days Late Result Can Lead to Interim Release	AFLCMC 65-3/AFSC 65-2	AGED, Mainte-nance Experi-ence, Inventory Capabilities	Contractor, MIL-HDBK 300, Inventory IM Files	Decision on Necessity for, and source of Specific Items	Contractor, AFSC	SPO
8 Determine Standard Sup-port Equip-ment Source	AFSC, SE/ALC Reg. & Dist. Branch	None	AFLCMC 65-3/AFSC 65-2	Approved AGED, Status of Source of Support	SPO, IM Files	Supply Ac-tion or PR/MIPR	Assigned Procuring Agency	SM
9 Acquire First Articles	Contractor, SPO, AFSC	By test need date	AFAD 71-685, AFLCMC 65-3/AFSC 65-2	Approved AGED, SE Engineering, PR/MIPR for Standard S.E.	SPO, Contrac-tor, SE/ALC	Support Equipment Available For Test	SPO Test Site	SPO, SM

TABLE 3. SUMMARY OF PRINCIPAL FUNCTIONS REQUIRED IN THE AIR FORCE SUPPORT EQUIPMENT ACQUISITION PROCESS (Continued)

Principal Function	Responsible Organization	Time Standard Or Requirement	Principal Regulatory Documents	Input Required To Perform Function	Source Of Inputs	Output(s) From		Authentication Of Output
						Performance Of Function	Recipient(s) Of Output	
10 Determine Required Support Equipment Data	SPO, AFPLC	By AGERD Approval	DD Form 1423 AFAD 71-685	AGERD, Maintenance Experience For Data	Contractor, SPO	ASD Form 170 Data Designations	Contractor	SPO
11 Prepare Required Support Equipment Data	Contractor	CMS-20 Days After AGERD Approval DSI-60 Days After AGERD Approval	ASD Form 170 DI-S-3515 DI-E-2112 DI-V-3024 DI-V-3804 DI-V-3805 DI-M-3407A MIL-STD 831 MIL-STD 490 MIL-STD 1519	ASD Form 170	SPO	CMS, AGERD, DSI, Detailed Test Plans, Tech. Orders Rec. Item Breakdown	SPO, AFPLC	SPO, AFPLC
12 Review Support Equipment Data	SPO, AFPLC	None	AFPLC 65-3/AFSCM 65-2	Submitted Support Equipment Data	Contractor	Approved S.E. Follow-on Data	SPO, SM, AFPLC, Using Command	AFSC, AFPLC
13 Conduct Pre-Delivery Reviews	SPO	None	MIL-STD 480	Preliminary Designs, Final Designs, First Articles	Contractor	Completed PDR, CDR, and FACI	SPO, Contractor	AFSC
14 Conduct Qualification and Acceptance Tests	SPO, AFPLC, Using Command	None	AFR 80-14, DI-T-3718 DI-T-3721	Support Articles Test Procedures	Contractor	ECR, UMR, S.E. Acceptance	SPO, AFPLC, Using Command	AFSC, Using Command
15 Negotiate Support Equipment Prices	SPO	PAGEL, 45 Days From Receipt of Order	AFAD 71-685, AFSCM/AFPLC 800-5, DI-V-3815	PAGEL	Contractor	Supplemental Agreement on Contract	SPO	AFSC
16 Manage Support Equipment Delivery	SPO, SM	Delivery 60 Days Before Receipt of System	AFR 67-1, AFSCM/AFPLC 67-3, AFPLC 57-15, AFAD 71-685, DI-V-3906	ASD Form 170, Delivery Schedules, Need Dates	SPO, Contractor	S.E. Available By Need Date, Shortages	AFPLC, Using Command	AFSC, AFPLC
17 Determine Required Support Equipment Changes	SP, AFPLC, Using Command	Approve ECRs within 45 Days	AFR 65-3, MIL-STD 480	UMR, ECR	Flight Test Program, Contractor, Using Command	Approved ECRs	Contractor	AFSC, AFPLC, Using Command
18 Control Support Equipment Charge Acquisition	SPO, AFPLC	None	AFR 65-3 MIL-STD 480	New AGERD Retrofit Experience	Contractor, AFPLC, Using Command	Improved Support Equipment	Using Command	AFSC, AFPLC

III. CASE STUDY SELECTION

Selecting a representative sample of support equipment from which to evaluate the effectiveness of policies, procedures and implementing actions proved to be a difficult task. The diversity in types of equipment, types of systems supported, and types of support concepts complicates the selection process. However, we found it possible to select items known to have specific sets of characteristics for which a comparison is desired, and to examine those items for all sets of characteristics for which comparisons are desired. For example, to examine the similarities and differences collectively of persons with regard to age, income, and sex, three sample sets might be drawn each of which is known to include the desired ranges of one of the characteristics--young and old, high and low incomes, and male and female. The final study sample then would be made up of all three sets so that the overall sample is known to include all characteristics for which comparisons are desired. We used that approach to select seventy-six support equipment cases for analysis.

This section describes the procedure by which the 76 cases were selected and identifies the specific characteristics of the items comprising the case studies. It is believed that the 76 case studies contained in Appendix B, collectively represent the Air Force support equipment acquisition process.

A. Defense Systems

All case study items were selected from the 8 systems listed in Table 1. The eight systems include old and new systems, large and small systems, single and multiple prime item programs, joint service development, joint command program offices, programs in all phases of development, and aircraft, electronics and missile systems.

B. Item Selection Criteria

Initial attempts were made to select support equipment items using statistically random selection procedures. These attempts, however, proved unworkable because the number of random draws required to assure representation of desired characteristics of support equipment proved to be extremely large. Since discarding items for study because they did not meet a particular characteristic destroyed the random nature of the selections, random selection procedures were discarded.

Instead sets of characteristics were developed for the sample. The sets of characteristics chosen include various functional types, levels of use, methods of procurement including Air Force manufacture, length of time in service, successful and unsuccessful examples of the acquisition process, high and low cost items, items for which significant trade-off studies had been accomplished, and types of items for which the Air Force was seeking reductions in the inventory. Items of support equipment were selected from the eight defense systems to represent these characteristics. Each item was selected for only one of the characteristics.

Initially a goal of 10 items per defense system was established. Final numbers selected from each system ranged from 6 to 11.

C. Case Study Characteristics

Each case study item was selected to satisfy one or another specific characteristic without regard to the remaining characteristics. Therefore, a display of the overall characteristics of all case study items will best describe the broad base of the sample selected. Because the characteristics are not mutually exclusive a great deal of overlap results. Table 4 lists the equipment types, functional areas, level of use, and methods of procurement of the 76 items selected.

Table 4. CASE STUDY CHARACTERISTICS

<u>Equipment Types</u>	<u>Quantity</u>
Complex Electronic	29
Automatic Test	13
Manual Test	15
Non-Complex Electronic	28
Operational Ground	7
Handling	6
Mechanical	16
 <u>Functional Areas</u>	
Airframe	5
Engine	4
Communication	13
Flight Control	6
Radar	6
Navigation	4
Identification (IFF)	3
Computers	4
SE for SE	5
Optical	2
Armament	2
Pyrotechnic	2
 <u>Level of Use</u>	
Organizational	22
Intermediate	56
Depot	20
 <u>Method of Procurement</u>	
New Design	42
Commercial Design	15
GFE	19
Air Force Manufacture	2

Although cost, problems, and delivery performance are discussed in detail in the next chapter, a summary may be helpful here in characterizing the overall sample. Nineteen items had acquisition costs⁶ exceeding \$1M, 12 items had acquisition costs below \$10,000, and the total acquisition cost represented by all 76 items was \$279.9M. Eleven items exhibited major problems, 22 items exhibited minor problems, including 7 items which showed potential for further standardization by reduction in the number of similar items in the Air Force inventory. Delivery performance was characterized by five cancelled items, 11 items remained pending, 38 items were delivered on time; and 22 items were delivered after the Air Force need.

LMI believes that these case studies provide a data base which is balanced, unbiased in its selection criteria, and large in relation to any other such detailed data base available. Therefore, the statistics and conclusions drawn from this data base are realistic and representative of the Air Force support equipment process in general.

⁶Throughout this document the term acquisition cost means all costs directly attributable to acquiring the item for its intended use. This includes development, all items procured, and software where it could be directly designated for the item. Operating and maintenance costs are excluded.

IV. FINDINGS AND ANALYSIS

This section summarizes our findings. First, five principal areas with regard to support equipment acquisition are observed and analyzed. These areas are:

- Delivery Performance
- Acquisition Costs
- Trade-off Studies
- Standardization
- Change Activity

Next, an analysis of procedures requiring improvement to meet their objectives is presented. Finally an analysis of problems and causes is presented.

The findings are in agreement with those of other studies and with the observations of Air Force personnel. Taken together the findings place support equipment problems in perspective and suggest the types of solutions required. The major conclusion is that the major problems as well as the greatest potential benefits, are peculiar to complex electronic test equipment. Therefore an approach that increases technical capabilities applied to complex electronic test equipment is required.

A. Delivery Performance

AFR 800-12 states that:

"Support equipment development and acquisition must recognize. . .the desirability of having such equipment available concurrent with the organic support function it is intended to perform. At the same time to preclude expensive modifications care must be exercised not to establish a firm support equipment design when the design of the mission equipment it is intended to support is unstable or the support equipment workload is not well defined. In this regard interim contractor support or other alternative procedures may be more cost-effective."

Air Force policy requires "timely" delivery of support equipment and defines timely delivery to be normally 120 days before receipt of the prime system to be supported.⁷

Recognizing Air Force requirements for timely delivery, each of the 76 case study items was classified as either late or on-time. In general, an item was judged late if extraordinary measures such as work around procedures or major milestone slippage were required by the Air Force due to delays in receiving the item of support equipment. Of the 76 items, 22 were classified as late under these guidelines.

Our analysis of delivery performance suggested a comparison of four categories of equipment, namely, automatic test equipment, complex manual test equipment, all other Contractor Furnished Equipment (CFE) and all other Government Furnished Equipment (GFE). Figure 1 depicts the delivery performance of the 76 items as a percent of the number of items in each category.

FIGURE 1
CASE STUDY DELIVERY PERFORMANCE
BY PERCENT OF ITEMS

HIGH COST CFE TEST EQUIPMENT



ATE



COMPLEX MANUAL



OTHER CFE

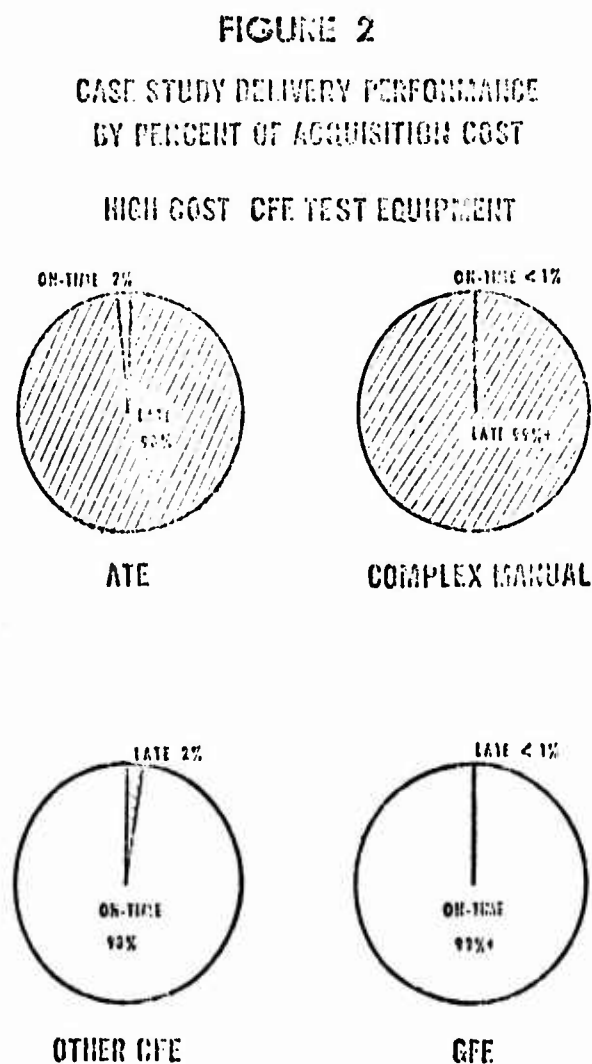


GFE

⁷ AFSCR/AFLCR 800-5; AFM 67-1, Volume 1, Part 1, Chapter 21; and AFAD 71-685.

Approximately 80% of the automatic test equipment and the complex manual test equipment was late. In contrast, categories of all other CFE and GFE were found to be over 80% on time. Thus, automatic and complex manual test equipment are highlighted as principal categories of support equipment delivered late. Note that there is no significant difference between automatic and complex manual test equipment or between CFE and GFE.

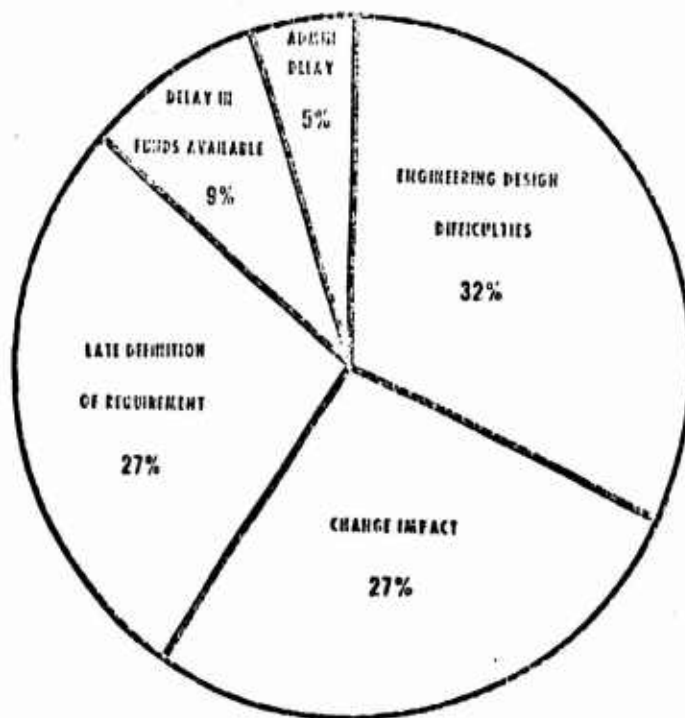
Figure 2 depicts delivery performance by the same categories as a percent of total category acquisition cost.



Items delivered late in categories of complex electronic test equipment represent approximately 99% of the acquisition cost of all items in those categories. On the other hand the items delivered late in the categories of other CFE and GFE represent only 1%-2% of the acquisition cost of the items in those categories. This finding is not surprising when it is recognized that acquisition costs and complexity normally correlate directly. It is apparent from the case study data that high cost complex electronic test equipment is the category where most delivery problems occur and is by far the most economically significant.

Reasons for late support equipment delivery were identified and grouped into five categories. These are: engineering design difficulties; change impact; late definition of requirement; delay in funds available; and administrative delay. Figure-3 shows the percent of late delivery items which fall into each category.

FIGURE 3
WHY SUPPORT EQUIPMENT WAS LATE



The first three categories are each significant contributors to late delivery and together account for 86% of the items delivered late. Those three categories cannot easily be corrected by policy and procedural improvements. Such problems are basically technical and require solutions through technical analyses and systems planning. For such items of support equipment, late delivery can be avoided only through greater attention to technical details and this requires an adequate source of technical expertise and the necessary time to undertake technical analysis. While the required technical expertise often exists within the Air Force or contractor organizations, the workload is normally such as to limit exhaustive technical analysis in all cases where such analysis is required. One way of dealing with this problem is to consolidate existing technical expertise in certain areas so that it can be directed more effectively toward the most significant and costly problem areas.

Case study 5 illustrates late delivery of an item due to engineering design difficulties. \$3.6M were expended for this item of automatic test equipment including design, software, and production. The item was delivered 10 months late due to technical difficulties in connectors, in software programing, and in electronic interference. Although the item has been delivered, it is still unsatisfactory due to low reliability--another technical problem. Semi-automatic production line test equipment is therefore required by the user to accomplish his mission.

Case study 3 illustrates the impact of changes on support equipment delivery. The Displays Test Station represents an acquisition cost of approximately \$27.5M. The item was delivered but subsequently withdrawn from the flight test facility because of design changes in the support equipment. In mid-1975 the item still was incomplete: eight out of 15 Line Replaceable Units (LRUs) remained design unstable.

Case study 1 illustrates a case of late delivery due to late definition of requirement. This item is over four years late and has caused prime system downtime due to lack of availability. Principal cause of the late definition of requirement was the necessity to coordinate the technical requirements of two System Program Offices.

B. Acquisition Cost

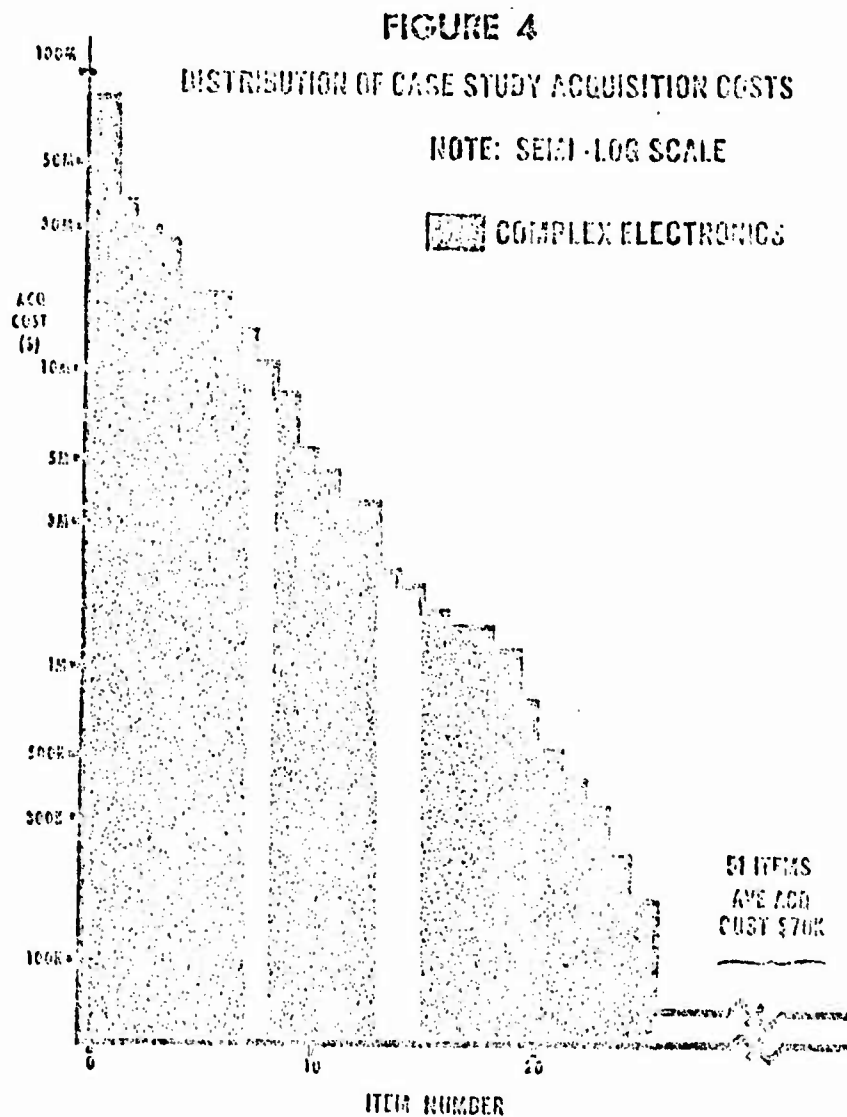
Due to the large number of case study items and the fact that all units of some case study items have not been acquired at the present time, it was not possible to examine all items to identify the actual acquisition costs in all cases or to determine lower cost alternatives except as previously studied by the Air Force. Therefore, the acquisition costs used in this report are the actual or the expected total expenditure for each case study item.

The total acquisition cost of all 76 case study items is estimated to be \$279.9 million. Table 5 represents the breakdown by category.

Table 5. ACQUISITION COST OF CASE STUDIES BY CATEGORY

<u>Category</u>	<u>Estimated Total Acquisition Cost (\$M)</u>
Automatic Test Equipment	115
Complex Manual Test Equipment	42
Other CFE	98
GFE	24
	TOTAL 279

Figure 4 shows distribution of case study acquisition cost plotted on a semi-log scale with the items in order of decreasing acquisition cost. The item having the highest acquisition cost was \$83M (Case study 29). The item having the lowest unit cost was a \$10 RF cable assembly which is manufactured by the Air Force (Case study 58). Referring to Figure 4 note that all but three of the highest 25 acquisition cost items were complex electronics. These three are case studies 60, 31 and 46 in decreasing acquisition cost order. The distorted distribution of acquisition costs is illustrated dramatically by the fact that 51 lowest cost items could be paid for by a single 4%% savings in the highest acquisition cost item.



The skewed distribution of acquisition costs as depicted in Figures 4 and 5 is typical of support equipment in many systems. For example, Figure 6 shows unit cost percentages as a percent of items for A-7D airframe contractor furnished support equipment.⁸ The shapes of the curves shown in Figure 5 and Figure 6 are very similar. Additional data supporting this skewed distribution as typical can be drawn from the F-15 CAGEL. That document shows that of 1916 items, only 35 (less than 2%) have unit costs exceeding \$50,000.

⁸These data are taken from a previous LMI study, Task 72-1.

FIGURE 5
CASE STUDIES COST DISTRIBUTION

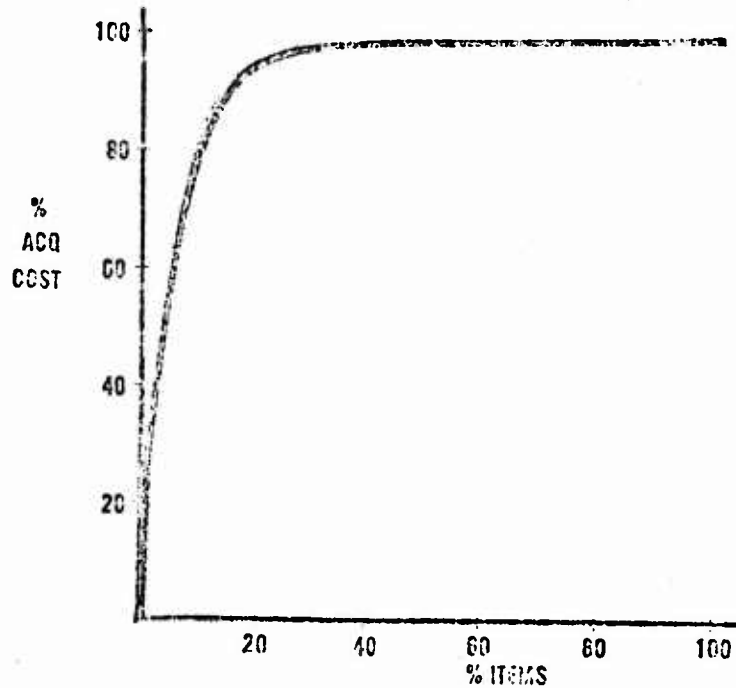


FIGURE 6
A-7D UNIT COST DISTRIBUTION
AIRFRAME CONTRACTOR FURNISHED AGE

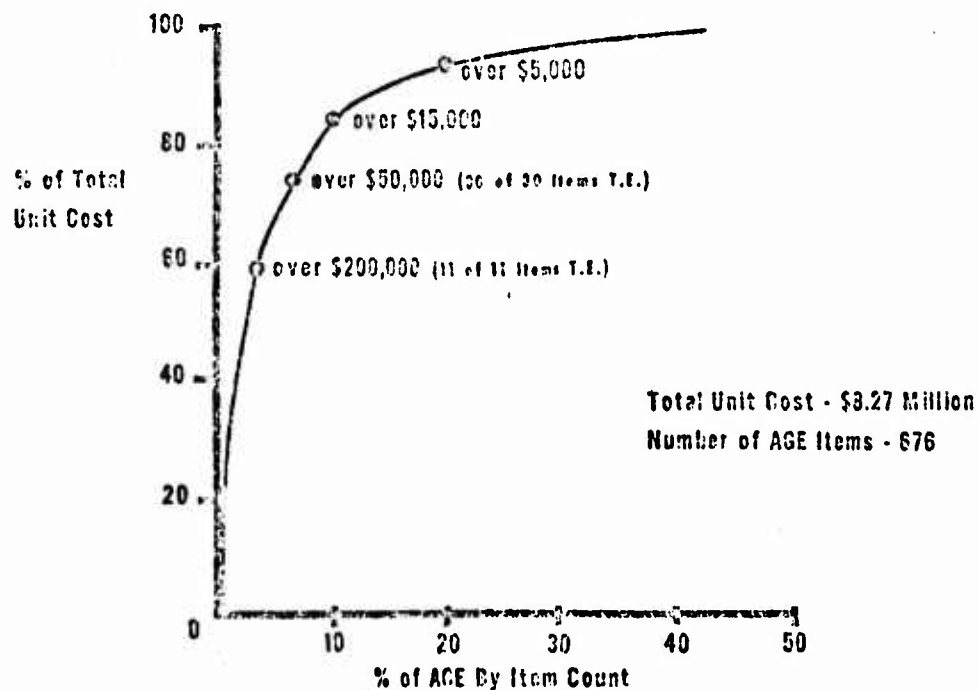
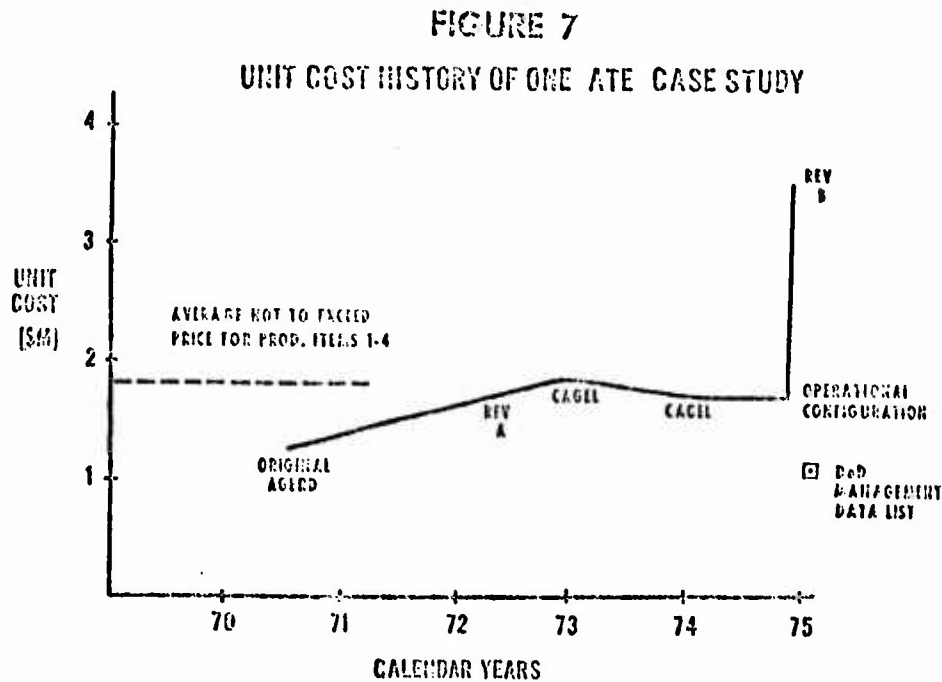


Figure 7 illustrates an example of one high cost complex electronic test item for which cost reduction efforts, although extensive, have been less than effective. Figure 7 shows the unit cost history for case study 2.



Major trade-off studies were accomplished for this item and a "Not to Exceed" price negotiated. Nevertheless, in late 1974 the contractor submitted a unit cost estimate exceeding the most recent previous unit cost estimate by \$2.8 million. This represented a 206% increase in unit cost from the most recent, and a 274% increase from the original cost estimate. In the same period the wholesale price indicator for electrical equipment rose 32.7%.

C. Trade-off Studies

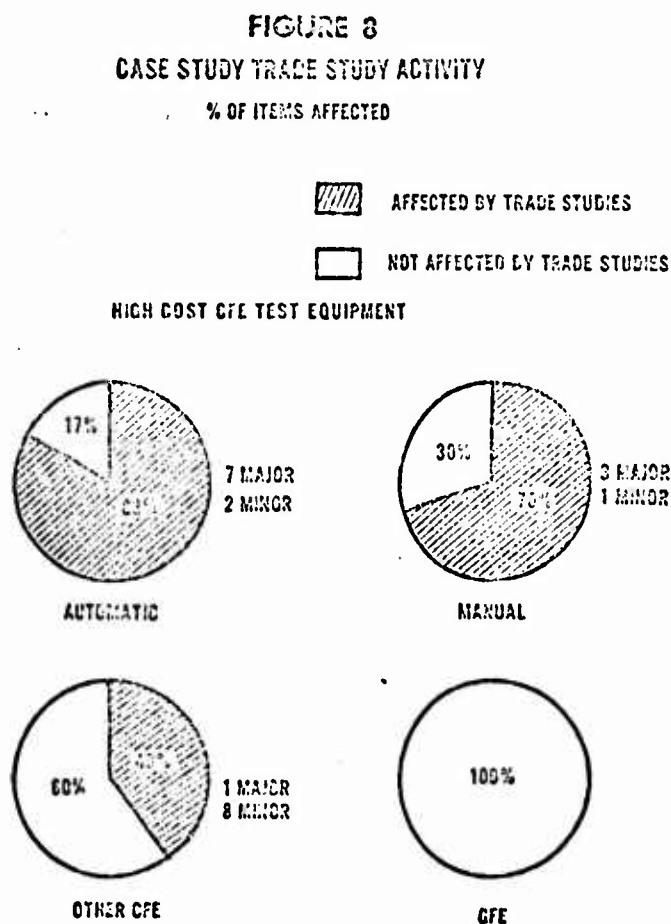
Seven principal trade-off studies that impact support equipment acquisition have been identified. These are:

1. Built-in versus detached test equipment.

2. Automatic versus manual test equipment.
3. Optimum Repair Level Analysis (ORLA).
4. Common versus peculiar support equipment.
5. Military specification versus commercial standard support equipment.
6. Production line versus peculiar depot test equipment.
7. Initial contractor support versus initial organic support.

The case studies data were examined to identify any trade-off studies that were made: twenty-two were identified. Eleven of those were major studies. The eleven major ones affected high dollar values, impacted major support policies, and were normally accomplished over a considerable period of time. We judged the remaining 11 to be minor studies. These involved single items, and impacted moderate dollar values.

Figure 8 shows the results of the case study trade-off study activity.



Note from Figure 8 that the percent of items affected decreases as category complexity decreases from automatic test equipment to complex manual test equipment to other CFE to GFE. The number of major trade-off studies decrease in the same sequence.

Eighty-three percent of the automatic test equipment case studies was affected by some type of a trade-off study. However, when the seven principal trade-off studies listed above are considered with respect to each ATE item, only 40% of the potential number of trade-off studies which could have been made had actually been accomplished. Although some of the potential trade-off alternatives are not applicable in all cases, there were numerous trade-off study alternatives which were not investigated by the Air Force.

D. Standardization

The trade-off study for which the most tools have been developed in the Air Force is standardization.⁹ AFR 800-12 identifies inventory items as the first priority for selection in the support equipment acquisition process. Principles are identified in AFR 800-12 for both horizontal (between systems), and vertical (within a system) standardization.

Selection of items already in the inventory can result in considerable cost savings. If a number of units of a selected item are available in the inventory, then all acquisition costs, except transportation, can be avoided. If additional units of an item already in the inventory are required, cost benefits are achievable by avoiding development, documentation and spare parts costs. On the other hand, several factors weigh against standardization. Improvements in the state-of-the-art of the item under consideration may be cost-beneficial. In addition, price reductions may be obtained as technology advances. A new peculiar item may be able to replace multiple items in the Air Force inventory, thus justifying the expense for a peculiar item. Therefore, the standardization decision must remain a trade-off study on an item-by-item basis.

⁹The term "standardization" as used in the context of a trade-off study is defined to mean the use of an existing inventory item of support equipment in lieu of acquiring a new item.

The case study data shows that only one of the complex electronic test equipment items is a standard item (case study 21). The standardization achievement can be attributed to the standardization of the prime system which the test equipment supports. The San Antonio ALC/MMD System Manager for ATE identified three items of ATE in multiple use in the Air Force inventory. Only one of those, however, was in use in one of the defense systems we selected, and was identified too late to be included in the case studies. Of all the remaining case study items, 34% were standard support equipment items in use on more than one defense system. Seven of those items showed potential for reduction in the number of items in their family. Only two were chosen for study due to that characteristic.

The percent of all other items that were standard appears to be low in the case study data. Counts from the defense systems studied indicate that about half of the support equipment in use by these defense systems is standard. However, the deviation is large. Because standardization is sensitive to a large number of variables high deviation should be expected.

A high level of standardization was achieved by the six complex electronic test stations of the F-15 Avionics Intermediate Shop (AIS). Examination of the drawer level components of those test stations reveals that 33% of the drawers in all six test stations are common to two or more test stations. Those common drawers represent 50% of the combined unit cost of the AIS test stations. This standardization was achieved because the technical requirements for all AIS test stations were treated by the same technical analysts with the goal of standardization during design. This demonstrates the potential for standardization within the complex electronic test equipment area at the drawer/component level.

Table 6 enumerates the principal standardization tools in use by contractor and Air Force personnel in the location of standard support equipment items. The column headed "Entry Data" lists the characteristics that must be known in order to use the tool indicated in the left hand column. Principal results of using the standardization tool are

Table 6 - STANDARDIZATION TOOLS

Standardization Tool	Entry Data	Result
MIL-HDBK-300D	Functional Class, Stock Number, Part Number, Nomenclature	Candidate Items
San Antonio ALC/MMD ATE Data Bank*	Technical Characteristics	Candidate ATE
Engineering Data Retrieval System*	Nomenclature, Characteristics	Candidate Items
Management Data Lists	Stock Number	Unit Cost, Source of Supply Manager, Other Data
Federal Stock Catalogs	Stock Number	Characteristics
DO97 Interchangeability and Substitution System	Stock Number	Status, Master Item, Order of Substitution
Tables of Allowance	TA Number and Stock Number	Candidate Items
Technical Orders	Prime Item	Required Support Equipment Items
Commercial Catalogs	Manufacturer	Candidate Items
T.O. 33K-1-101 Calibration Standards and Associated Equipment	Model, Part, or Type Number	Candidate Items

*Computer Interactive System

also enumerated. Probably the most powerful standardization tool in use today is not listed. That is the collective technical knowledge of the contractor and Air Force personnel involved with selecting and managing specific categories of support equipment items. We are recommending incorporation of that knowledge in existing data bases.

The first three entries in Table 6 deserve special review. MIL-HDBK-300D is the tri-service handbook for the DoD Standardization Program and the Standard Integrated Support Management System (SISMS). The purpose of the document is to provide data to familiarize designers, engineering and maintenance personnel, and government contractors with the characteristics, performance capability, and physical makeup of equipment presently in the DoD inventory and under development for aircraft and missile weapon systems. The document has been significantly improved in recent years by its publication in microfiche form and the inclusion of five indices for entry into the document. Nevertheless, significant problems remain. The cost criteria for entry, (at least \$1000 unit cost or \$100,000 total expense regardless of unit cost) have been arrived at arbitrarily. Applying the criteria leads to items with standardization potential being omitted and items of no potential being included. Long delays from specification of an item for entry to actual entry cause many entries to be out of date. Specification of an item for entry is made by AFLC; however, funds to obtain the required data are provided by AFSC. This leaves the data item entry vulnerable to reductions in data costs. All contractors interviewed reported finding either obsolete, out of supply, or low reliability equipment in MIL-HDBK-300D.

Of our case study items, 40% were already in the Air Force inventory and qualified on the basis of cost for listing in the handbook. Yet 73% of the items qualified for entry were not contained in MIL-HDBK-300D. If the case study data represent a typical sample, then MIL-HDBK-300D must exclude large quantities of items in the Air Force inventory.

The San Antonio ALC/MMD ATE data bank is the computerized inventory search tool of the ATE System Managers Office for the Air Force. The data bank contains the technical parameters of 45 items of ATE in the DoD inventory and 26 commercially

available items. The office has only recently become fully operational and should lead to significant cost savings through the standardization of ATE in the future for the Air Force.

The Engineering Data Retrieval System of the Naval Air Engineering Center, Lakehurst, New Jersey, has recently become available for the computerized location of support equipment items by characteristic required. This data base includes approximately 20,000 items and includes all items in MIL-HDBK-300D (about 3500). Principal source for the remaining 16,500 items are Support Equipment Recommendation Data submitted to the Navy. ATE is included but characteristics are minimum. The system includes approximately one thousand nomenclatures for which applicable characteristics are coded. Six hundred and twenty characteristics are available for selection following the choice of nomenclature. These characteristics are based on MIL-STD-864 Ground Support Equipment Functional Classification Categories.

A nomenclature search of the Navy system leads to a display of the number of items which contain the nomenclature. Either individual item examination or further refinement of items for consideration can then be undertaken. If the latter is chosen, the user specifies values for characteristics, including specific values or ranges until the number of items is reduced to manageable size. Cross reference capability by part number and stock number is also included in this data base.

Several Air Force contractors who also identify support equipment for the Navy already have the operational capability to use the Navy system. Others interested in using this system should write for details to:

Naval Air Engineering Center

Code 92A3

Lakehurst, New Jersey 08733

When significant operational use has been experienced the Navy system should be considered for replacing MIL-HDBK-300D as the tri-service designated support equipment

standardization data base. Capability should be incorporated into the Navy system to note when an item has been previously submitted and rejected; and to feedback experience data for use by designers.

Three additional standardization tools show a high potential for improving standardization in the future. The first system to be available will be the characteristics screening capability of the Defense Integrated Data System (DIDS). The Federal Item Identification Guides (FIIG) of this system will provide computerized characteristics searches of the entire DoD inventory including bits and pieces as well as support equipment. Items will be assigned Item Name Codes (INC) whose characteristics will be listed in the FIIGs. Characteristics codes will be based on the DD form 146 Federal Item Logistics Data Records. This search capability is already available for some FIIGs and should be available completely within the next two years.

The DIDS system should improve standardization achievement principally in the area of non-complex items. Complex electronic test equipment will be entered into the system but not characteristics coded. Characteristic samples must be analyzed critically when using this system. For example, tension load is not a required characteristic of a towbar. DIDS personnel stated that this characteristic could be included as an alternate.

The second future standardization tool is an identification of all support equipment items entered in Air Force tables of allowance assembled in a data bank by functional classification. This effort is being accomplished at the Ogden ALC. The resultant data base will provide SPOs and contractors with hard copy lists of inventory items by functions. A four level hierarchy of approximately 500 functions is planned. An example of the lowest characteristic level would be Doppler Radar. Characteristics search of similar functions will be possible through a series of application codes.

Finally, the Standard Electronic Modules program of the Air Force Avionics Laboratory will improve standardization in the distant future. The use of standard electronic modules will allow for the use of standard test equipment. Moreover, standard

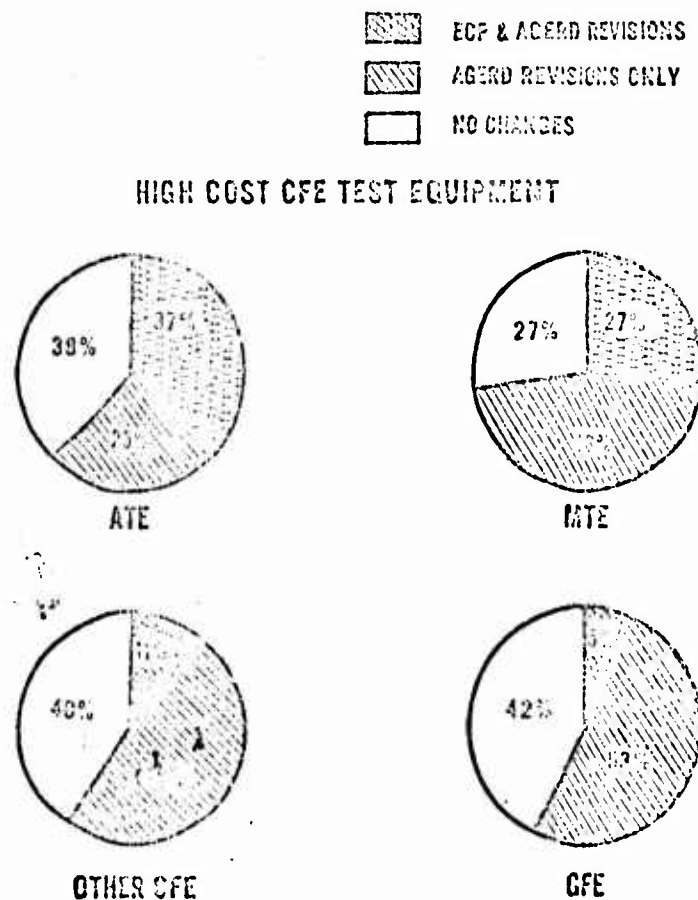
and non-standard test equipment may consist of many standard modules, thus reducing cost. A third advantage resulting from the use of standard electronic modules would be a reduction in training costs.

E. Change Impact

Analysis of the case studies showed that the second largest cause of late delivery of support equipment was design changes or changes in planned use. Such changes are initiated by any one of three procedures. First, during design, AGERD revisions may be submitted noting changes to the support equipment or planned use. Second, engineering change proposals are submitted for specific support equipment design changes. Finally, engineering change proposals are submitted for the prime system which subsequently require changes in associated support equipment.

Figure 9 shows the percent of the case study items affected by changes.

FIGURE 9
CASE STUDY CHANGE IMPACT
% OF ITEMS AFFECTED



Note from Figure 9 that the percent of total changes is relatively constant for each of the four categories. For three of the four categories the percent of items not affected by change varies only 4%. The remaining category (complex manual test equipment) is only 11% below the lowest of the other three. The percent of items affected by engineering change proposals, however, is significantly less in the other CFE and GFE categories. Moreover, the number of engineering change proposals that affect a single item of complex test equipment is normally greater than one. For example each item of ATE contained in the AIS was affected by seven or more engineering change proposals. Furthermore, the ECPs in the complex equipment categories were more costly than in the simpler equipment categories.

Figure 9 shows that the percentage of items affected by AGERD revisions is relatively constant throughout all categories of support equipment. Case study 46 had experienced 18 AGERD revisions as of January 24, 1975, even though the item was GFE. However, no guidelines for processing AGERD revisions exist in Air Force support equipment documentation.

Many of the AGERD revisions in all four categories were of a minor nature such as changing entries for work unit codes and national stock numbers. AGERD revisions are subjected to the same processing procedure as new AGERDs. Thus, a large flow of paper work is created in all categories of support equipment.

AGERDs are often submitted to the Air Force in batches of 50 or more bound together. There is no entry on the revised AGERDs to indicate the reason for revisions. Marginal notes, however, are included by a large number of contractors to indicate changes. A great deal of the manpower expended in reviewing revisions could be rechanneled into higher priority activity if the nature of the revision were more easily identified.

F. Analysis of Procedures

LMI observed five procedural areas which could benefit from improvement in

accomplishing their purpose. These are:

- MIL-HDBK-300D
- The AGERD process
- AGERD processing time standards
- Trade-off study estimates
- Feedback of experience data

This section discusses these areas.

Seventy-three percent of the eligible case study items are not included in MIL-HDBK-300D. Of complex electronic test equipment items, 100% are not included in the document. In addition to incomplete entry into the handbook, items are frequently late in entering the document. For example, the entry for the AN/UPM-137A Radar Test Set does not include a four-year old major revision. Preference for reuse of an item has not been achieved as an entry criteria. For example a Honeycomb Structure Repair Kit (Case study 63) is listed in MIL-HDBK-300D but was rejected by the A-10 program office. Instead parts of the kit are being ordered separately.

LMI previously recommended replacing MIL-HDBK-300D. A detailed decision on what action to take regarding changes in standardization tools must await a comprehensive study of these tools by the Air Force.

The AGERD process is the best developed, most comprehensive, most understood procedure for approving support equipment in use in the Air Force. This process was not in use on 20% of all the support equipment cases studied and on 28% of the complex electronic test equipment studied. Stronger emphasis of the AGERD process is required to make system program directors aware of its advantages to encourage them to select this procedure. General application of the process should improve effectiveness of support equipment acquisition and provide a basis for easier communications among system program offices.

Further improvement of the AGERD process can be achieved by developing guidelines for the preparing and processing of AGERD revisions. Such guidelines would minimize time consuming reviews of minor revisions in AGERDs presently submitted.

Finally data quality control within the AGERD process requires improvement. Table 7 shows the percent of case studies affected by five data quality control problems for all items and for complex electronic test equipment items which were acquired through the AGERD process.

Table 7. PERCENT OF CASE STUDIES AFFECTED BY
DATA QUALITY CONTROL PROBLEMS

PROBLEM	Complex Electronic Test Equipment	All Items
Inadequate Functional Designation	6%	23%
Need Date Missing	22%	21%
Development Cost Missing	29%	37%
Unit Cost Missing	28%	39%
Mistakes in Entries	4%	11%

It should be noted that the data quality control for complex electronic test equipment AGERDs was better than for all items with regard to four out of the five problems. In the critical problem area of inadequate functional description, the complex electronic test equipment AGERDs were significantly better. The point is that data quality control is a procedural function and that the function is performed as well or better for complex electronic test equipment as it is for all other items. Yet, the major problems with support equipment have been shown to fall into the category of complex electronic test equipment. This suggests that solutions to the major problems do not lie in the area of procedural improvements--a conclusion which seems to be apparent time and time again.

A third area not achieving its established standard is the processing time standards specified in Air Force regulations. These standards were exceeded in almost all cases. Of all the case studies where measurable time standards could be compared, the average processing time for an AGERD was 200% of the specified value. In order to provide a more thorough sample, one hundred support equipment items were drawn at random from the F-15 system. The average processing time for the 100 sample items was 165% of the specified value. No statistical difference could be detected between complex electronic test equipment items and other items.

LMI thinks these time standards should be retained. For normal support equipment items, the standards present an optimistic goal which helps to motivate involved personnel. For complex electronic test equipment, however, realistic coordination should be expected to exceed the standards.

Fourthly, an area which would benefit from improvement is the development of appropriate estimates for trade-off studies. Technical and economic data were poorly estimated in most of the major trade-off studies we reviewed. Fifty-five percent of the major trade-off studies associated with the case study items contained technical or economic data estimates which were significantly inaccurate when measured against actual values. Technical and economic data are normally estimated individually for each major trade-off study. No central file of trade-off studies was found. Therefore, it is difficult to use or validate previous estimates developed by the Air Force or contractors because of the diversified locations of the offices initiating and making trade-off studies.

The final procedural area where improvement would be beneficial is the feedback of experience data to support equipment decision makers. The successful or unsuccessful experience of users of Air Force support equipment is well known to users and item managers. However no central accessible documentation exists to bring this information quickly to the attention of contractor support equipment identifiers and SPO support equipment selectors. Such data should include performance adequacy, reliability, costs,

and obsolescence information, and should be integrated with the management information available in existing Air Force data bases.

G. Analysis of Problems and Causes

To summarize the findings subsections A-F we have seen that the category of complex electronic test equipment has the greatest percent of items delivered late. Principal reasons for this late delivery are technical in nature and require technical solutions. Costs also are heavily concentrated in the complex electronic test equipment area. Such distributions of cost indicate maximum return from cost reduction efforts in the complex electronic test equipment area. Trade-off studies are done more often and more of them are major in the complex electronic test equipment area but numerous trade-off study alternatives are not investigated. Complex electronic test equipment is not at the present time highly standardized, although potential exists for more standardization particularly at the drawer/component level. Numerous standardization tools exist; others are under development. None of the standardization tools found address exclusively standardization for complex electronic automatic and manual test equipment. Formal engineering change proposal activity is greatest and most costly in the area of complex electronic test equipment. AGERD revisions are relatively constant for all categories of support equipment and mostly apply to minor changes. Five procedural areas for improvement are highlighted but do not appear to be appropriate solutions for complex electronic test equipment since this equipment performed better than other support equipment in almost all areas.

As a first step in searching for solutions problems encountered in the case studies were identified and analyzed.

We have classified problems associated with the support equipment acquisition process as either major or minor. A problem was considered to be major if it results in a high cost for solution, significantly affects the ability to support the prime system, or a solution requires considerable time.

Examples of major problems included the following:

- Support equipment caused down time of the prime equipment (Case Study 1)
- The F-15 AIS quantity decision which required the rewriting of AFR 28-40 in order to procure the quantity desired.
- Two corporate bankruptcies (Case studies 46 and 21).
- The deletion of 30% of the support equipment items in one program by the ORLA study. This ORLA was being revised at the time of the review (Case studies 24, 25, and 43).

Examples of minor problems included the following:

- Subcontractor delivery of an item of prime equipment which did not meet specifications and required a temporary modification of a piece of standard support equipment (Case study 30).
- The use of the AGERD process for items which should be procured on the standard hand tool list (Case study 67).
- Contractor misunderstanding resulted in incorrect assessment of the application of an item of GFE (Case study 66).
- Inadequate functional description for the selection of an item of support equipment.

Forty percent (40%) of the complex electronic test equipment items were affected by major problems, while only 4% of the other support equipment items were so affected. Thus, complex electronic test equipment represents a significant category where major problems occur in Air Force support equipment acquisitions. The remainder of this section addresses the causes of problems in order to give insight into the type of solutions required.

To better identify the nature of solutions required, the analysis was expanded beyond the data base of the 76 case studies to include the assessment of support equipment

acquisition in general. This expansion led to the construction of Table 8 which shows a matrix of 17 problems and 20 causes judged to be the most significant in Air Force support equipment acquisition. Thirteen of these problems and 16 of these causes can be illustrated by case study examples. An "X" in a box of Table 8 indicates that the cause probably leads to that problem. Of 340 intersections in this matrix, 144 were judged so related. This illustrates the complex nature of the interrelation of problems and their causes in Air Force support equipment acquisition.

Of the 20 problems identified in Table 8 only seven are of a nature that is directly addressable by Air Force regulation. The remainder can only be addressed through technical analyses and system planning functions. Thus simple procedural solutions again appear not to yield satisfactory solutions to the most significant problems.

The interrelation of problems and causes in complex item acquisition is illustrated by the AN/UPM-137A Radar Test Set (case study 21). The item is functioning improperly because of lack of calibration equipment. A contract for the required calibration equipment was awarded more than two years ago but was terminated after a corporate bankruptcy. The second contract award was successfully protested. The third contract award was made in early 1975. A four and one-half year old major revision in this item has not been incorporated in the MIL-HDBK-300D entry. The MIL-HDBK-300D entry for the original version is dated 8 days before the date of the ECP for the major revision. An entry for the revised version is now on order after the A-10 contractor identified the revision by telephone contact with the manufacturer and the Air Force selected the item for entry. Although two contractors manufacture the item, its unit cost has increased 28.5%. The Air Force has invested more than \$18 million in the acquisition of this item.

Table 9 summarizes the causes, impact and solutions of problems in acquiring support equipment.

PROBLEMS	CAUSES	1. ENGINEERING DESIGN ERROR	2. OMITTED OR IN-QUALIFICATION TEST	3. INADEQUATE DATA BASE	4. OMISSION OF RE-LIABILITY SPEC.	5. ORLA NOT PERFORMED	6. RESULTS OF RE-CALCULATED ORLA NOT AVAILABLE	7. LONG TECHNICAL REQUIREMENTS	8. HIGH TECHNICAL DESIGN RISK	9. ENGINEERING CHANGES IN PRIME EQUIPMENT	10. LONG PROCUREMENT CYCLE	11. LONG APPROVAL CYCLE	12. DESIGN NOT SUB-JECT TO VALUE	13. CHANGES IN OPERATIONAL PLANS	14. CHANGES IN SUPPORT CONCEPT	15. TRADE-OFF STUDIES NOT MADE	16. RESULTS OF TRADE-OFFS NOT AVAILABLE	17. OFF LOCATIONS & UTILIZATION NOT READILY AVAIL.	18. COST ESTIMATES INCOMPLETE	19. CORPORATE BANKRUPTCY	20. FUNDING LIMITATION
		X	X						X	X				X		X	X				
1. SE DOES NOT PERFORM ITS INTENDED FUNCTION		X	X						X	X				X		X	X				
2. SE PERFORMS ITS INTENDED FUNCTION POORLY		X	X		X			X	X	X				X		X	X	X			X
3. SE UNNECESSARY				X		X	X			X				X		X	X	X			
4. SE REQUIREMENT NOT RECOGNIZED				X		X	X			X					X	X	X				X
5. SE UNRELIABLE		X	X		X				X	X						X	X			X	X
6. SOFTWARE NOT PROVIDED WITH SE				X											X					X	X
7. SOFTWARE INCOMPLETE OR INADEQUATE			X	X					X	X				X	X	X	X			X	X
8. SE FOR SE NOT PROVIDED				X											X				X	X	X
9. SPARES FOR SE NOT PROVIDED				X	X										X				X	X	X
10. TRAINING FOR SE NOT PROVIDED				X										X	X				X	X	X
11. CONTRACTOR UNABLE TO DELIVER SE	X								X	X	X	X							X	X	X
12. SE OVERDESIGNED FOR INTENDED FUNCTION	X		X	X	X			X	X	X			X	X	X	X					
13. NUMBER PROCURED INSUFFICIENT			X	X		X	X							X		X	X	X		X	X
14. NUMBER PROCURED EXCESSIVE			X	X		X	X							X		X	X				
15. OPTION SE AVAILABLE BUT NOT FOUND			X							X				X	X	X	X	X			
16. COST SIGNIFICANTLY EXCEED ESTIMATE	X		X	X		X	X	X	X	X	X	X	X	X	X	X	X		X	X	X
17. LATE DELIVERY	X					X	X	X	X	X	X	X		X	X			X		X	X

Table 8 - SUPPORT EQUIPMENT ACQUISITION PROBLEMS AND CAUSES

Table 9 - SUPPORT EQUIPMENT PROBLEM SUMMARY

	Causes	Impact	Solutions
Complex Electronic Test Equipment	Complexity Trade-offs Not Made Funding Limits Inadequate Data Technical Requirement Definition	Poor Support Very High Cost Late Delivery Low Reliability	Technical Expertise Technical Analysis Historical Analysis Alternative Approaches Improved Data
Other Support Equipment	Inadequate Data Administrative Errors and Delays	Inefficient Support Medium Cost	Procedural Change Improved Data

V. CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the three conclusions and seven recommendations of the study. Conclusion 2 is by far the most significant and the most difficult to develop into appropriate and non-controversial recommendations. Recommendation 1 is made in response to conclusion 2. Recommendations 2-7 are subsequently presented in response to conclusion 3.

A. CONCLUSIONS

1. Air Force Support Equipment Policies are Sound and Comprehensive. Air Force policies are appropriately directed to desirable objectives and address all areas related to support equipment acquisition. The basis of Air Force policy can be traced to DoD Directives and are consistent with DoD policy with respect to program management.

2. Complex Electronic Test Equipment Requires and Warrants Increased Management Attention and Technical Analysis in the Air Force. Complex electronic test equipment was highlighted in all areas of our findings as a major problem. Technical and economic problems abound in this area. Additional management attention and an increased emphasis of technical analysis is required. The Air Force should define technical requirements more precisely and assess technical risks more realistically, particularly during the earlier phase of acquisition of complex electronic test equipment. Alternative means of providing support should be more thoroughly investigated. This requires detailed technical trade-off studies. An increased emphasis on both management attention and technical analysis requires that improved economic and technical data bases be developed.

Three viable alternatives were considered as means to increase Air Force emphasis on management attention and technical analysis of complex electronics test equipment. First, increasing resources for analysis within individual SPOs was considered. Second, consideration was given to assigning responsibility within an Air Force organization

supporting the SPOs. Finally centralization of Air Force technical assistance for complex electronic test equipment was considered. The final alternative was selected because LMI believes it is the most resource efficient and will lead to the most cross-fertilization among systems. Recommendation 1 is the result of this selection.

3. Air Force Procedures for Acquisition of Support Equipment (other than complex electronic test equipment) are Reasonably Effective: however, a Number of Simple Procedural Improvements in the Process are Feasible and Desirable. Other than for complex electronics, we observed that a substantial percentage of support equipment items is delivered on time, has sufficient capability to perform required functions, and is adequate in number. This is not to say procedures cannot be improved. We have identified a number of procedural changes that, while modest in scope, when taken together will further enhance the Air Force's capability to acquire support equipment at minimum cost and in a more timely manner.

B. RECOMMENDATIONS

1. Complex Electronic Test Equipment

A significant change in the methods now being applied by the Air Force in acquiring complex electronic test equipment is necessary. While basic policy appears to be sound, the organization and procedures for carrying out policy can be improved.

Recommendation 1

THAT THE AIR FORCE ESTABLISH A COMPLEX ELECTRONIC TEST EQUIPMENT TECHNICAL SUPPORT OFFICE TO PROVIDE TECHNICAL ASSISTANCE TO SYSTEM PROGRAM OFFICES, SYSTEM DEVELOPMENT CONTRACTORS AND AIR FORCE LOGISTICS SUPPORT CENTERS IN THE REVIEW, SELECTION AND ACQUISITION OF COMPLEX ELECTRONIC TEST EQUIPMENT.

The Complex Electronic Test Equipment Technical Support Office should be assigned responsibilities as outlined in the following.

a. All support equipment plans which include the use of complex electronic test equipment should be reviewed. In particular ILS Plans, Support Equipment Plans, and Support Equipment Recommendation Data (SERD) should be reviewed. These reviews should result in advice to SPOs of available courses of action in fulfilling requirements.

b. Alternative approaches should be recommended where appropriate. The seven trade-off studies mentioned in Chapter 4 Section C should serve as an initial list of alternatives from which trade-off studies are recommended. All data used in such studies should be reviewed for completeness and accuracy.

c. For each specific equipment this office should make recommendations on the validity of the requirement, the suitability of the specific contractor recommended equipment, and the quantity requirement for that equipment.

d. A technical data file should be maintained of all complex electronic test equipment currently in the Air Force inventory, under development or available through commercial sources. This data base should not duplicate the San Antonio ALC/MMD ATE data bank information on the capabilities of items but should include all other pertinent technical data. Such data should include previously performed trade-off studies including all values estimated such as time-to-repair data, reliability data, and cost data for specific items. Performance and applications data should be included for items not in the ATE data base. The data file should include an identification of preferred items of complex electronic test equipment for reuse throughout the Air Force. Several categories of preferred items should be identified including drawer level components. The data bank should include the locations and utilization rates of all items of complex electronic test equipment currently in the Air Force inventory for use in evaluating potential commonality.

e. Technical assistance on all matters related to complex electronic test equipment should be given to appropriate requestors including Air Force support organizations, other services, and systems development contractors as well as SPOs.

The proposed technical support office will allow the Air Force to consolidate the required technical expertise necessary to thoroughly evaluate alternative support methods and equipments in the support equipment area with the greatest impact on cost and support effectiveness. The consolidation of such technical expertise will foster the cross-fertilization of technology among systems, provide an effective utilization of technical resources and allow more time for SPO personnel to address critical problems in areas other than complex electronic test equipment.

While the purpose of the proposed office is to assist and advise, the office can only be effective if it is used. It is, therefore, recommended that Air Force policy be established which requires review by the proposed office of all Support Equipment Recommendation Data (SERD) for electronic test equipment items with unit costs exceeding a specified amount. After this review the final decision should be made by the System Program Director (SPD). It is recommended that the specified amount be initially set at \$50,000 until the effectiveness of the proposed office to deal with high cost items has been demonstrated. The specified amount might then be decreased since many low cost items often have a significant impact on support facts and support posture.

A workload analysis of a complex electronic test equipment technical support office as described indicates that approximately 14 technical personnel would be initially required to perform the responsibilities of the office for all new acquisitions of test equipment items exceeding \$50,000 unit cost.

2. Procedural Improvements in the Total Process

Recommendation 2

THAT THE SUPPORT EQUIPMENT RECOMMENDATION DATA (SERD) FORMAT BE REVISED TO INCLUDE ADDITIONAL INFORMATION.

The SERD data item description should be revised to incorporate information which will more accurately pinpoint the data required by the Air Force to properly select support equipment items and to incorporate new state-of-the-art improvements in support equipment analysis. Principal among these revisions is the specifications of quantitative technical characteristics required for the support equipment item. The present title, "Functional Analysis," is too general and results in inadequate descriptions. The case studies showed that 23% of the entries submitted by contractors were inadequate descriptions of technical characteristics. Changing the title on the SERD data form from "Functional Analysis" to "Technical Requirements" would more accurately describe the type of information needed for analysis of recommended items. Guides could be developed identifying the types of technical characteristics which should be considered for various types of support equipment when stating technical requirements.

The inclusion of data relating to software now is left to the discretion of the contractor. For complex electronic test equipment, software requirements are essential. Software requirements should be specifically identified on the SERD where complex electronic test equipment is being recommended. Software requirements should include not only programing tapes and test instructions, but also associated software such as compilers, users manuals, technical orders, and programmers notes.

The ORLA trade-off study interrelates with the selection of support equipment to such a high degree that coordination with the ORLA study will contribute significantly to the analysis of support equipment required. Such coordination currently takes place unofficially. Some provisions should be made to include the results of ORLA on the SERD form.

Many items of support equipment require their own support equipment (such as calibration equipment). Requirements for such second level support equipment

should be identified and included on the SERD form together with planning schedules for acquiring the equipment. In addition, spares and training requirements for support equipment should be included on the SERD form. Even if detailed descriptions cannot be made at the time the SERD is submitted, including these data will provide a check for future planning and improve the ability to analyze alternative approaches.

The support equipment recommendation data form should include a checklist of data sources used by the contractor in their search for common items. This will prevent Air Force duplication of contractor effort in the search for common items.

A small space or checklist should be provided on the SERD form for the purpose of explaining briefly the reason for recommendations to revise support equipment. Indicating briefly the reason for a recommended revision will save the time of personnel who now must examine the revision in detail in order to determine whether they have an interest.

Finally, the SERD form should indicate whether the quality of the data in a SERD has been checked. Space for authenticator's signature should be provided. In the case of complex electronic test equipment, the review of quality of data should be made by the office proposed in recommendation 1.

Recommendation 3

THAT THE SUPPORT EQUIPMENT RECOMMENDATION DATA PROCESS BE APPLIED TO ALL NEW SUPPORT EQUIPMENT ACQUISITIONS.

The existing SERD process for identifying and selecting support equipment items is thorough and well known to the working level personnel in the Air Force. The SERD process should be required for use by those systems which are not presently using it and should be applied by all new program offices. Application of the SERD process in many system acquisition programs has already contributed significantly to inter-organizational communications.

Recommendation 4

THAT THE IDENTIFICATION AND SELECTION PROCESS FOR NON-COMPLEX GFE ITEMS BE SIMPLIFIED.

In order to concentrate attention on higher priority categories such as complex electronic test equipment, simple items of GFE should be procured in a simple manner. One method of simplifying the process is to procure the SERD figure 1B only for non-complex items. Essential technical requirements could be included in the remarks space. Another method of simplifying the process is to use the DI-L-3334, Pre-Operational Standard AGE List or a tooling summary list in lieu of the SERD form. The Standard/Modified Hand Tools List, DI-Y-3824, should be used wherever possible. Such simplification methods might also be applied to non-complex items of CFE and commercial support equipment. The Air Force should retain the option of requiring the complete SERD form for any item submitted in simple form that later proves to be more complex than anticipated.

Recommendation 5

THAT A FEEDBACK DATA SYSTEM BE ESTABLISHED FOR SUPPORT EQUIPMENT PERFORMANCE EXPERIENCE.

To prevent the reuse of support equipment which has proven unsuccessful in field experience, the Air Force should develop a feedback data system to document operational experience with support equipment. Experience data can be collected and disseminated through existing data systems. The type of data collected should include a measure of support equipment success or failure in performing intended functions, reliability, cost, and reproducibility. Most of these data already exist within the Air Force at the user, item manager, and contractor levels. These data should be consolidated into useable format, incorporated into existing data systems, and made available to individuals responsible for selecting and specifying support equipment items.

Recommendation 6

THAT SAFETY CONSIDERATIONS BE EXPLICITLY STATED IN THE GUIDELINES FOR AIR FORCE MANUFACTURE OF SIMPLE LOW COST SUPPORT EQUIPMENT.

Four criteria for Air Force manufacture of low cost support equipment are stipulated in AFR 800-12, Attachment 1, Section 12. These are:

- Cost-effectiveness analysis that verifies the decision.
- Any materials and the necessary manufacturing data available.
- Process of manufacture or modification compatible with tools, equipment, or skills locally available.
- Quantities requirements which are small, or do not impose an undue workload.

Retention of system safety is implicit in cost-effectiveness and process of manufacture considerations. Explicit mention of safety considerations is, however, omitted.

Case study 52 illustrates the potential results of failure to consider specifically safety precautions. Contractor personnel disclaimed responsibility in the event of accidental pyrotechnic explosion caused by poor quality support equipment manufactured by the Air Force. A criterion should be added to the four above which explicitly states that safety hazard potential must be considered before designating an item for Air Force manufacture.

Recommendation 7

THAT INCONSISTENCIES IN SUPPORT EQUIPMENT ACQUISITION DOCUMENTATION BE CORRECTED.

Four inconsistencies in Air Force support equipment documentation should be corrected. First, duplication of the program office responsibilities should be eliminated from AFLCM 65-3/AFSCM 65-2. Such responsibilities are stated in two separate sections of the document--one under Program Manager and the other under

Program Office. The stated responsibilities overlap and are confusing. Duplication should be eliminated and the distinct responsibilities of the Program Manager should be combined in one section.

AFLCM 65-3/AFSCM 65-2 contains three inconsistencies between the text of part 10 and the flowchart in part 16 representing the same process. First, the text contains no list of responsibilities for the subsystem item manager ALC although four branches of the subsystem item manager ALC are shown on the flowchart. Second, the Air Force plant representative's office and service engineering branch are listed on the flowchart but are not included in the text. Finally, the packaging and handling branch is listed in the text but does not appear on the flowchart.

The Support Equipment Plan, DI-A-3014, should be distributed to all offices which receive SERDs. The support equipment plan shows how individual support equipment items fit into the total plan. Knowledge of the overall plan will aid in the selection and identification of items by personnel concerned with specific areas of support. Existing documentation does not require distribution of the Support Equipment Plan to all offices reviewing SERDs. A requirement for distribution should be incorporated in AFSCR/AFLCR 800-5.

Case study 1 illustrates the absence of Air Force procedures for multi-SPO development of major components. Procedures for multi-SPO development should be included in AFSCR/AFLCR 800-5. Such procedures should include the designation of a lead SPO and the requirement for approval by other SPOs involved in the selection of support equipment. Such procedures would eliminate the need for a Program Management Directive from Hq. USAF in the event of common development such as occurred in Case study 1. Coordination of major components which are electronic test equipment should be the responsibility of the Complex Electronic Test Equipment Technical Support Office proposed in Recommendation 1.

BIBLIOGRAPHY

1. Air Force/Industry Standard Electronic Module Workshop, Consolidated First Session Minutes, 19-21 May 1975, prepared by EG & G Washington Analytical Services Center, Inc.
2. Automatic Test Equipment Acquisition Planning Guide, San Antonio ALC/MMD, Jan. 31, 1974.
3. Budget Allocation Procedures For Naval Aircraft Ground Support Equipment, S. C. Jaquette, and R. C. Morey, Office of Naval Research, October 1970, AD 714 527, LD 25772.
4. The Cost of Aerospace Ground Equipment Could Be Reduced, General Accounting Office, B-177751, OSD Case 3791, Sept. 11, 1974.
5. The Development of a Precision Navigation, Guidance and Control System for Future Unmanned Vehicles, Barry Rodgers, Lear Siegler, Inc., Santa Monica, California.
6. Estimating Life-Cycle Costs: A Case Study of the A-7D, Marco Fiorello, The Rand Corp., R-1518-PR, Feb. 1975.
7. A Generalized Procedure for Evaluation of Maintenance Aids, W. F. Ford, Texas A & M University, May 1970, AD 739 002, LD 25617.
8. Index of Federal Catalog System Publications, Defense Supply Agency, Part III, June 1974, DSAH 5025.1, DA Pam 310-23.
9. Joint AFSC/AFLC Evaluation of Aerospace Ground Equipment (AGE) Acquisition Procedures, Inspector General Report, 1974, JPN 75-27.
10. Maintainability of Air Force Ground Systems Nonelectronic Equipment/Devices, H. S. Wilburn, L. H. Gerdes, and D. R. Rupert, The Boeing Co., Oct. 1972, AD 905 566L, RADC-TR-72-251, LD 28677.
11. Management Procedures for Evaluating Requirements and Relationships Between AGE/ATE and System Acquisition, LMI Task 72-1 Rev., Phase I Report, Dec. 1972.
12. National Military Command System (NMCS), Processing and Display System (PDS), First Technical Report, TRW System Group, July 1, 1974, 24904.00AJ.
13. National Military Command System (NMCS), Processing and Display System (PDS), Second Technical Report, TRW Systems Group, Aug. 2, 1974, 24904.00AQ.
14. Procedure for the Selection of Automatic Test Equipment (ATE), Office of the Chief of Naval Materiel, Aug. 1974, AD 009 052, LD 33914A.
15. Project ACE Findings and Progress Report, June 1974, AFSC/CCC.

16. A Stochastic Network Approach to Test and Checkout, L. J. Watters, and M. V. Vasilik, The Rand Corp., P-4486, Oct. 1970.
17. Study/Evaluation of Candidate Field Support Equipment for the Tactical Air Control System (TACS), Maj. Robert E. Reid, USAF, TAC Project 74E-067T, AD B003 509L, LD 33794A.
18. Study of Aerospace Ground Equipment Acquisition Policies, Prepared Jointly by AFSC and AFLC, Oct. 1972.
19. Test Requirements Input Coding Instructions, AFLC Automatic Test Equipment Data Bank, San Antonio ALC/MMD.
20. The Transition of F-111 Intermediate Level Automatic Test Equipment Software Responsibility from AFSC to AFLC: A Case Description and Analysis, Maj. Frank T. Kimball, USAF, Sept. 1973, AD 916 530L, LD 30749.
21. Trends in the Development of Automatic Test Equipment, J. Lustig, New York University, June 1973, SETE 210/106, AD 765-739, LD 29814.



ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D.C. 20301

DATE: 31 May 1974

INSTALLATIONS AND LOGISTICS

TASK ORDER SD-321-29
(Task 74-22)

1. Pursuant to Articles E-1 and E-3 of the Department of Defense Contract No. SD-321 with the Logistics Management Institute, the Institute is requested to undertake the following task:

A. TITLE: Case Studies of the Air Force Aerospace Ground Equipment (AGE) Acquisition Management Process

B. SCOPE OF WORK: The purpose of this task is to determine the effectiveness of the currently prescribed policies and procedures for acquiring AGE in terms of stated objectives. By an analysis of the process, determine those areas that have not been implemented or are not achieving their intended purpose and recommend changes that will permit objectives to be obtained and to streamline the process. A further objective is to prepare a proposed draft of an AGE acquisition guide, the purpose of which is to describe the actions necessary to identify, recommend, review, approve and acquire AGE.

In accomplishing the above objectives, LMI will perform the following tasks:

- 1) Develop and document a procedural flowchart which describes in detail the current AGE acquisition process.
- 2) With concurrence of the Air Force select several defense systems which will be examined for general and in-depth case studies. The systems selected will include aircraft, electronic and missile systems.
- 3) Conduct a number of case studies which provide a basis for determining the effectiveness of the current AGE acquisition process.

TASK ORDER SD-321-29
(Task 74-22)

-2-

4) Analyze the case studies to determine: a) the extent to which current AGE acquisition policies, regulations and procedures are being followed; b) the principal reasons for deviation from current policies, regulations and procedures and c) the necessary actions required to improve or strengthen the current AGE process.

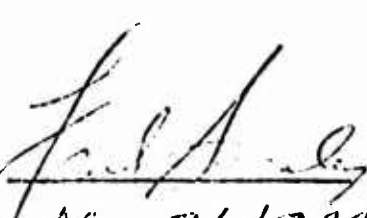
5) As a result of the analysis conducted above, prepare a draft of an AGE acquisition guide which can be used by Program Offices, staff elements, and other Air Force personnel concerned with the acquisition of AGE.

2. SCHEDULE: A detailed study plan will be developed and presented to the Air Force by 30 July 1974. It is anticipated that the five principal tasks described under the Scope of Work will be accomplished as follows:

- a. Development of a procedural flowchart -
30 September 1974
- b. Selection of Defense systems for study -
15 October 1974
- c. Data collection for Case Studies - 30 January 1975
- d. Analysis of Case Studies - 31 March 1975
- e. Preparation of AGE acquisition guide - 31 July 1975

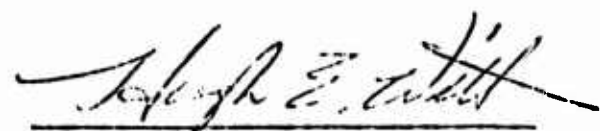
A briefing including the results of the case studies analyses and recommendations resulting therefrom will be presented to the Air Force on or before 15 April 1975. A final report including a draft of the AGE acquisition guide will be presented to the Air Force on or before 30 September 1975.

3. Further clarification of the Scope of Work and Air Force participation required in this Task Order is set forth in the attached Memorandum of Understanding.

ACCEPTED 

DATE Nov. 31/1974

Attachments - 1


A-2

MEMORANDUM OF UNDERSTANDING

SUBJECT: LMI Task "Case Studies of the Air Force Aerospace Ground Equipment (AGE) Acquisitions Management Process"

1. This memorandum is provided for clarification of the scope of work and Air Force participation required in LMI performance of subject task.
2. LMI will be responsible for the direction and execution of the task. A representative of Hq AFLC or Hq AFSC, as appropriate, shall accompany LMI personnel during visits to activities of those Commands.
3. The Air Force will designate representatives from the Air Staff, the Air Force Systems Command and the Air Force Logistics Command, each of whom will serve as a task coordinator for his respective organization.
4. A detailed study plan will be developed by the task group and coordinated with the designated representatives from the Air Force Systems Command, the Air Force Logistics Command, and the Office of the Deputy Chief of Staff, Systems and Logistics.
5. The detailed study plan will include specific areas to be investigated by the study group, the type of data to be collected, and a schedule for completion of the study effort. Since considerable thought has already been given to the study approach, the following guidance is initially provided for the study group.
 - 1) Develop and document a procedural flowchart of the AGE acquisition process which, as a minimum will:
 - a) Depict all mandatory steps or tasks in the current process from the earliest phase of a program (to include all pre-contract effort) to the point of Air Force acceptance and delivery of AGE item to using activities.

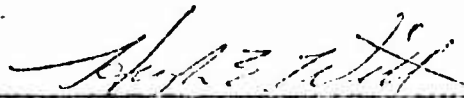
- b) At each step in the process, identify what is to be done, the organization (to the lowest possible level) responsible for action, the time permitted for action, the cumulative process time allotted to arrive at that step, and, the directive, regulatory or contractual document which directs or governs that action.
 - c) Depict information feedback and problem resolution loops included in the process.
 - d) Highlight process quality assurance and control checks, checkpoints and responsible organization(s).
 - e) Depict interface points with other logistic processes such as Logistics Support Analysis and Optimum Repair Level Analysis, which contribute to or are triggered by actions in the AGE acquisition management process and briefly identify what the process interfaced with provides or is provided.
- 2) Select several Air Force defense systems to be examined for general and in-depth case studies including at least one each of aircraft, electronic and missile systems.
- 3) Using the defense systems selected above develop a number of general case studies of AGE items which fall into five categories. (A description of the categories is provided in IMI Report, Task 72-1 (Rev), "Management Procedures for Evaluating Requirements and Relationships Between AGE/ATE and System Acquisitions" on pages 38-43). For each AGE item determine, as a minimum, the following:
- a) Date requirement for AGE was recognized or established.

- b) Date development or procurement contract was awarded.
 - c) Date AGE was tested and accepted.
 - d) Date AGE was delivered to Air Force.
 - e) Date AGE was needed by Air Force.
 - f) Number and type of engineering changes to AGE which occurred before final deployment.
 - g) Development and production cost of AGE.
 - h) Indicate if and when AGE was subjected to trade-off analyses. (The types of analyses considered should include at least those described on page 44 of the LMI report, Task 72-1 (Rev)).
 - i) Indicate types of problems, if any, experienced with AGE after delivery.
- 4) Using the flowchart developed in 1) above and the results of the general case studies developed in 3) above, perform and provide reports on in-depth case studies of a number of AGE items acquired and in the process of being acquired through the process. As a minimum the in-depth case study reports will include:
- a) Complete identification of the AGE item including:
 - 1 Part/Model Number
 - 2 Manufacturers Name
 - 3 Item Noun Name
 - 4 System/Equipment AGE is intended to support
 - 5 Contract Unit Cost
 - 6 Federal Stock Number (if assigned)

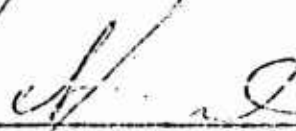
- 7 Quantity procured or intended to be procured and its intended use (e.g., training, organizations, Intermediate or Depot Maintenance).
 - 8 Procurement Contract Number
 - 9 Engineering/R&D Cost
 - 10 Date of AGE item contract award/order
 - 11 Date of acceptance/anticipated acceptance by the Air Force
 - 12 Source and identification of the procurement specification (if any) to which the item was or will be procured including an analysis of a requirement for reprourement data.
 - 13 Data, software and training item acquired for each AGE item.
- b) For items acquired, a synopsis of current performance in terms of reliability and maintainability and the adequacy of the logistic support posture. For items in the process of being acquired, a brief summary of R and M goals, their source, the proposed/planned specification source, and the degree to which support plans for the AGE have been developed.
- c) A detailed listing of any and all steps of the acquisition management process from which the Air Force or the Contractor deviated in terms of what was done, who did it, time taken, "tools" used other than those intended, changes in sequence of steps, omission of steps, etc. An explanation of the reasons for deviations and an assessment of expected or experienced impact of the deviation will be provided in each instance.

- d) Indicate whether "tools" provided or used in each step were developed in strict compliance with contractual and/or regulatory requirements. Where "tools" appear or have been proven inadequate for stated purposes, provide an explanation of inadequacies and an assessment of why inadequacies exist.
 - e) Indicate whether or not quality assurance/control checks were made as required. If not, provide an assessment of reasons for not checking and indicate experienced or potential impact of non-compliance.
 - f) Indicate when firm costs were available and whether or not AGE could have been negotiated as fixed price as part of the basic contract.
 - g) For items in use provide a synopsis of operational usage including original programmed requirements vs. actual use.
- 5) After the case studies have been completed:
- a) Develop and provide a matrix which depicts in the aggregate all step/action deviations noted among the case studies.
 - b) Provide analyses of the principle reason(s) for common deviations and impacts resulting therefrom.
 - c) Provide recommendations on what could or should be added, deleted, or changed to strengthen the process.
 - d) Provide specific recommendations and procedures for negotiating AGE as fixed price in the basic contract.

- 6) a) This paragraph is provided for additional clarification of the scope of work required in Logistics Management Institute (LMI) performance of subject task.
- b) In order to accrue the greatest possible benefits from this task as it is presently defined, it is necessary that the areas of study to be considered as a part of the "acquisition process" will include the methodology for the determination of Aerospace Ground Equipment (AGE) logistics support requirements and procedures for validation of the AGE requirements on a technical basis in support of testing and operation of the weapon system.



OASD (I&L)



LMI

APPENDIX B
CASE STUDY DETAILED DATA

TABLE OF CONTENTS - APPENDIX B

CASE STUDY DETAILED DATA

<u>Case No.</u>		<u>Defense Systems</u>	<u>Page</u>
	<u>Automatic Test Equipment</u>		
1	User Display System Module Tester	DSP	B- 2
2	Microwave Test Station	F-15	B- 4
3	Displays Test Station	F-15	B- 7
4	Computer Test Station	F-15	B- 9
5	Fault Locator, Missile System Checkout	MMIII	B- 12
6	Circuit Analyzer	MMIII	B- 13
7	Inertial Navigation System Test Station	F-15	B- 14
8	Electronic Circuit Plug-in Unit Test Set	485L	B- 16
9	Digital/Analog Module Test Station	485L	B- 17
10	Armament System Flight Line Test Set	A-10	B- 18
11	System Test Console	RPV	B- 20
12	Programmer/Lateral Controller Test Set	RPV	B- 22
13	Final Inspection Test Stand	AIMS	B- 23
	<u>Complex Manual Test Equipment</u>		
14	Indicators and Controls Test Station	F-15	B- 24
15	Communications Navigation & Identification Test Station	F-15	B- 28
16	Antenna Test Station	F-15	B- 31
17	Universal Avionics Component Tester	RPV	B- 34
18	Transmitter Shop Test Set	RPV	B- 36
19	Programmer Bench Test Set	RPV	B- 37
20	Heads-up Display Test Set	A-10	B- 39
21	AN/UPM-137A Radar Test Set	A-10, F-15, AIMS	B- 41
22	DRC Simulator-Verifier	DSP	B- 42
23	UHF Receiver-Transmitter Test Set	AF SATCOM	B- 44
24	1 KW. Radio Frequency Amplifier	AF SATCOM	B- 46
25	Satellite Communication Control	AF SATCOM	B- 47
26	Message Processor Test Set	AF SATCOM	B- 48
27	ILS Hot Mock-up	AF SATCOM	B- 49
28	Test Translator	485L	B- 50
	<u>Operational Ground Equipment</u>		
29	Digital Data Computer Set	MMIII	B- 51
30	MD-1 Towbar	A-10	B- 53
31	MJ-4 Aerial Stores Lift Truck	A-10	B- 54

TABLE OF CONTENTS - APPENDIX B (Continued)

Electrical Instruments

32	High Voltage Probe	DSP	B - 55
33	Vectorscope	DSP	B - 56
34	Network Analyzer	DSP	B - 58
35	Pulse Generator	DSP	B - 59
36	Oscilloscope	AF SATCOM	B - 60
37	Oscilloscope	485L	B - 61
38	Attenuator	AF SATCOM	B - 62
39	Bolometer	AIMS	B - 63
40	Spectrum Analyzer	AIMS	B - 64
41	Variable Calibrated RF Attenuator	AIMS	B - 65
42	Voltmeter	MMIII	B - 66

Other Electrical Equipment

43	Teletypewriter Test Set	AF SATCOM	B - 68
44	Pilot Tone Detector Test Set	485L	B - 69
45	Radio Orderwire Test Set	485L	B - 70
46	A/M32A-60A Generator Set	F-15	B - 71
47	Computer Test Set	DSP	B - 73
48	AN/APM-245 Simulator Test Set	AIMS	B - 74
49	AN/GGM-16 Digital Data Analyzer	485L	B - 76
50	AN/GRM-103 Radio Receiving Set	AF SATCOM	B - 77
51	Wideband Modem Test Set	AF SATCOM	B - 78
52	Squib Shorting Test Kit	RPV	B - 80
53	Squib Test Kit	RPV	B - 82
54	Wiring Harness	DSP	B - 83
55	Cable Kit	AF SATCOM	B - 84
56	Card Extender	AF SATCOM	B - 85
57	AC/DC Load Assembly	AIMS	B - 86
58	RF Cable Assembly	AIMS	B - 87
59	Test Adapter Kit	MMIII	B - 87

Mechanical Equipment

60	Payload Transporter	MMIII	B - 90
61	Non-Magnetic Trailer	RPV	B - 92
62	Borescope	F-15	B - 94
63	Honeycomb Structure Repair Kit	F-15, A-10	B - 95
64	Outer Wing Panel Adapter	A-10	B - 96
65	Integrated Drive Generator Adapter	A-10	B - 97
66	Canopy Release Pin Assembly	A-10	B - 99
67	Crimping Tool	A-10	B-100
68	Hydraulic Crimping Tool	A-10	B-102
69	Bellmouth	RPV	B-103
70	Alignment Fixture Kit	RPV	B-104
71	Optical Alignment Fixture	DSP	B-106
72	Indicator Dial	DSP	B-107
73	Capstan Alignment Fixture	DSP	B-108
74	Refrigeration Unit Service Tool	AF SATCOM	B-109
75	Stopwatch	AIMS	B-110
76	Maintenance/Supply Shelter	485L	B-111

APPENDIX B

CASE STUDY DETAILED DATA

INTRODUCTION

This appendix presents, in summary form, each of the 76 case studies. They are presented by type of equipment with the emphasis placed on the data available during the process of acquiring the equipment. This appendix provides a major source of examples and statistics for the findings and conclusions contained in the body of the report.

The reader is assumed to be familiar with several sources of data in common use in the support equipment acquisition process. These include: 1) The AGE Plan, DI-A-3014, 2) The AGERD, DI-S-3596, 3) The AFLCM 65-3/AFSCM 65-2 AGERD processing cycle, 4) The CAGEL, DI-V-3804, 5) The AGE Illustration, DI-E-3112, 6) MIL-HDBK-300D, the assembled AGE Illustrations, 7) The DO97 Interchangeability and Substitution System, 8) The Defense Integrated Data System, and 9) The Minuteman III Integrated Logistics Support Process. A review of most of these is included in the body of this report. Abbreviations used in this appendix are included in the list of abbreviations for the main report.

Not all the data originally requested for the case studies could be obtained. Many data items were not applicable, do not yet exist, or never will exist. Others were missing, or were never documented and the cognizant personnel no longer work in the responsible office. Limited resources also reduced the amount of time devoted to searching for data. Some data not originally requested have been included wherever they bear directly on the case under study. A factual approach to each case is presented here. This approach was chosen for applicability to training future support equipment acquisition personnel and for additional hypothesis testing by other researchers. As a result of these limitations no single case study can be considered truly representative of the Air Force support equipment acquisition process. Taken as a whole however, they convey the diversity both of the make-up of the support equipment category and of the process that leads to its Air Force ownership.

CASE 1 - USER DISPLAY SYSTEM MODULE TESTER

Defense System:	DSP- User Display System
Type:	Automatic Test Equipment
Functional Area:	Electronics
Level of Use:	Intermediate
Method of Procurement:	CFE

This item has no NSN, and no manufacturer's part number. It was the subject of Program Management Directive R-S-047-(1) dated Feb. 8, 1974. The purpose of this item is to provide Display System users the capability to verify failure, fault isolate, and verify serviceability of removable units of the system without using the operational end item. Six testers are required to serve six locations.

The requirement for this item can be found in the AGE Plans for both the CONAD/ADC User Display System submitted Jan. 8, 1971, and the SAC/NMCS User Display System submitted May 24, 1971. The former lists this item in section 3.3.4 as one of 13 required for intermediate maintenance. The latter lists this item in section 3.3.4 as one of 23 required for intermediate maintenance. Neither contains any data about the test set beyond the requirement for the item. Someone with no technical knowledge could not recognize the importance of this item over the entry immediately following it in the latter AGE Plan which is "Stepladders."

Two AGERDs were submitted for this item, one for the Data Acquisition System and one for the User Display System. Neither was approved and the AGERD process was never used because of the complexity of this procurement.

The procurement of this item became critical between March and October of 1972. During this time the basic elements of the DSP became operational. Delay in acquiring organic maintenance capability necessitates expenditures for interim contractor support, and requires the operational system to be used in fault isolation. This increases prime system downtime due to lack of this item of support equipment.

Numerous factors have contributed to the delay in acquiring this item. One factor was the imposition of a \$1M funding ceiling attributed to, "OSD," in a message from the Air Staff to the SPO. LMI was unable to establish the initiation of this funding limit. OSD reorganization and personnel transfers prevented exhaustive investigation. This funding limit led to a study of how to meet it which was completed April 11, 1973. Air Staff evaluation of this study produced definitive direction to combine DSP requirements with those of the 427M NORAD Cheyenne Mountain Complex improvement program. Thus a second factor began to work to delay capability delivery, the need to coordinate two SPOs' requirements.

No specific policy exists in either DoD or Air Force regulations establishing how multiple SPOs should go about developing common major components. Conflict must be avoided with the single manager concept contained in DoDD 5000.1. This requires extensive coordination to reach a compromise solution that will best benefit the Air Force as a whole. The 427M required fault isolation capability for its modules whose requirements were not completely defined during the early coordination stages.

During Nov. 1973 two pieces of common support equipment were evaluated to accomplish this task, the General Dynamics ICT-105 and the Sperry 3100. Neither of these is contained in MIL-HDBK-300D. AFR 66-8 Maintenance Evaluation Reports of these tests are available. These tests determined that maximum requirements could not be met and only 15 to 20 percent of the modules could be fault isolated. Therefore these alternatives were discarded.

Program Management Directive R-S-047-(1) was issued Feb. 8, 1974 to provide guidance in acquiring this item. Further queries were required, however, to clarify the status of the \$1M funding ceiling. Clarification of this issue lifted the ceiling and required the acquisition of the most cost-effective method of test and repair. Subsequently a plan for acquisition of commercial modular expandable automatic test equipment was formulated. A search of the San Antonio ALC ATE Data Bank, did not result in further candidates for testing but did identify manufacturers of the type of equipment required. Therefore a request for proposal was prepared and coordinated for a competitive procurement of this item. This was originally scheduled for release to contractors in Sept. 1974. Coordination of technical specifications and obtaining funding have delayed this release approximately one year. No specific MTBF is called for in this specification but a MIL-STD-756A reliability prediction is called for and reliability will be a source selection criteria.

The expected cost of this item including associated software and other data has been a source of controversy since before the imposition of the \$1M ceiling. Depending on the extent of capability being costed estimates have ranged from \$3.2M to \$11.5M. An independent cost evaluation resulted in an estimate of \$8.6M in mid-1974. Current programming calls for \$3.6M in fiscal year 76 and \$3M additional in later years.

This case study illustrates that, although rare, downtime of a prime system can be caused by lack of a piece of support equipment. Delay in acquiring this item was due to lengthy coordination of requirements, specifications, and funding methods. A major contributor to this delay was the lack of Air Force or DoD policy to guide the development and procurement of major end items for multiple SPOs under the single manager concept.

CASE 2 - MICROWAVE TEST STATION

Defense System:	F-15
Type:	Automatic Test Equipment
Functional Area:	RF Transmissions
Level of Use:	Intermediate
Method of Procurement:	CFE

This item is AGERD 121 and 2562 of the F-15 program contract with McDonnell Aircraft Co. It is NSN 6625-00003-1849DQ and Navigation and Control Division of Bendix Corp. part number 13A6570-2. It is one of the automatic test stations of the AIS. Its purpose is to verify and isolate faults in five LRUs of the radio and radar systems of the F-15 and to align LRUs after repair.

AGERD 121 was originally submitted on July 22, 1970. Earlier and ongoing studies are referenced including AGE Plan paragraph 6.3.5 and the F-15 ORLA. The functional analysis lists seven LRUs tested and lists excellent qualitative but no quantitative data about test requirements including 27 tests required to be accomplished. The recommended solution contains the description of a five-cabinet automatic test station encompassing 23 drawers of equipments of which two are already stock listed, 14 are identified by manufacturer's part numbers, and seven are new design. Seven of these remained under investigation at the time of submittal. The prime item specification number CP328A04B1005 is listed. No software description or reference appears in any of the AGERDs for this item.

The figure 1B of this AGERD contains the need date Feb. 1974, the development cost estimate \$14,373,900, and the unit cost estimate \$1,286,400. Quantity recommendations paralleled those of Case 14 and so will not be repeated. The FSC 4920 had been submitted but penciled over with 6625 on the system manager's copy, which also listed the Material Management Code FX later changed to DQ.

This AGERD was approved Oct. 23, 1970. Notes included changes in the test and depot quantities, the FSC 6625 and MMC FX, and the requirement for preliminary and critical design reviews. Thirteen data items were specified for procurement including an AGE illustration.

Revision A was submitted March 27, 1972. This AGERD contained the part number 13A6570-1, the FSC 6625, and the MMC YA. The development cost estimate had decreased to \$12,619,200 but the unit cost increased to \$1,710,100. The total cost estimate was six times the unit cost although seven were recommended. A capability limitation of one item per 24 aircraft was noted. The system manager's copy was extensively marked up assigning numerous codes to the item and identifying the preliminary stock number 6625-NC601396PDQ. One such mark-up dated May 16, 1972 stated that an AGE illustration was not required. This AGERD was approved July 5, 1972.

The original AGERD 2562 was submitted Sept. 17, 1974. Inexplicably no cancellation of AGERD 121 was submitted as in four other similar AIS submissions. This AGERD lists five LRUs to be tested of which only one has identical nomenclature to one of the original seven, but four have essentially unchanged descriptions including tests required of the test station. The recommended solution describes a six-cabinet automatic test station with 33 drawers. All part and stock numbers have been deleted but 23 drawers are designated Precision Measuring Equipment (PME). Much quantitative data has been deleted. Twelve accessory equipments are also described.

The development and unit cost estimates are identical to AGERD 121 revision A. The need date is Sept. 1974, the month of submission. A new prime item specification number CPO4B1073 is listed and three data items excluding an AGE Illustrative are recommended for this item. This AGERD was rejected Dec. 6, 1974 in consonance with a telegram to McDonnell dated October 4, 1974 delineating ground rules for AIS documentation.

On November 21, 1974 revision B of AGERD 121 and revision A of AGERD 2562 were submitted. The latter simply cancelled the original AGERD 2562. From numerous imperfections in the typing it is clear that the figure 1A of revision B of AGERD 121 has not even been retyped from the original AGERD 2562. Marginal notes of some changes from the last revision are added and the page numbers are changed only. Even the new prime item specification number is retained. The figure 1B contains a third specification number CPO4B1005 which appears to be a mixture of both earlier numbers. The need date has returned to Feb. 1974, nine months prior to the submission date; the development cost is unchanged; however, the unit cost has more than doubled to \$3,529,381. This AGERD remained pending SPO action on Jan. 24, 1975.

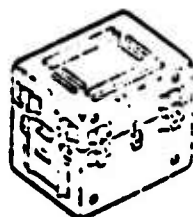
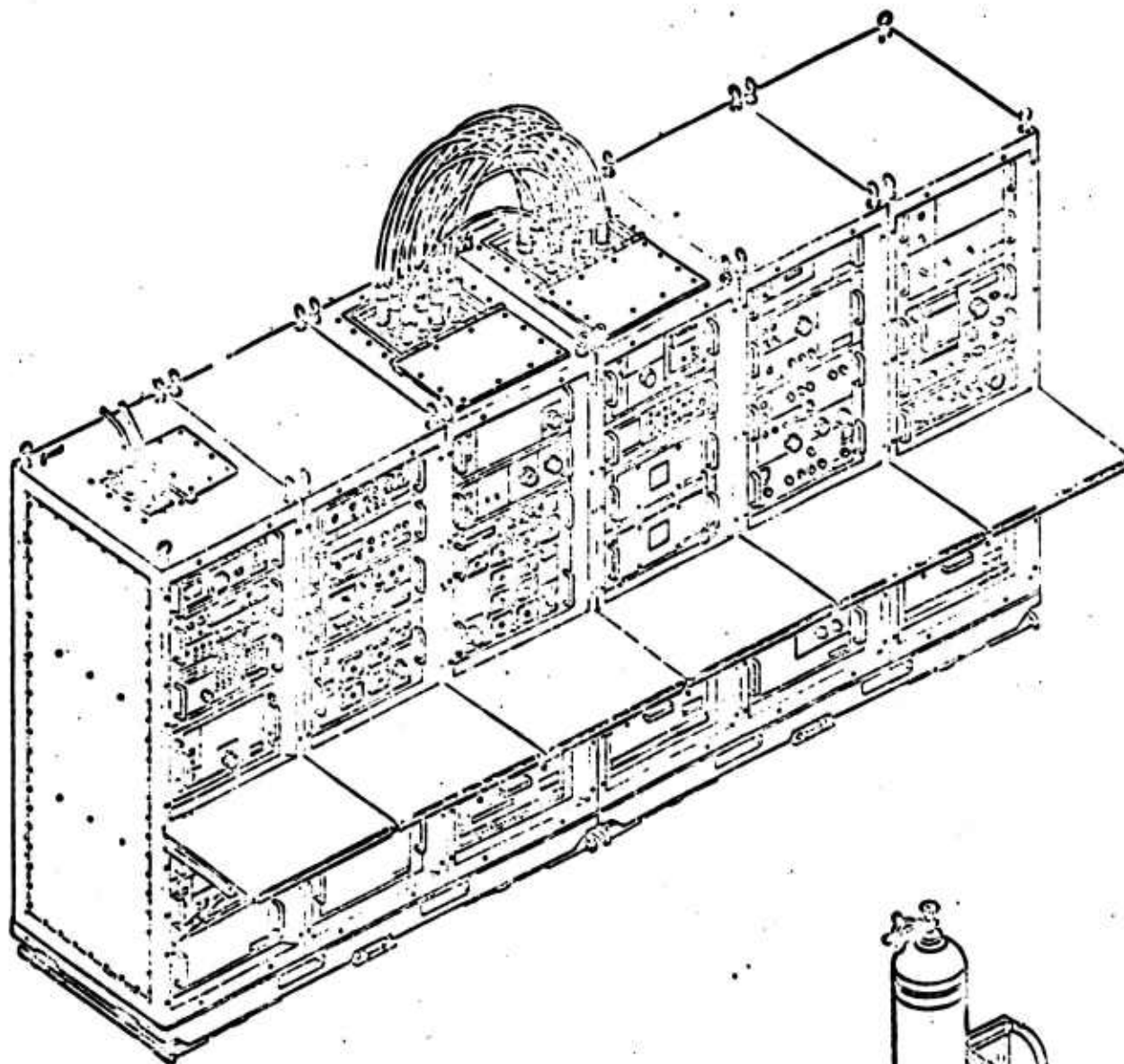
The quantity of this item to be procured has been the subject of much controversy. For a discussion of these issues and present Air Force positions see Case 14.

Efforts to reduce expenditures on this item have included planning to refurbish at least four test and design articles for operational use at a cost of approximately \$696,627 per article. In addition part of the spares for this item were procured by exercising a low cost option for an entire test station and disassembling it.

Two of the LRUs tested by this test station remained design unstable as of April 1975. In addition seven ECPs (numbers 170, 192, 241, 257,266, 297, and 381) are outstanding on LRUs tested. Three additional ECPs (numbers 319, 320, and 321) are active against components of the test station itself. ECP 320 was chosen as an example because it affected 3 AIS test stations. It was found to be a compatibility ECP, "required to enable testing of the Electronic Control Amplifier." The cost estimate to incorporate ECP 320 was \$7,500.

The instability and change activity above caused this item not to be delivered to the flight test program as of late-1974. First squadron activation also took place without this test station. LRUs requiring repair were being flown at contractor's expense to their representatives at the flight test facility.

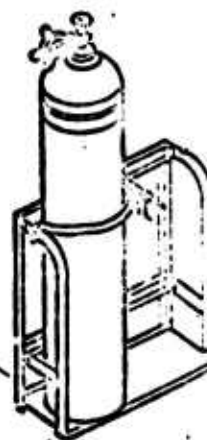
This case study illustrates a complex piece of automatic test equipment for which major trade-off studies were accomplished but technical difficulties, as reflected in changes, caused the item to be late. Extensive price increases could not be avoided despite much effort. The early definition of this item showed more LRUs tested by fewer drawers at less cost than the latest version. No change in the acquisition process could have obtained earlier better estimates of the final configuration.



EXTERNAL CONTROL
PANEL



PRESSURE
TEST SET



NITROGEN SUPPLY ASSY.

CASE 2 - MICROWAVE TEST STATION

CASE 3 - DISPLAYS TEST STATION

Defense System:	F-15
Type:	Automatic Test Equipment
Functional Area:	Displays
Level of Use:	Intermediate
Method of Procurement:	CFE

This item is AGERD 129 of the F-15 program contract with McDonnell Aircraft Co. It is NSN 4920-00169-3000DQ and Navigation and Control Division of Bendix Corporation part number 13A6560-2. It is one of the automatic test stations of the AIS for the F-15. Its purpose is to verify and isolate faults in 15 LRUs principally in the display area of the F-15 and align modules following repairs.

The original AGERD 129 was submitted July 24, 1970. Comprehensive studies of the F-15 avionics were referenced as documented in the AGE Plan paragraph 6.3.5 and the ORLA. The functional analysis describes an automatic system having digital, low frequency analog, video, and optical test capabilities. No information on the software system is contained or referenced in any of this item's AGERDs. Fifteen LRUs from five subsystems are enumerated to be tested but no quantitative or qualitative data is provided about the tests. The recommended solution contains the description of a four-cabinet automatic test set containing 18 drawers of which three are already stock listed, seven have contractor part numbers, and six are new designs. One of these remains under investigation at the time of submission. Two test fixtures are also described. Volume, weight and power estimates are listed and the prime item specification number CP328A04D1009 is noted. Eight items of data excluding an AGE illustration are recommended by the contractor. The line drawing included is identical to the line drawing for Case 4.

The figure 1B of this AGERD contains the need date Feb. 1974, the development cost estimate \$17,353,400, and the unit cost estimate \$1,213,500. Quantity recommendations parallel those of Case 14 so will not be repeated. The engineering criticality identified on the figure 1A is omitted from the figure 1B.

This AGERD was approved on Nov. 2, 1970. Notes on the ASD form 0-169 approval specified changes in power requirements for consistency with the specification, changes in test and depot quantities and locations, the requirement for preliminary and critical design reviews, and the call-out of 13 data items including an AGE illustration.

Revision A of AGERD 129 was submitted on March 27, 1972. The principle revisions were addition of the part number 13A6560-1, notation of the capability of one item to support 24 aircraft, decrease in development cost estimate to \$11,424,600 and increase in unit cost estimate to \$1,474,000. This AGERD was approved July 5, 1972.

Revision B of AGERD 129 was submitted April 10, 1973. The principle revisions of this AGERD were the update of the part number to 13A6560-2 as established by ECP 0070-01, an increase in the development cost estimate to \$13,335,600, and an increase in the unit cost estimate to \$1,684,500. This AGERD shows a total cost equal to the quantity recommended times the unit cost. This is contrary to the AIS submissions in early-1972, with the same quantity recommendations. Revision B was approved July 16, 1973.

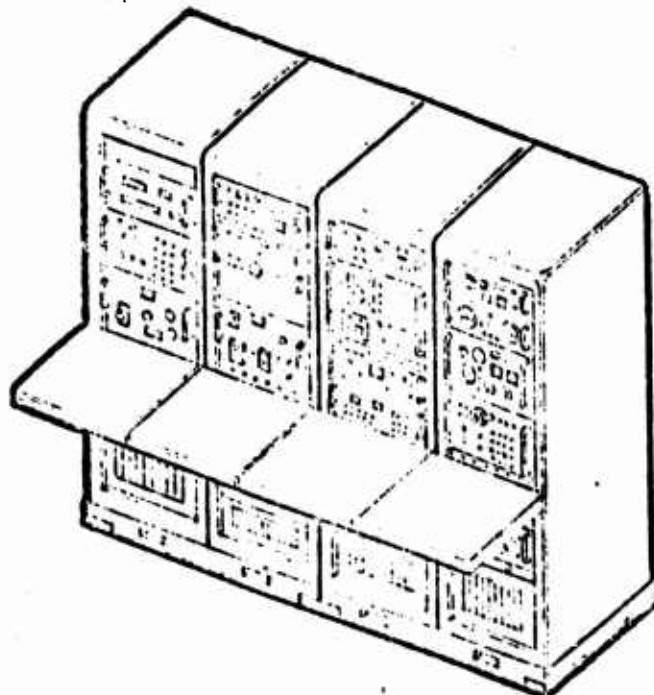
The quantity of this item to be procured has been the subject of much controversy. For a discussion of these issues and the present position see Case 14.

Air Force efforts to reduce expenditures for this item include plans to refurbish at least four test and design articles for operational use. This will cost approximately \$675,345 per item. In addition spare parts for this item have been partially procured by exercising a low cost option for a complete article and disassembling it.

Besides ECP 0070-01 noted above, 7 ECPs were active in April 1975 on five LRUs tested by this station. Completion of compatibility tests on these LRUs is scheduled for March 1976. Two ECPs (numbers 319, and 320) were in work against components of the test station itself. A summary discussion of ECP 320 will be found in Case 2.

Due principally to the above instability and changes, this article was withdrawn from the flight test facility and remained undelivered to the first squadron activation as of April 1975. Work around procedures were in use by McDonnell representatives at the flight test facilities to support failed LRUs. Transportation to the flight test facility was being provided at McDonnell's expense.

This item illustrates a highly complex automatic test equipment for which major trade studies were accomplished. Nevertheless, design instability and change activity prevented on-time delivery and cost escalation could not be avoided. Documented increases in this case, however, are on the order of inflationary rises.



CASE 4 - COMPUTER TEST STATION

Defense System:	F-15
Type:	Automatic Test Equipment
Functional Area:	Computers
Level of Use:	Intermediate
Method of Procurement:	CFE

This item is AGERD 34 and 2537 of the F-15 program's contract with McDonnell Aircraft Co., NSN 4920-00169-3002 DQ, and Navigation and Control Division of Bendix Corp. part number 13A6550-2. It is one of the automatic test stations of the AIS. Its purpose is to verify and isolate faults in 28 LRUs principally related to computers on the F-15 aircraft. It also aligns the repaired modules for reuse. Note that the nomenclature for this item differs only slightly (Set replacing Station) from Case 47 which costs less than one thousandth as much per unit.

The original AGERD 34 was submitted June 30, 1970. Comprehensive studies of F-15 avionics as documented in AGE Plan paragraph 6.3.5 and the ORLA are referenced. The functional analysis describes an automatic test station with digital, low frequency analog, inertial and pneumatic test capabilities. No further quantitative or qualitative data about test requirements is listed. Twenty-seven LRUs are listed in five subsystems for test by this test station. The recommended solution contains the description of a 4-cabinet automatic test station consisting of 24 drawers of which 6 are already stock numbered, 9 have contractor part numbers, and 9 will be new designs. Six of these drawers are still under investigation including four which contain notes that total test requirements have not been determined at the time of submission. The latter category includes both of the associated test fixtures included as a part of this test set. No data on the software system is listed or referenced. Size and weight estimates are included, prime item specification number CP328A04F1009 is listed, and the item is identified as engineering critical. The line drawing included is identical to the line drawing submitted for Case 3.

The figure 1B of this AGERD contains the need date Feb. 1974, the development cost estimate \$16,386,000 and the unit cost estimate \$1,387,100. Quantity recommendations for this item are identical to those of Case 14 so will not be repeated. Nine data items excluding an AGE Illustration were recommended for this item by the contractor.

The AGERD was approved Nov. 2, 1970. The ASD form 0-169 approving it contained notes on power specification inconsistencies, test and depot requirements, and the requirement for preliminary and critical design review.

Revision A was submitted March 27, 1972. Principal revisions were addition of the part number 13A6550-1, the complete NSN, decrease in development cost estimate to \$8,867,000, and decrease in unit cost estimate to \$1,087,500. The capability of this item to support 24 aircraft is listed. This revision was approved July 5, 1972.

Revision B of AGERD 34 and the original AGERD 2537 were both submitted Sept. 3, 1974. The former simply noted that the dash 2 version superseded the dash one version. The functional analysis of AGERD 2537 lists 28 LRUs tested including many nomenclature changes as well as additions and deletions to the original AGERD 34 list. No data is given on tests required. The recommended solution describes a six-cabinet semi-automatic test station including 31 drawers and 4 accessory fixtures. Data on the source of these components has been deleted. The weight estimate has increased 56%. A new prime item specification number CP04F1075 is referenced.

The Figure 1B of AGERD 2537 contains a blank need date block but the identical development cost estimate to Revision A of AGERD 34. The unit cost estimate has increased to \$3,616,981. This is the highest single unit cost encountered by LMI in this study. Three items of data excluding an AGE Illustration were recommended.

Both these AGERDs were rejected on Dec. 6, 1974 in consonance with a telegram dated Oct. 4, 1974 delineating ground rules for AIS documentation. These ground rules excluded renumbering previously submitted items.

On Nov. 21, 1974 Revision A of AGERD 2537 and Revision C of AGERD 34 were submitted. The former simply cancelled the original AGERD 2537. The figure 1A of the latter is an eight page duplicate of the original AGERD 2537 with marginal change marks continuous over the entire eight pages. Even the new prime item specification number is retained. The figure 1B returns to the need date Feb. 1974 even though this is nine months before the submission itself. The development and unit cost estimates of AGERD 2537 are retained. This AGERD remained pending SPO action as of Jan. 24, 1975.

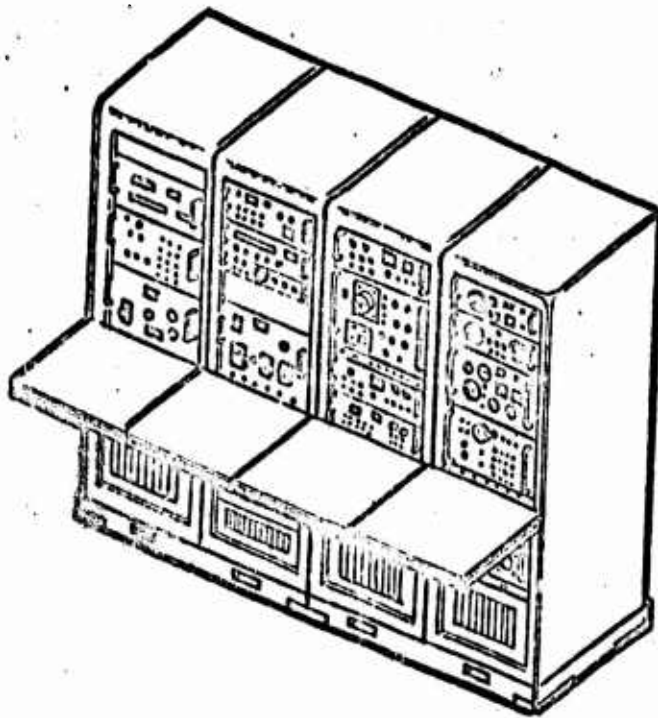
Air Force efforts to reduce expenditures for this item include plans to refurbish at least four test and design articles for operational use. This is estimated to cost \$488,248 per article. Spares for this item are being bought in part by exercising a low cost option for an entire article and disassembling it.

Eight ECPs (numbers 162, 221, 270, 277, 287, 289, 330, and 333) were active against eight LRUs tested by this test station as of April 1975. Two ECPs covered 2 LRUs and two LRUs are affected by two ECPs. Two other LRUs remain design unstable without ECPs. Two ECPs (number 319, and 320) remained active against components of the test station itself. For a summary of ECP 320 see Case 2.

Due to design instability and change activity this item was withdrawn from the flight test facilities and remained undelivered to the first squadron activation as of April 1975. LRUs requiring repair were being transported to the contractor representatives at the flight test facility at the contractor's expense. Work-around procedures, principally manual testing, were used to accomplish intermediate repair.

The quantity to be procured of this item has been the subject of much controversy. For a discussion of these issues and the present position see Case 14.

This case study illustrates a complex piece of automatic test equipment for which major trade-off studies were accomplished. Nevertheless, technical difficulties and design instability forced the Air Force to support operations using work-around procedures. Although a confusing sequence of AGERD submissions could have been avoided, no acquisition changes could have affected the major problems. In addition cost growth for this item far exceeded inflationary factors.



CASE 4 - COMPUTER TEST STATION

CASE 5 - FAULT LOCATOR, MISSILE SYSTEM CHECKOUT

Defense System:	Minuteman III
Type:	Automatic Test Equipment
Functional Area:	Computers
Level of Use:	Depot
Method of Procurement:	CPE

This item is Minuteman III figure A number 17886 and NSN 4935-00732-5972AH. Users refer to this as the ATS for Automatic Test System. The purpose of this test set is to functionally test and fault isolate to the depot removable component the airborne computer in the inertial guidance system. It is located at Newark Air Force Station in a secure controlled area.

Procurement of this article began with a trade-off study between this fully automatic article as a new design and existing manufacturer's production line semi-automatic test equipment. This study concluded that six production line test equipments costing \$400,000 apiece would be required to accomplish the same number of functional tests as one of the study items. Furthermore, the production line test equipments would not have any fault isolation capability. Therefore, design of this article was considered cost effective. If the final cost and reliability of this test set had been used in this study this decision would have been reversed.

The requirement for this item was formally established in Sept. 1967 and placed on contract in Oct. 1967. Production of this item was placed on contract less than one year later in June 1968. Six articles were originally planned due to high expected workload. Subsequently reduced number of prime items and higher reliability of the on-board computer reduced the requirement to one article.

This item has over 500,000 words in the test programs and 2000 test point interfaces with the tested item. A fully automatic test system of this magnitude proved to be technically infeasible to accomplish. Nevertheless creative contractor engineering personnel were successful in convincing their own and Air Force management that they were able to accomplish it.

The Air Force need date for this item was June 1970. Acceptance and delivery were accomplished 10 months later in April 1971. The delay in delivery was due to technical difficulties encountered during checkout of the computer programs and the interface hardware. Several problems were encountered after delivery also. These required changes in wiring and connectors and grounding to reduce interference problems.

The design cost of this item was \$1,103,000. The production cost was \$1,191,000. An additional \$1,300,000 was expended for the test programs. A 1972 CAGEL prepared by the Boeing Co. showed a unit cost for this item of \$2.29M. This is the sum of the design and production cost excluding the software.

Users of this test set reported that it accomplishes its mission successfully on approximately 25% of attempts to use it. Because of this low reliability only 50% of the workload can be repaired using this test set. The remaining workload is accomplished using three of the semi-automatic production line test sets traded-off against this item with manual fault isolation. These are located adjacent to this item at the user's facility.

This case study illustrates the same problems under the Minuteman III system of acquisition as the AGERD process. Technical difficulties, especially contractor technical optimism, led to high cost, 10-month late delivery, and continued changes. This article also exhibited unacceptably low reliability. No change in the acquisition process would address these technical problems.

CASE 6 - CIRCUIT ANALYZER

Defense System:	Minuteman III
Type:	Automatic Test Equipment
Functional Area:	Electronics
Level of Use:	Depot
Method of Procurement:	CFE

This item is Minuteman III Figure A 18295, NSN 4935-00490-7391, and manufacturer part number DITMCO 660. It is a commercial-off-the-shelf automatic test equipment whose purpose is to check electronic circuit boards contained in the Minuteman III.

Procurement of this item began with a manual versus automatic trade-off study in September 1968. The extra time required by the manual test set required greater expense to meet workload requirements than the procurement of the case study item.

The requirement was formally established in Oct. 1968. The design and production were simultaneously placed on contract in Feb. 1969. Design efforts were primarily cable interfaces and adapters since the article itself was designed already for the commercial automatic test equipment market. This article was accepted and delivered in December 1969. The Air Force need date was June 1970. Production costs were \$98,880. No problems have been encountered in the use of this item.

This case illustrates that commercial automatic test equipment is a viable alternative for some Air Force requirements. This item, for example, displays great success in on-time delivery, in low cost, and in trouble free operation.

CASE 7 - INERTIAL NAVIGATION TEST SET

Defense System:	F-15
Type:	Automatic Test Equipment
Functional Area:	Inertial Guidance
Level of Use:	Depot
Method of Procurement:	CFE

This item is AGERD 721 of the F-15 program contract F33657-70-C-300 with McDonnell Aircraft Co., NSN 4920-00163-6042DQ and, Guidance and Control Systems Division of Litton Systems Inc. part number 09200. The purpose of this item is to validate failures, fault isolate, and checkout units of the inertial navigation system at the depot.

AGERD 721 was originally submitted on May 18, 1972. The Maintenance Ground Equipment section of the AGE Plan, paragraph 6.3.6.1.4, was referenced as was the item specification number CP04S1019. The functional analysis and recommended solution were excellent. They included reference to the F-15 Avionics Depot Trade Study and the Test Requirements Documents for this item. Quantitative technical data is included as well as a full page description of the software required. The item recommended was a modified version of an in-production commercial automatic tester. The figure 1B contained the development cost estimate \$519,500 and the unit cost estimate \$481,000. One article was recommended with need date in May 1975. The quantity that would be recommended if the number of prime systems repaired increased was included. The System Area Index 04S appeared on this, all subsequent AGERD revisions, and the F-15 CAGEL. This index refers to the Central Computer Complex Depot Test Station. Only three items of data, not including an AGE Illustration, were recommended for procurement by the contractor.

On June 22, 1972 the System Manager approved this item with the requirement for an AGE illustration. On Sept. 21, 1972 the SPO disapproved this item because it included in one test set both items that were to be repaired at Newark AFS and Warner-Robbins ALC. The SPO directed that a study of alternatives be completed by the contractor by Oct. 30, 1972.

On Feb. 13, 1973 revision A of AGERD 721 was submitted containing the following changes: 1) detailed listing of 31 LRUs and Subassemblies of the Inertial Measuring Unit and deletion of the Navigation Control and Display Unit LRUs which will be repaired at Warner-Robbins ALC as noted in the disapproval, 2) an increase in the number and capability of input and output serial logic lines, 3) the manufacturer's name for the in-production item changed from Maintenance Automated Test Set (MATS) to Litton Automated Test Set (LATS), 4) an 8K increase in central computer storage and a 500K decrease in disk storage, 5) Volume estimate increase of 350% and weight estimate increase of 10%, 6) development cost estimate increase to \$1,020,800 and unit cost estimate increase to \$530,600.

This AGERD was approved by the System Manager March 2, 1973, and by the SPO March 26, 1973. An AGE illustration was required in this approval and approval was given to the above numbered development specification.

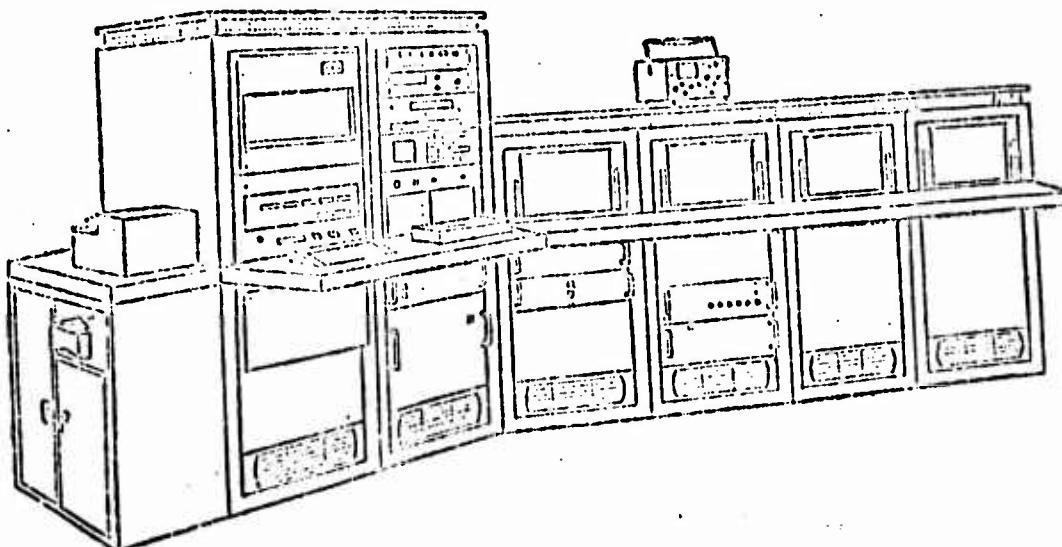
Between November 1972 and April 1973 a series of letters were exchanged between Oklahoma City ALC, Warner-Robbins ALC, and the F-15 SPO which indicated that the use of System Area Index 04S instead of 35A (Inertial Navigation System) had misdirected the subsystem IM copy of this AGERD away from Oklahoma City ALC who is the correct subsystem IM. Numerous questions about this item including the quantity were put forth. The SPO answered all questions and did not change any decisions. These letters revealed that a specification of 85% availability of the tester was applied in planning for this item.

Revision B of AGERD 721 was submitted Feb. 2, 1974. The following changes were included: 1) NSN 4920-00163-6042DQ added, 2) manufacturer's code changed from McDonnell to Litton, 3) part number 09200-1 added, 4) responsible agency San Antonio ALC added, 5) unit cost estimate increased to \$549,010. This AGERD was concurred in by the System Manager Mar. 18, 1974 and approved by the SPO April 17, 1974.

Revision C of AGERD 721 was submitted Aug. 23, 1974. The only change on this AGERD was the deletion of the -1 from the manufacturer's part number. This change had been identified earlier in a telegram from the prime contractor. Nevertheless this revision was distributed to all parties and approved by the SPO Dec. 5, 1974.

Although all AGERDs contained the need date May 1975 this article was scheduled for delivery to Newark AFS in August 1975 with software to be delivered in Oct. 1975. This delivery after need was caused by technical difficulties in preparing software and in implementing hardware modifications.

This case study illustrates one unnecessary AGERD revision submitted, mistakes in coordinating with subsystem IM, and late delivery due to technical difficulties. Nevertheless, the results of a major trade study were used, and a commercial item was modified thus savings costs over a new design to military specifications.



CASE 7 - INERTIAL NAVIGATION TEST SET

CASE 8 - ELECTRONIC CIRCUIT PLUG-IN UNIT TEST SET

Defense System:	485L
Type:	Automatic Test Equipment
Functional Area:	Command and Control
Level of Use:	Intermediate
Method of Procurement:	CFE

This item is AGERD 63 of the AN/TSQ-91(V) ART Operations Center procured under contract F19628-74-C-0056. It is a Fluke Inc. TRENDAR 1900 semi-automatic commercial-off-the-shelf test modified by Hughes Aircraft Company. No NSN has been assigned. The purpose of this item is to test analog and digital circuit cards added to the AN/TSQ-91 ART by a recent improvement program at the intermediate level.

The original AGERD 63 was submitted April 15, 1974. An ART Improvement Summary was referenced as preceding data. The functional analysis was three lines long and contained no technical data. However, it referenced, "Previous discussions." The recommended solution contained extensive technical data including details of software and required modifications including which modifications were to be done by Fluke and which by Hughes. Four TRENDAR Bulletins are referenced for more detail. This item is identified as both engineering and procurement critical for the contractor.

The figure 1B of AGERD 63 contains a development cost estimate of \$57,800 excluding technical data preparation and a unit cost estimate of \$23,700. Twenty articles are recommended for a total expenditure exceeding \$0.5M. Only the match code block is inexplicably blank. A need date of Feb. 1975 is listed and identified with phase B of the project. MIL-HDBK-300C screening is noted under remarks.

This item was considered and recommended in a major trade study conducted for Case 9. This illustrates the fact that Air Force successfully does use commercial-off-the-shelf test equipment when it can satisfy the requirement. Further, common use of existing automatic test equipment is fostered in the existing support equipment acquisition system, although successful tools are limited to personal knowledge of existing equipment.

CASE 9 - DIGITAL/ANALOG MODULE TEST STATION

Defense System:	485L
Type:	Automatic Test Equipment
Functional Area:	Command and Control
Level of Use:	Intermediate and Depot
Method of Procurement:	CFE

This item is AGERD 1 of the Tactical Air Command and Control Automation (TACC Auto) project. It was procured under contract F19628-73-C-0071 with General Dynamics Corporation. NSN and contractor part numbers are yet to be assigned. The purpose of this item is to fault locate analog, digital, and hybrid circuit cards used on the prime system.

AGERD 1 numbered Original-1 was submitted to the SPO March 28, 1974. Only the Figure 1B could be found for examination. This AGERD contained a need date of Feb. 1, 1975. The development cost estimate was \$1,968,234 and the unit cost estimate was \$425,557. Five articles were recommended for intermediate use and one for depot use. The total cost estimate given did not include the development cost but this was emphasized by a note under remarks. This AGERD stated that MIL-HDBK-300 had been screened. The item was identified as engineering critical. This AGERD was rejected by the SPO.

Subsequently a major trade-off study of alternatives was undertaken by the contractor and the Air Force. The results included five alternatives evaluated on the basis of 12 criteria. Life Cycle Cost was not included as a criteria although recurring cost and programming cost per card were included. This study ordered the alternatives as, first a new equipment design, second the Fluke, Trendar 1000 Card Tester (case study 8). The Trendar 1000 is recommended by the study because of its lower cost although specific costing is omitted.

The contractor evaluated 22 circuit cards for testing on the Trendar 1000A and found the value of the card tester, "limited." They estimated 3.6 man-years of effort would be required to analyze all circuit cards.

MITRE Corp. noted apparent discrepancies between this study and the contractor's ORLA. The ORLA found only 54% of circuit cards required repair and only 8% at the intermediate level. Furthermore MITRE disagreed with the part of the 8% which were core memory cards. In January 1975 the resolution of this item remained pending.

This case study illustrates how late definition of requirements due to a high degree of technical complexity causes late delivery of supportability. Furthermore, the interface between support equipment acquisition and the ORLA process was not well defined.

CASE 10 - ARMAMENT SYSTEM FLIGHT LINE TEST SET

Defense System:	A-10
Type:	Automatic Test Equipment
Functional Area:	Armament
Level of Use:	Organizational
Method of Procurement:	CFE

This item is NSN 4920-00395-6894 and AGERD #80 of the A-10 aircraft. Its function is to fault isolate the Armament Control System to the LRU level in 30 minutes in order to meet the requirement of the ROC for quick turnaround. This semi-automatic test set generates 60 signals to simulate stores, monitors 150 output signals, processes the operations of the test, and provides self-test capability.

This item was not contained in the AGE Plan even though it is an item of high cost complex electronic test equipment. The original AGERD was submitted on May 2, 1973. This was first deferred May 14, 1973 then disapproved May 21, 1973 by the Depot Provisioning Committee with the note that the system could be checked with standard Air Force equipment. No reference was made to the turnaround requirements or to what specific equipment could be used. The SPO disapproved the original AGERD on Aug. 22, 1973 while inviting a revised submission by requesting additional information.

Revision A could not be found. However, revision B was submitted Jan. 15, 1974. The Depot Provisioning Committee approved the requirement and disapproved the solution Feb. 7, 1974 with notes that requested data had not been supplied. The SPO, however, approved Revision B on March 8, 1974 without comment. All items of data listed on ASD Form 0-169 were checked to be procured and the item was identified as engineering critical. Revision C was submitted April 15, 1974, approved by the Depot Provisioning Committee June 6, 1974 and by the SPO on Aug. 7, 1974. This approval did not carry the engineering critical designation.

Revision D was submitted on Nov. 15, 1975. A detailed comparison of revision C and revision D showed the following differences:

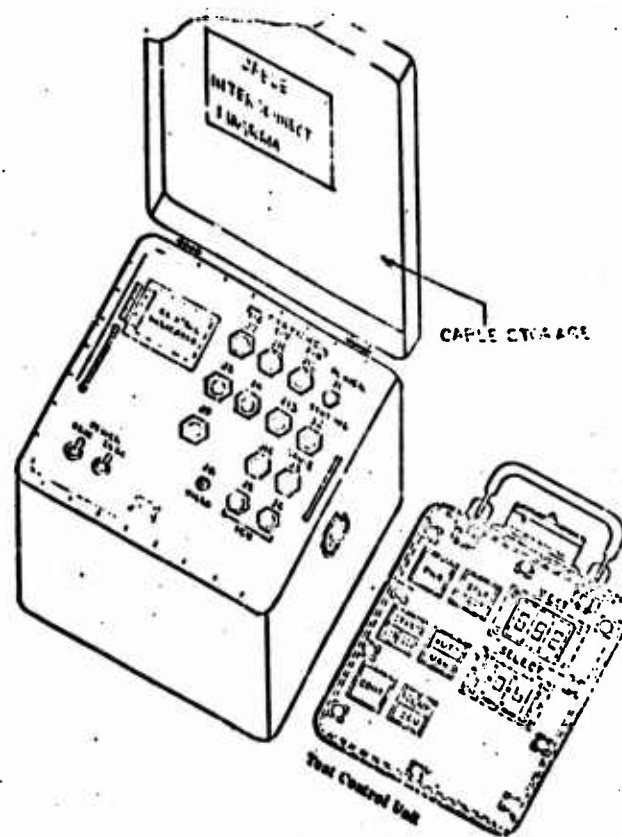
1. Change from single phase to three phase electrical power.
2. Reduction in the number of electrical connectors.
3. More detailed description of typical operations.
4. Test Control Unit no longer fits in main storage container. This increases storage volume 6% and increases the number of items required from one to two.
5. Fifty percent increase in weight.

The following table lists the costs, time to need date, and quantities shown on the AGERDs examined:

	Development Cost	Unit Cost	Days to Need Date	Quantity Recommended
Original	blank	\$ 1,800	blank	5*
Rev B	blank	\$ 3,000	blank	55
Rev C	\$187,840	\$72,930	240	52
Rev D	\$187,840	\$33,000	30	52

*Test only

The contractor reported problems in programming this tester including the need to train a new programmer during development. In addition approximately 12 safety changes have had to be incorporated in the design. No mean time between failure has been specified for this test set in order to keep the unit price low. No documentation was found trading off life cycle costs with reliability. This item was undelivered at the time of this study and workaround procedures were being considered using manual test equipment.



CASE 10 - ARMAMENT SYSTEM FLIGHT LINE TEST SET

CASE 11 - SYSTEM TEST CONSOLE

Defense System:	RPV-Avionics Update
Type:	Automatic Test Equipment
Functional Area:	Avionics
Level of Use:	Organizational
Method of Procurement:	CFE

This item is AGERD 1 of the Low Altitude Drone Avionics Update Program, Contract F33657-72-C-0502. This item is not stock listed because it is not used in operations. It is identified by Lear Siegler Inc. Astronics Division drawing number 457100. This test set performs 1100 tests on 12 subsystems contained in the prime vehicle at the organizational level.

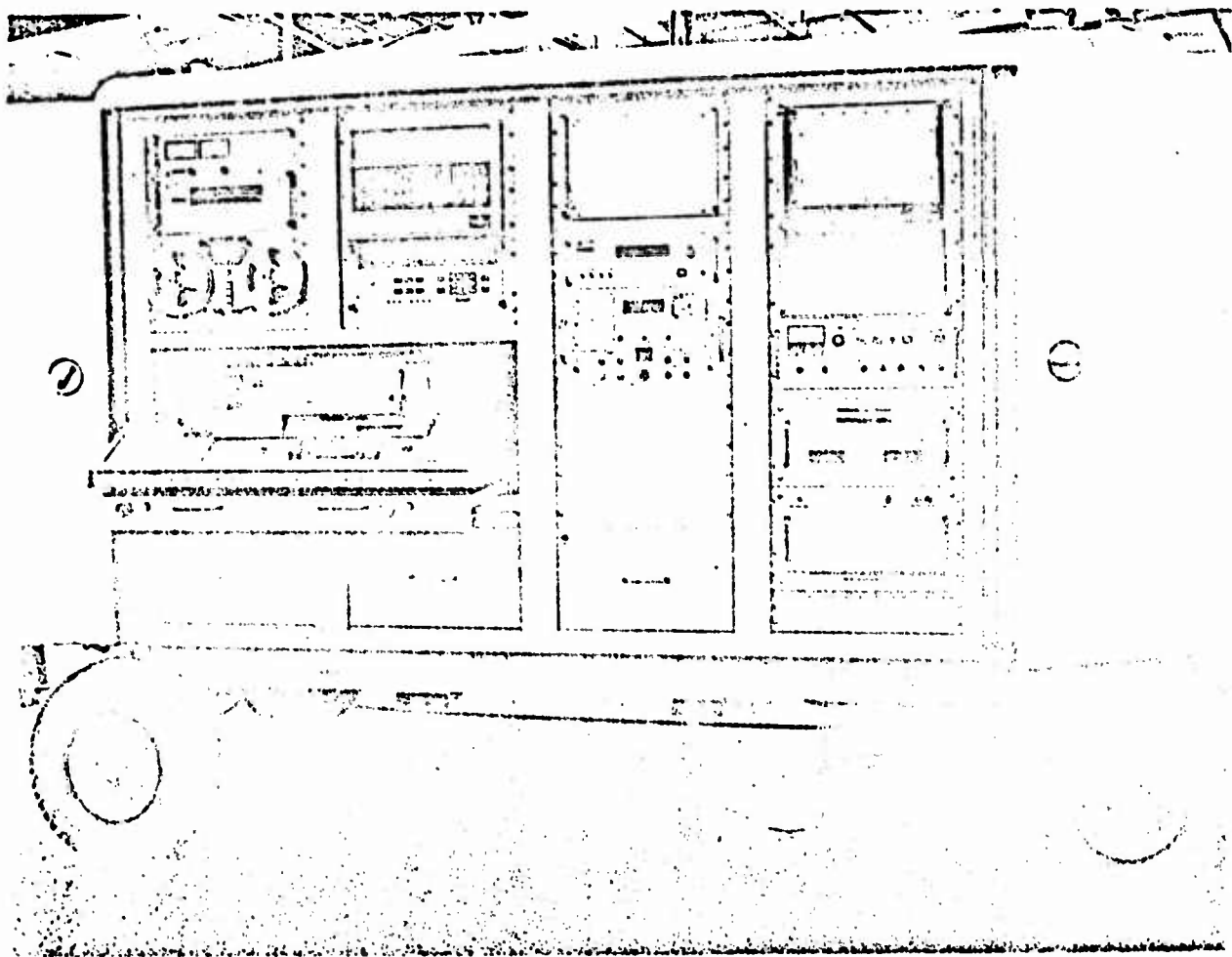
The requirement for this item was included in the contractor's proposal to the Air Force in late-1971 in competition with at least four other contractors. Significant preliminary design work was included. Contract number F33657-72-C-0502 of which this was a line item, was initiated in January 1972. AGERD 1 was submitted February 25, 1972. Development cost estimate, unit cost estimate, contractor part number, and need date were all blank on this AGERD. The functional analysis and the recommended solution were interspersed with those of three other items for which separate figure 1B data was submitted. A development specification dated December 28, 1972, a product fabrication specification dated April 18, 1973, and an acceptance test plan dated January 1973 were all procured for this item. The former specified 260 hours mean-time-between-failures as a design goal. No verification test of this goal could be identified. However, operators reported satisfaction with the reliability of this item. Although no documentation of a commercial vs. military standard trade-off study was found, this item is principally commercial-off-the-shelf equipment. Satisfactory reliability therefore, indicates potential savings from military hardware where environments are sufficiently benign. Note that organizational use in this case takes place in a hanger.

Two Systems Test Consoles were delivered to flight test beginning in January 1973 and were operated by contractor personnel until test completion in October 1974. This item demonstrated a reduction from eight hours using conventional methods, to 62.5 minutes to make the approximately 1100 tests required before flight.

Development cost of this item including software was approximately \$1M. Unit cost was approximately \$197,000 in 1971. New programs on which these items will be used will add X- Y plotting capability and more storage. These coupled with inflation will bring the unit cost to \$250,000.,

1

This case study illustrates that commercial-off-the-shelf automatic test equipment can result in low cost to the Air Force while performing the required mission. Further, this item was negotiated before the contract was finalized. If the AGERD process had identified a common item funds already expended would have been lost. In this case common item search needs to be accomplished before contractual commitment.



CASE 11 - SYSTEM TEST CONSOLE

CASE 12 - PROGRAMMER/LATERAL CONTROLLER TEST SET

Defense System:	RPV-Combat Angel Update
Type:	Automatic Test Equipment
Functional Area:	Flight Control
Level of Use:	Organizational and Intermediate
Method of Procurement:	CFE

This item is Teledyne Ryan Aeronautical Company part number 255G001-1. It is being procured on contract F33657-74-C-0722 dated August 1, 1974 for the Combat Angel Update Program. Its purpose is to check out and test components of the vehicle's flight control systems at the organizational and intermediate level.

This item is the result of combining two test sets (including case 16) used on earlier vehicles. No documentation of the trade-off study could be found. This trade-off study took place at the first design review in October 1974. It is implemented by Specification Change Notice 1 dated January 15, 1975 to procurement specification 108107878110C dated May 20, 1974.

A quantity of three of this item was originally planned but options are being costed out for quantities of 3, 6, and 9. The unit cost estimate of this item is \$34,000. There is no MTBF reliability requirement on this item specifically but the general AGE specification calls for a minimum of 150 hours MTBF for all predominately electronics items. The contractor has encountered minor design problems on this item involving electromagnetic interference. No delivery date had been established as of February 1975, pending SPO decision on handling of this problem.

This case study illustrates how trade-off studies lead to the elimination of unnecessary items as they are identified in evolving programs. Since the AGERD process was not used, availability of a common item to do this job is dependent on undocumented searches of the contractor and Air Force personnel involved with the project. Technical problems were encountered under this system which impacted schedule. This illustrates the difficulty in dealing with these problems through procedural solutions.

CASE 13 - FINAL INSPECTION TEST STAND

Defense System:	AIMS
Type:	Automatic Test Equipment
Functional Area:	Altitude Computers
Level of Use:	Depot
Method of Procurement:	CFE

This item is AGERD 7 for the CPU-66/A Altitude computer, NSN 4920-00422-273INT, AIMS Spec. number 69-874-4 and Bendix part number 31TL2867-1. Its purpose is to provide fault isolation and final checkout capability for one to five prime items at the depot. 1960 CPU-66/As have been delivered to the Air Force.

This item was originally AGERD 49 for the CPU-46/A Altitude Computer with NSN 4920-00969-4684NT, Aims Spec. No. 65-860, and Bendix part number 31TL2614-1. 2579 CPU-46/As have been delivered to the Air Force.

All but the first page of AGERD 49 in revision A dated July 16, 1965 was examined. The functional analysis could not be judged because it was incomplete. The recommended solution contained considerable quantitative technical data which would have been adequate for selection if associated with an adequate functional analysis. A 6-point rationale for the use of automatic rather than manual test equipment is included.

The figure 1B of this AGERD contains blank approval date and need date blocks although the item was already stock numbered. The development cost estimate contained a dash. The unit cost estimate was \$160,600. The AIMS AGE Document of June 30, 1973 shows the unit cost of this earlier item as \$160,000 and of the later item as \$295,000. The Air Force Management Data List shows a unit cost for the later item of \$236,704. One article only is recommended for depot use. This item is identified as both engineering and procurement critical and the requirement for calibration is noted. This AGERD reached revision D before completion.

This item can be found under the part number 31TL2614-1 and AGERD number 49 in the December 9, 1968 AGE Plan for the CPU-66/A Altitude Computer. This document states that this item is "... used without change," however cables and fixtures are added. This appears to be incorrect because the item was renumbered by both contractor and government and the price increased 84% as noted above. Furthermore, the latter item is listed as an alternate for the CPU-46/A in the AIMS AGE document but is the only item listed for the CPU-66/A.

Both these items are listed in MIL-HDBK-300D although in different sections. The earlier test stand was entered on April 1, 1970 in section AA-9.3 Subsystem and Component Testing without the Material Management Code NT suffixed. The later test

stand was entered December 1, 1971 in section AA-9.1 Combined General-Purpose Functional Testing. Both these entires contain the entry, "None," under the similar equipment heading. It is impossible to determine from these entries what physical properties of the later equipment warrant its higher price and the inability of the earlier version to test the CPU-66/A. Only the earlier item contained range and accuracy data on pressures measurable by the manometers associated with the test stand. Neither item is listed in the D097 Interchangability and Substitution System.

SPO personnel stated that this item was delivered several months after the Air Force needed it to test operational prime items. In the interim period contractor support was used to accomplish depot repair of this item. There was no trade study performed to determine if delay would be advantageous. Delay was dictated by contractor inability to design and produce this item between approval and need dates.

This case study illustrates the importance of contractor support trade-off studies. Only such studies can assure management attention where it is required to bring required equipment into the inventory with least cost for both contractor support and change activity. Further, MIL-HDBK-300D entries appeared five years after revision A of the AGERD and the entry of a later version did not eliminate the earlier entry in a different section. The entires themselves also proved insufficient for selection of the items.

CASE 14 - INDICATORS AND CONTROLS TEST STATION

Defense System:	F-15
Type:	Complex Manual Test Equipment
Functional Area:	Indicators and Controls
Level of Use:	Intermediate
Method of Procurement:	CFE

This item is AGERD 75 and 2536 of the F-15 program contract with McDonnell Aircraft Co. It is NSN 4920-00169-3001AX and Navigation and Control Division of Bendix Corp. part number 13A6530-2. It is one of the manual test stations of the F-15 Avionics Intermediate Shop (AIS). The purpose of this item is to verify and isolate faults in 45 indicator and control LRUs of the F-15 aircraft and align repaired assemblies for reuse.

AGERD 75 was originally submitted on July 16, 1970. This submission referenced the F-15 McDonnell AGE Plan paragraph 6.3.5 as well as comprehensive trade-off studies of the F-15 avionics* and the Optimum Repair Level Analysis (ORLA). The functional analysis contained excellent qualitative data including a list of LRUs tested and a

*The methodology of this trade-off study has been documented in MIL-STD 1513 Criteria for Selection of Avionics Test Support Systems.

summary of eleven functions required by the test station, but referred to the above studies for quantitative data. The recommended solution contained a list of 12 drawers to accomplish the requirement including four each that were already stock numbered, modified contractor part numbered items, and new design items. The weight estimate was 1800 lbs, and the volume estimate was 12 cubic feet.

The figure 1B of this AGERD contained the need date February 1974, a development cost estimate of \$7,523,700, and a unit cost estimate of \$228,000. This unit cost still appears in the DoD Management Data List. Three articles per intermediate maintenance squadron and five others for training, IRAN, depot, and testing were recommended. Two was pencilled over the three per intermediate squadron on the system manager's copy. The prime item specification number CP328HO4E1007 was also included. Eight data items not including an AGE Illustration were recommended by the contractor.

This AGERD was approved by the SPO November 2, 1970 with extensive comments including a conflict in power requirements between the AGERD and the specification, change in location of category I and II test requirements, reservation of depot quantity, and the requirement for preliminary and critical design reviews. Twelve data items were specified including an AGE Illustration and the item was identified as engineering critical.

Revision A of AGERD 75 was submitted March 27, 1972. Only the figure 1B could be located. Changes included 1) addition of part number 13A6530-1, 2) decrease in development cost estimate to \$2,141,000 and decrease in unit cost estimate to \$204,000, 3) increase in quantity recommended to 7, 4) notes that nonmobile TAC wings are represented, that test and training requirements are omitted, and that one tester can support 24 aircraft. This AGERD was approved July 5, 1972.

Both revision B of AGERD 75 and the original of AGERD 2536 were submitted September 3, 1974. The former simply noted that the dash 2 version superseded the dash one of the same part number. AGERD 2536 was meant to represent the operational configuration of this item. The functional analysis was virtually undistinguishable from that of the original AGERD 75 except that the list of LRUs supported decreased to 41 and the list of functions required increased to 15.

The recommended solution contains much more detail including 40 components of the test station encompassing all the original 12 drawers including extensive quantitative data. The amount of new design equipment could not be determined due to deletion of this data. The weight estimate has doubled to 3600 lbs. The volume estimate was more than double the original at 32 cubic feet.

The figure 1B of AGERD 2536 shows need date of September 1974, the month of submission. The cost estimates are exactly those of AGERD 75 Revision A. The quantity recommended has increased to eleven although three per intermediate squadron is retained. The capability of one test station per 24 aircraft also remains. Four data items excluding an AGE Illustration are recommended with this AGERD. A new prime item specification of CPO4E1074 is noted and a FSC of 4930 Lubrication and Fuel Dispensing Equipment, which is clearly in error, is shown.

Both these AGERDS were disapproved on October 6, 1974 in consonance with AIS documentation ground rules delineated in a telegram dated October 4, 1974. The use of new AGERD numbers to represent operational configuration was rejected.

On November 21, 1974 revision C of AGERD 75 was submitted. The functional analysis and recommended solution differed from AGERD 2536 by the deletion of the LRU Blower Panel drawer. Even the new prime item specification number is retained.

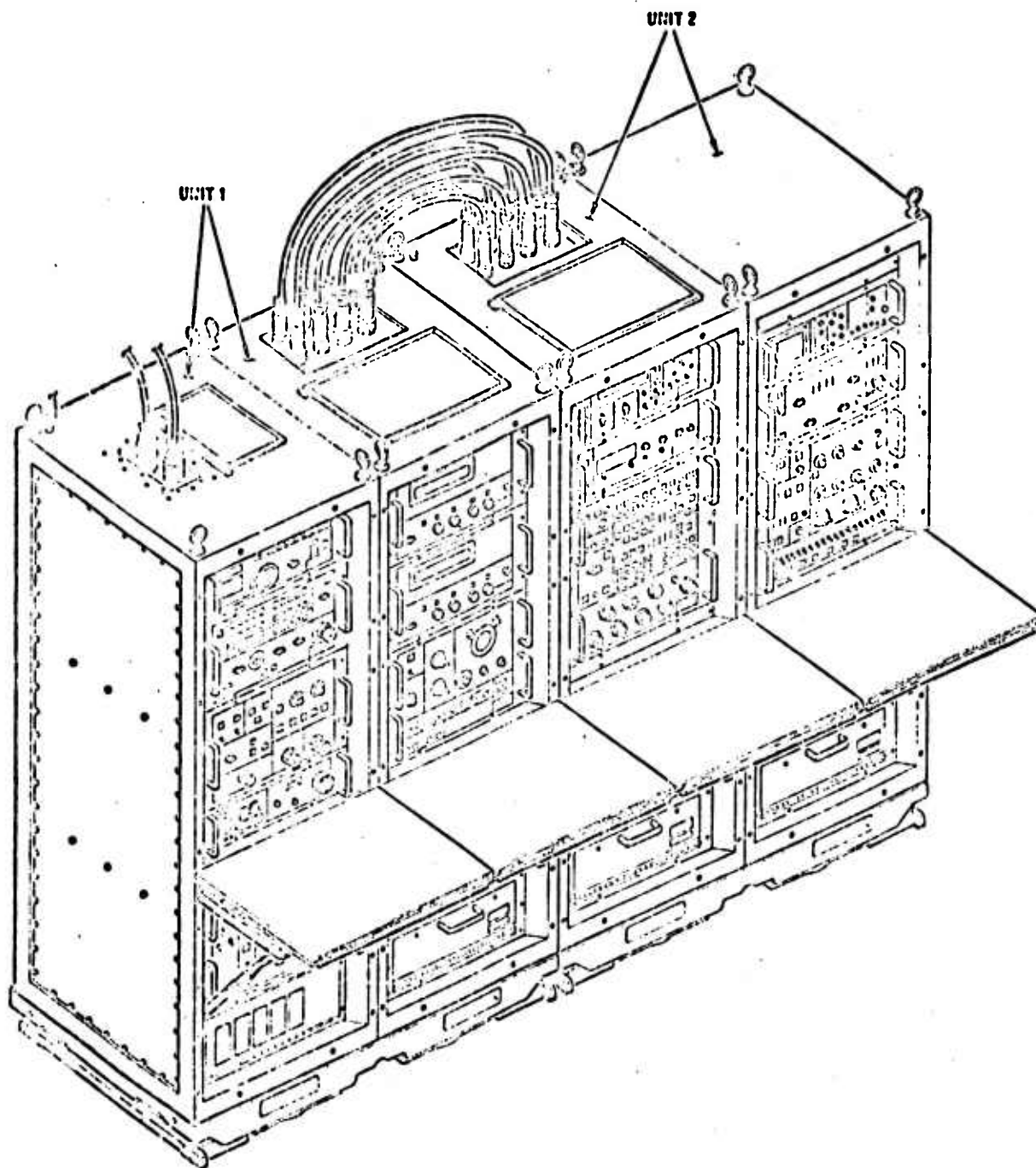
The figure 1B, however, contains a nearly five-fold increase in the unit cost estimate to \$1,054,122. SPO action on this AGERD remained pending on January 24, 1975.

Air Force efforts to reduce expenditures for this item include planning to refurbish at least four test and design articles for operational use. This is expected to cost approximately \$150,792 per article. In addition spares for this item were partially procured by exercising a low cost option for an entire article and disassembling it.

This item was delivered in early-1974 to the flight test site with some discrepancies, and was fully delivered to Luke Air Force Base on time for the first squadron activation. Nevertheless as of April 1975 three Engineering Change Proposals, numbers 350, 268, and 307, effect LRUs tested on this test station. All three require re-evaluation of the test station for LRU compatibility which could alter the item. These tests are scheduled for completion by October 1975.

What quantity of the entire AIS to procure has been the subject of much controversy. The position of the Tactical Air Command and the contractor is that three per intermediate maintenance squadron are required because when one squadron is deployed with one set, the remaining two squadrons cannot be supported by the remaining set. The position of the Air Staff, and the SPO, is that the high cost of this system warrants waiting for an actual deployment to make this decision. Accordingly the Vice Chief of Staff directed in a telegram on June 17, 1971 that the basis of issue be established as two per wing. This decision required revising AFM 28-40 Mobility of Tactical Forces. This revision has been completed. As of November 1974 this decision had not been reflected in the F-15 McDonnell CAGEL which continues to list 3 per intermediate maintenance squadron as the basis of issue.

This case study illustrates a complex item which was the subject of extensive trade-off studies and was delivered reasonably on-time with only a few changes outstanding. Nevertheless, confusing AGERDs were submitted and required processing by all offices. A unit price increase of well above inflationary rates could not be avoided. This item is so expensive the quantity procured has been limited to reduce costs.



CASE 14 - INDICATORS AND CONTROLS TEST STATION

CASE 15 - COMMUNICATIONS, NAVIGATION AND IDENTIFICATION TEST STATION

Defense System:	F-15
Type:	Complex Manual Test Equipment
Functional Area:	Communications, Navigation, and Identification
Level of Use:	Intermediate
Method of Procurement:	CFE

This item is AGERD 62 and 2529 of the F-15 program contract with McDonnell Aircraft Co. It is NSN 6625-00160-1324YA, and Navigation and Control Division of Bendix Corp. part number 13A6540-2. This test station is one of the 3 AIS manual test sets. The purpose of this item is to verify and isolate faults and align repaired assemblies of the communications navigation, and identification portions of the F-15 avionics.

AGERD 62 was originally submitted on July 8, 1970. AGE Plan paragraph 6.3.5 was referenced as were comprehensive trade-off studies of F-15 avionics and the F-15 ORLA. The item was identified as engineering critical for the contractor. The recommended solution lists 8 LRUs tested by this test station and extensive qualitative data but no quantitative test requirements. The recommended solution describes a system with 20 components. Six are already AN numbered, two are already stock numbered, ten are contractor part numbered, and only two are new design. Three of these components continue under analysis at the time of submission. Case 21, the AN/UPM-137, is one of the components contained in this test set. There is significant quantitative data on the capabilities of these components. Prime item specification number CP328A04C1006 is referenced.

The figure 1B of this AGERD contains the need date February 1974, the development cost estimate \$4,099,300, and the unit cost estimate \$613,900. Quantity recommendations parallel those of Case Study 14 and so will not be repeated. The contractor submitted a Federal Supply Class of 4920 which was replaced by 6625 then returned to 4920 and again changed to 6625 on the system manager's copy. These changes alter the office which receives the AGERD in the AFLCM 65-3/AFSCM 65-2 prescribed procedure. Material Management Code CW is also replaced by YA. Nine items of data are recommended by the contractor including an AGE Illustration.

This AGERD was conditionally approved on October 23, 1970. Approval was contingent upon including the transponder diversity function in the test requirement and resolution of conflict in power requirements with specification. Further investigation is called for in one component and preliminary and critical design reviews are called for. Thirteen items of data including an AGE Illustration are called for by the SPO.

Revision A of AGERD 62 was submitted March 11, 1971. Changes from the original were, 1) addition of the diversity function mentioned on the approval form, 2) correction of a typographical error in the resistance range of a stock listed multimeter, 3) addition of the weight of the AN/UPM 137, 4) addition of DC power requirements. Apparently none of those components under study had been resolved. The contractor again submitted a FSC of 4920 which was corrected once to 6625. The system manager's copy contained the reduction from 3 to 2 in the basis of issue for intermediate maintenance squadrons. This AGERD was approved 10 months later on January 11, 1972.

Revision B was submitted March 27, 1972. This AGERD added the part number 13A6540-1, reduced the unit cost to \$601,900, showed an approval date of November 5, 1970, and included the capacity of the item as one per 24 aircraft.

Revision C of AGERD 62 and the original of AGERD 2529 were submitted on September 3, 1974. Revision C simply noted that the dash one version was superseded by the dash two. The functional analysis of AGERD 2529 contains some renaming and reordering but only contains more technical detail in the Instrument landing system and the antenna selector. The other 8 remain unchanged. The recommended solution is one page shorter and contains less technical data than AGERD 62. The originator of the subsystems (i.e., new design, contractor part number, or already stock listed) has been deleted.

Although two years into implementation the A version of the AN/APM-137 has not been included. The volume and weight estimates have increased 33%; however, the costs are unchanged. Deletion of the depot article is penciled in on the system manager's copy.

Both these AGERDs were disapproved on December 6, 1974 in consonance with a telegram dated October 4, 1974 delineating ground rules for AIS documentation. These rules disallowed renumbering identical items as attempted by the contractor.

On November 21, 1974 Revision A of AGERD 2529 and Revision D of AGERD 62 were submitted. The former cancelled the original AGERD 2529 noting its replacement by the latter. The figure 1A of revision D is an eleven-page duplicate of the original AGERD 2529 except for margin marking of the word changes from AGERD 62 revision C, additional subsystems tested by the stopwatch, and a return to the specification number of AGERD 62.

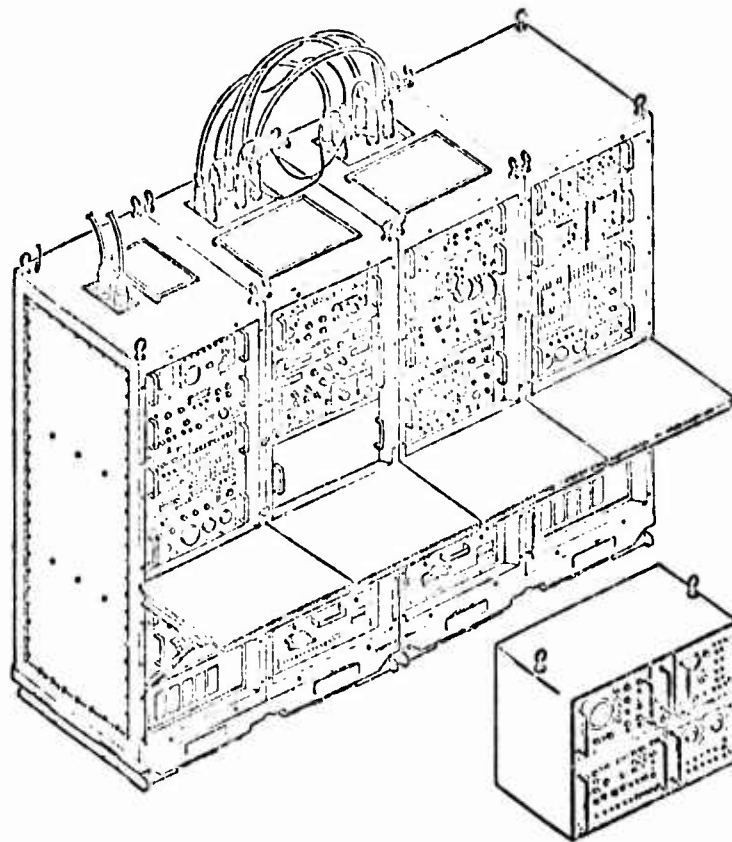
The figure 1B of this AGERD contains blank match code and approval date but for the first time contains the complete and correct NSN. The unit cost has more than doubled to \$1,346,050. SPO action on this AGERD remained pending as of January 24, 1974.

In order to control expenditures for this article the F-15 program has planned to refurbish at least 4 test and design articles for operational use. This will cost approximately \$281,985 per item. In addition spare parts are being obtained in part by exercising a low cost option for one entire article and disassembling it.

The dash one version of this test station was delivered to the flight test site in early-1974 with minor discrepancies. It was delivered complete and on-time to Luke Air Force Base for the first squadron activation. Technical Order T.O. 33A1-3-466-1 is being procured in support of this test station.

The quantity to procure of this test station has been the subject of much controversy. The discussion of this issue is contained in Case Study 14 and will not be repeated here.

This case study illustrates a complex piece of equipment which was subjected to major trade studies which resulted in relatively successful procurement except for chaotic AGERD revision techniques and high cost growth. The quantity procured of this item has been limited by its high cost.



CASE 15 - COMMUNICATIONS, NAVIGATION AND IDENTIFICATION TEST STATION

CASE 16 - ANTENNA TEST STATION

Defense System:	F-15
Type:	Complex Manual Test Equipment
Functional Area:	Radar
Level of Use:	Intermediate
Method of Procurement:	CFE

This item is AGERD 71 and 2535 of the F-15 program contract with McDonnell Aircraft Co., NSN 6625-00160-1321YA and Navigation and Control Division of Bendix Corp. part number 13A6520-2. It is one of the AIS manual test stations. Its purpose is to verify and isolate faults and align repaired assemblies at the intermediate level for three LRUs related to the fire control radar on the F-15 aircraft.

AGERD 71 was originally submitted July 10, 1970. AGE Plan paragraph 6.3.5 and prime item specification number CP328A04A1004 were referred to as were detailed trade-off studies of the F-15 avionics and the ORLA. The functional analysis of this AGERD contains excellent qualitative data including 17 tests that must be performed by this test station. No quantitative data is listed, however. The recommended solution contains the description of a dual channel test station able to test any combination of 2 of the 3 LRUs simultaneously except two radar antennas. This configuration is optimum based on workload projected and cost of the antenna test fixture. All drawers not exclusively used by the radar antenna or very low usage are provided in duplicate. Fifteen drawers are described including three already stock listed, nine with contractor part numbers and two which are to be new designs. Four of the part numbered drawers remained under investigation at the submission of this AGERD. In addition three fixtures required with the test station were described and extensive volume and weight data was provided.

The figure 1B of this AGERD contained the need date February 1974, the development cost estimate \$3,130,300 and the unit cost estimate \$1,031,600. Quantity recommendations for all AGERDs were the same as Case 14 and will not be repeated. The FSC was submitted as 4931 which does not exist but was corrected to 6625 on the system manager's copy. The entire NSN and contractor's part number was penciled in by the Air Force.

This AGERD was conditionally approved on October 23, 1970 with the direction to include interconnecting hardware, and incorporate FSC 6625 and Material Management Code CW (later changed to YA).

Revision A of AGERD 71 was submitted March 27, 1972. This AGERD included an increase in the development cost estimate to \$6,313,200, and a decrease in the unit cost to \$829,500. The capacity of this item was listed as 1 per 24 aircraft. The total cost stated was \$4,977,000 which is 6 times the unit cost and excludes the development cost although a total quantity of 7 is recommended. This AGERD was approved on July 5, 1972.

Revision B of AGERD 71 and the original of AGERD 2535 were submitted on September 3, 1974. The former stated only that the dash two version superseded the dash one version. The latter contained an incorrect date on the figure 1B and replaced the Waveguide Assembly LRU with the Low Voltage Power Supply LRU. Only two combinations of two LRU are listed as testable simultaneously. There is no explanation for the reduction from 8 combinations. Part numbers have been changed from manufacturer's part numbers to McDonnell part numbers. National Stock Numbers have been deleted. Twenty-five unique drawers are listed and five duplicated drawers have duplicated designations. One of these lists the part number of one earlier drawer with the description of another. Only two fixtures are required rather than three and a line drawing is omitted. Figure 1B contained blank need date, and development and unit cost estimate blocks.

Both these AGERDs were rejected on December 6, 1974 in consonance with AIS documentation ground rules delineated in a telegram to McDonnell October 4, 1974. These ground rules disallowed renumbering items already established under an AGERD number.

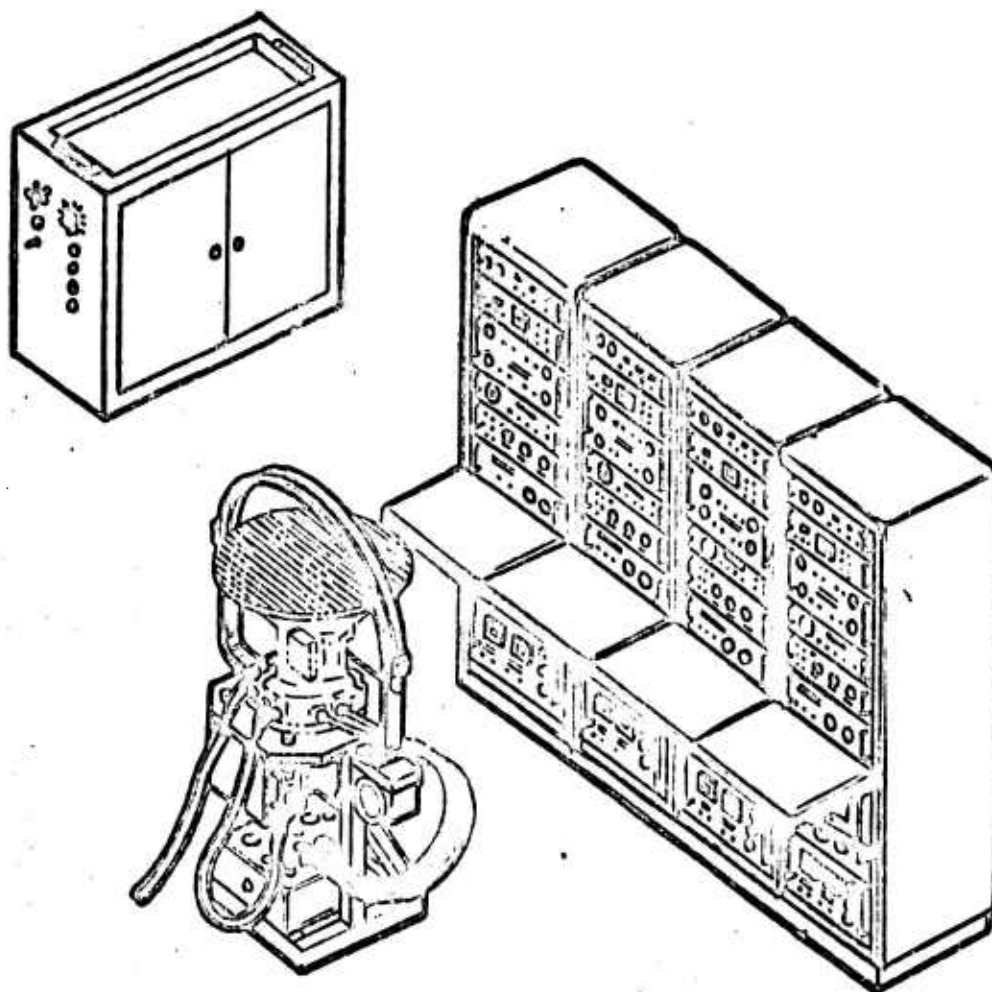
Revision C of AGERD 71 and revision A of AGERD 2535 were submitted November 21, 1974. The figure 1A of the former AGERD differed only in three part numbers and four weight estimates of components, in 10 pages of single spaced text. Some of these revision, including the correction of the part number error noted above, are not noted as revised in the margin. The figure 1B contains an increase in unit cost to \$1,850,723. This AGERD remained pending SPO action as of January 24, 1975.

The Air Force has attempted to reduce expenditures on this item by planning to refurbish at least four test and design articles for operational use. This effort will cost approximately \$374,947 per article. In addition spare parts for this article have been partially procured by exercising a low cost option for an additional article and disassembling it.

This item was delivered to the flight test program in early-1974 with minor discrepancies and to Luke Air Force Base on time for the first squadron activation. Nevertheless, two ECPs, numbers 192 and 282, currently impact two of the LRUs tested. These ECPs require recompatibility testing which could impact hardware in this test station. This testing is scheduled to be completed in June 1975.

The final quantity of this item to be procured has been the subject of much controversy. The issues and current positions are discussed in Case 14 and will not be repeated.

This case illustrates a very complex equipment for which major trade-off studies were accomplished. Nevertheless, capability of the test station for simultaneous testing was reduced during the acquisition process while components contained in the test station and price increased. Changes have continued to impact this item well after initial delivery. The only difficulties addressable by the acquisition process itself is the confusing pattern of AGERD submissions which would not affect the major problems of early inability to obtain precise definition.



CASE 16 - ANTENNA TEST STATION

CASE 17 - UNIVERSAL AVIONICS COMPONENT TESTER (UACT)

Defense System:	RPV - Avionics Update
Type:	Complex Manual Test Equipment
Functional Area:	Avionics
Level of Use:	Intermediate
Method of Procurement:	CFE

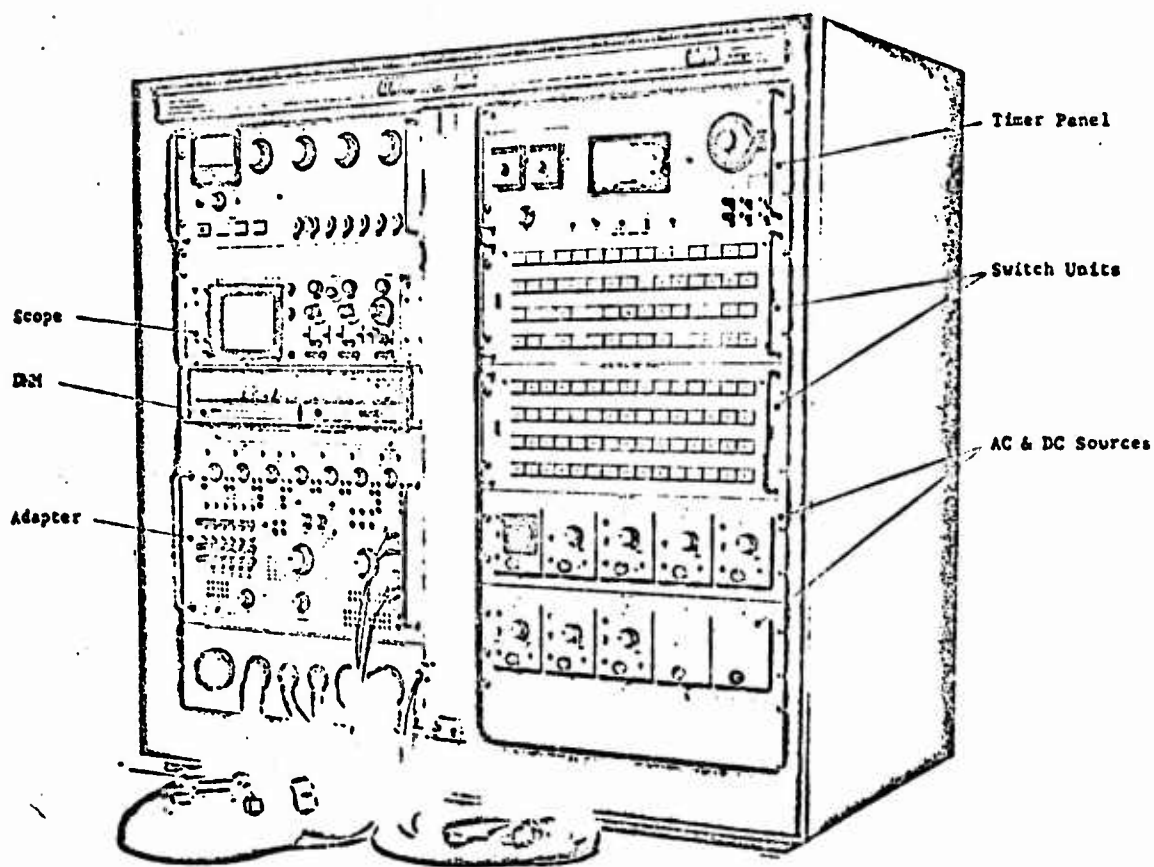
This item is AGERD 5, 5A, and 5B of the Low Altitude Drone Avionics Update Program and is identified by Lear Siegler part number 458500-01-XX. It is not stock listed because it is only used in research and development, not in operations. The purpose of this item is to test and fault isolate the Flight Control and four other LRUs at the intermediate level. It is a piece of commercial-off-the-shelf test equipment used by the commercial airlines to test flight control electronics.

This item was included in the contractor's proposal in late-1971 in competition with at least four other contractors. The contract was awarded in January 1972 including this test set as a line item. AGERDs 5, 5A, and 5B were submitted on February 25, 1972 in the same package of AGERDs as Case 12. These three AGERDs contained one sentence functional analyses with no quantitative technical requirements, and triplicate data on the UACT in the recommended solution. The descriptions of the adapters used with the item were nearly identical however differing in part number. Triplicate pictures of the UACT, a typical adapter, and figure 1B for the UACT were submitted. The figure 1B for the adapters differed only in part number. The unit cost estimate was blank on all AGERDs and the need date was July 30, 1972. Two items were recommended for purchase on all AGERDs. A misunderstanding could easily have led to an order of six of this item but this did not happen. LMI estimates that these 18 pages of data could have been reduced to 6 while improving the coherence of the submission by eliminating triplication of data.

A development specification dated July 10, 1972, a product fabrication specification dated August 1, 1973, and an acceptance test document dated January 29, 1973 were procured for this item. Five engineering changes are noted on these documents. All these were classed as minor by the contractor. The only reliability statement in these documents is that wear out failures will not increase failure rate until 2,000 hours of operation.

This item was delivered to flight test in time to accomplish its mission. It was operated by contractor personnel until the completion of tests. Reliability was satisfactory. The unit price for this item in 1971 was \$26,300. In addition approximately \$25,000 was expended in development of the adapters.

This case study illustrates that contractors are more motivated to show reduced costs to enhance proposal prospects in competition than to design new peculiar items where they can locate existing items. Of course the items they locate the easiest are their own as in this case. Misuse of the AGERD process by the contractor led to excess confusing data being procured but this did not impact the program.



CASE 17 - UNIVERSAL AVIONICS COMPONENT TESTER (UACT)

CASE 18 - ECM TRANSMITTER SHOP TEST SET

Defense System:	RPV - Combat Angel Update
Type:	Complex Manual Test Equipment
Functional Area:	ECM
Level of Use:	Intermediate
Method of Procurement:	CFE

This item is identified by product function specification number 208107878010A dated May 10, 1974 and approved by the SPO May 21, 1974. The purpose of this item is to check out and fault isolate at the intermediate level three different LRUs two of which are duplicated for a total of 5 LRUs on the prime vehicle.

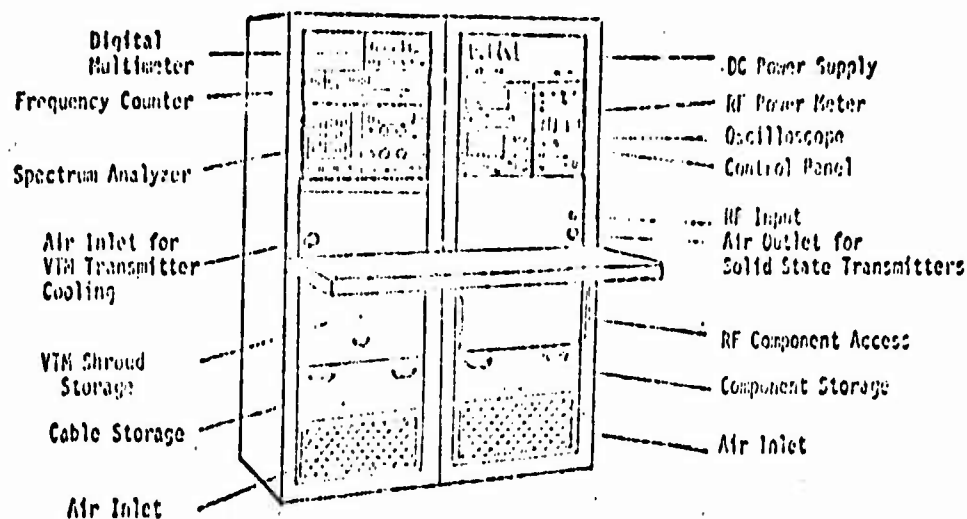
The requirement for this item was established in March 1974 and placed on contract August 1, 1974. The development cost is \$137,000 and the unit cost is \$68,000 for three items included in the contract.

The contractor reported he was not requested to search the Air Force inventory for comparable support equipment. The system manager had searched for a usable item but failed. The submission of an AGERD for this item was originally considered but was rejected when the contractor estimated the cost to be \$11,500.

A minor trade study was accomplished on this item through the consideration of automatic and manual test equipment at a joint technical meeting between the Air Force and the contractor. There is no documentation of the decision to use manual test equipment. The contractor stated there were no optimum repair level analyses or turnaround time studies because of the Air Force's desire to field a system quickly. The contractor identified on-going studies of turnaround time for the final versions of this vehicle.

This test set is made up of commercial-off-the-shelf components and interconnections. The specification states that the reliability of the test set shall be basically established by the reliability of the commercial equipment used. One Engineering Change Proposal has been submitted and approved to add a retractable outrigger to prevent tipover due to concentration of heavy equipment near the top of this item. Acceptance test is scheduled for late-June 1975 with delivery to the Air Force July 10, 1975.

This case study illustrates the difficulty in procuring AGERDs when contractors estimate their costs excessively high. Further it illustrates the use of commercial-off-the-shelf equipment to reduce cost to the Air Force.



CASE 18 - ECM TRANSMITTER SHOP TEST SET

CASE 19 - PROGRAMMER BENCH TEST SET

Defense System:	RPV - AQM-34 Series
Type:	Complex Manual Test Equipment
Functional Area	Flight Control
Level of Use:	Intermediate
Method of Procurement:	CFE

This item is NSN 4920-00109-0464KH and Teledeyne Ryan Aeronautical part number 147G152-45. It has been procured on five Air Force contracts dating from February 8, 1965. The earliest contracts were cost-plus-fixed-fee while the last two were cost-plus-incentive-fee. The purpose of this item is to checkout and fault isolate the programmer LRU of the prime vehicle at the intermediate level.

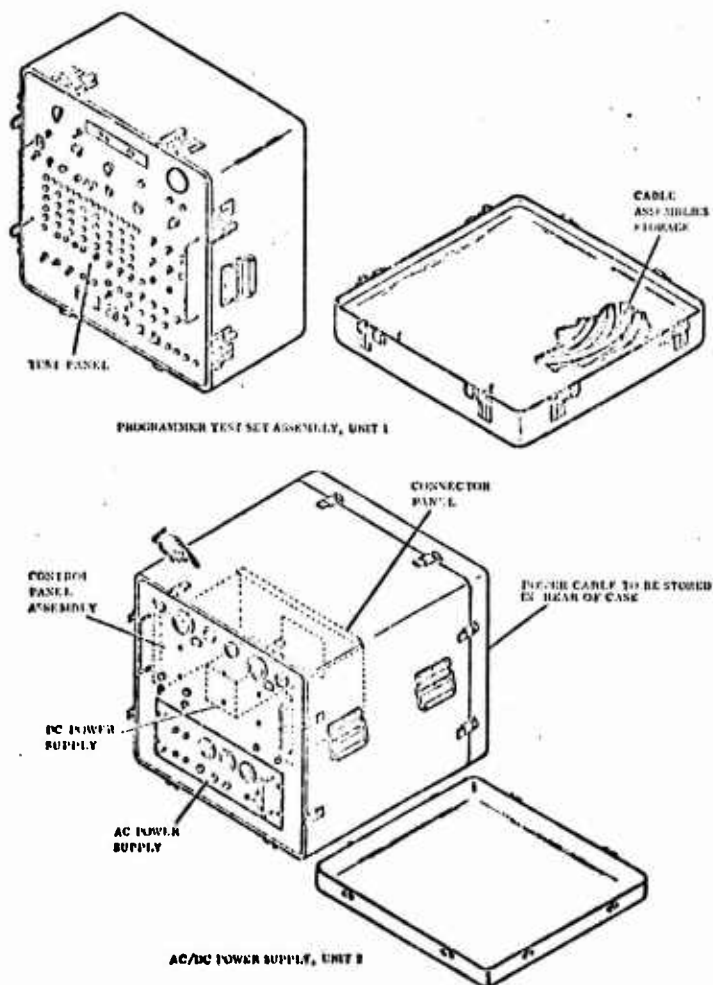
This item was originally procured under the "Big Safari," concept of rapid capability development while avoiding routine procurement channels. Under this plan the original 17 months to develop this item was reduced to 5 months from contract to delivery for the

second lot. The remaining lots averaged 9 months from contract to delivery. In all a total of eight are in the Air Force inventory at a most recent unit cost of \$16,500. Technical order T.O.-33D3-G152-2 was acquired for support of this item.

This item is one of the two combined to form Case Study 12 for the Combat Angel Update program. This item is listed by part number as existing peculiar AGE in Appendix II of the general AGE specification dated May 20, 1974 of that program. Eight modifications are listed in this document for inclusion with the new program. In fact, in the contractor's numbering system the dash 45 after this part number indicates that there have been 22 modifications prior to these 8.

This item is not contained in MIL-HDBK-300D although it should be both on financial and procurement bases. It is, however, listed as a master item with one alternate in the D097 Interchangeability and Substitution System.

This case study illustrates that contractors can continuously modify their equipment over long periods to maintain capabilities required. The principal requirement is knowledge of the technical characteristics of the equipment. This is achieved best when the contractor uses his own previous equipment. MIL-HDBK-300D failed to achieve this goal even with 9 years of item use.



CASE 19 - PROGRAMMER BENCH TEST SET

CASE 20 - HEADS-UP DISPLAY TEST SET

Defense System:	A-10
Type:	Complex Manual Test Equipment
Functional Area:	Displays
Level of Use:	Intermediate and Depot
Method of Procurement:	CFE

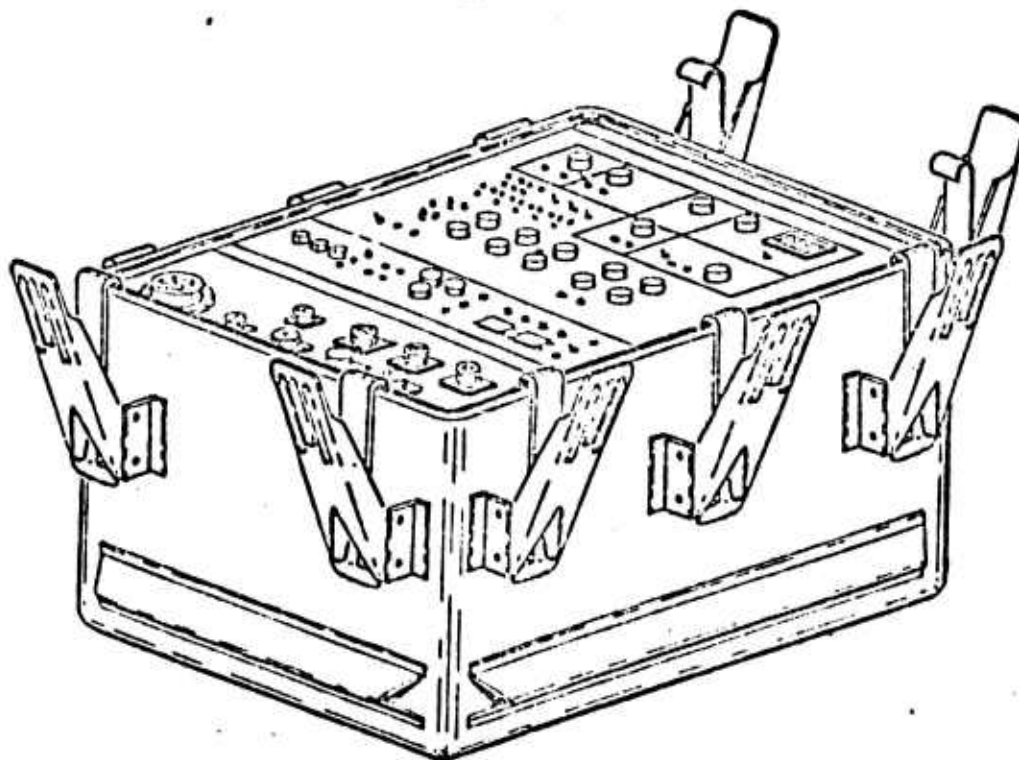
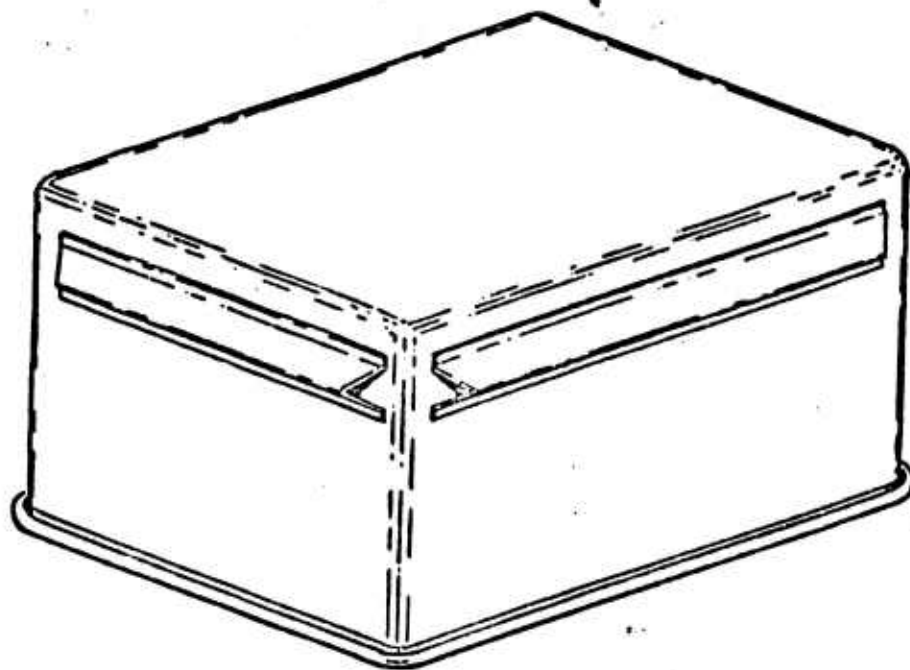
This item began as AGERD 87 but a change of subcontractor led to the present version submitted as AGERD 233 of the A-10 program. The purpose of this manual test set is to test and repair the individual LRUs of the Heads-up Display System or the entire system at either the intermediate or depot level.

This item was identified in the AGE Plan as CFE. The original AGERD 87 was submitted on April 15, 1974, approved by the Depot Provisioning Committee without comment on June 6, 1974, and by the SPO on August 7, 1974. This AGERD contained a unit cost estimate of \$49,030, a development cost estimate of \$67,210, a need date of November 1974, a recommended quantity of 29, but no data on potential common items investigated.

Subsequent problems in development and associated cost increases in the heads-up display unit led to the decision to terminate the original subcontract and subcontract again with a new manufacturer for the airborne and ground support systems. The new manufacturer submitted AGERD 233 on March 21, 1975. The development cost estimate was \$130,909, the unit cost estimate was \$83,915, the quantity recommended remained 29, and the need date was November 1975. This AGERD further stated that the DoD Inventory was screened unsuccessfully for a GFE item to meet the requirement. Six auxiliary items of GFE and two peculiar items required to use this test set are included. Data sources screened were not determined but MIL-HDBK-300D does not contain any heads-up display test sets despite the fact that the DoD has had heads-up displays in aircraft for many years. The A-10 heads-up display is designed for simplicity to reduce cost. Thus cost-effective simplified peculiar support equipment is justified as well. The F-15 heads-up display and 13 other LRUs are tested on an automatic test station costing approximately twenty times as much. The A-7D heads-up display test set cost over three times as much even though procured approximately four years earlier.

The change of subcontractors will cause aircraft to fly without heads-up display systems which was not originally planned. The test set, therefore, will not be needed as early as planned. Nevertheless, no planning was identified to work around this test set if delivery should be later than need.

This case study illustrates the impact of technical problems on support equipment acquisition. Although no comments were made by the system manager or the SPO in approving this item, unforeseen problems caused delivery delay and cost increases in this piece of complex electronic test equipment.



CASE 20 - HEADS-UP DISPLAY TEST SET

CASE 21 - AN/UPM - 137A RADAR TEST SET

Defense System:	A-10, F-15, and AIMS
Type:	Complex Manual Test Equipment
Functional Area:	Identification
Level of Use:	Intermediate and Depot
Method of Procurement:	GFE

This item is NSN 6625-00086-1215, AGERD 1015 of the A-10 program, is contained in AGERD 62 of the F-15 program (see Case 15). It is described by AIMS specification 64-851. The purpose of this item is to simulate inputs and monitor outputs of IFF transponders and interrogators. The AGERDs state that it is made up of 4 modules, the SIF generator, the RF generator, the Interrogator Signal Simulator, and an oscilloscope but the MIL-HDBK-300D description lists a fifth module called the RF module.

The A suffix designates a series of 14 capability improvements in the process of being added to all of the original AN/UPM-137s (NSN 6625-00264-2249). This revision is described in ECP 9 dated April 9, 1971. The revision requires 70 manhours of depot labor and costs approximately \$1000 per item.

This item was originally procured through the Navy procurement office of the tri-service AIMS SPO. 1047 are being procured for the Air Force and 877 for the Navy. The June 30, 1973 DoD AIMS/TRACALS Aerospace Ground Equipment Document No. 123 lists this item as support equipment for 10 prime items and lists 33 items of support equipment required to support it (including Case 49). The production cost estimates for this item shown in this AIMS/TRACALS document range from \$15,000 to \$18,000. The Air Force Management Data List shows a unit price of \$14,930 which was being used by the A-10 system manager.

AGERD 5 Revision A of the AN/APX-83 Interrogator, one of the ten supported equipments mentioned above, was submitted July 22, 1969. This AGERD contained blank unit cost and quantity recommendations and a need date of March 1969, four months before the submission.

This item was contained in the A-10 AGE Plan dated November 1972, the A-10 GFE AGE list (item 247), and the original AGERD 1015 dated June 5, 1973 as the AN/UPM-137 (the unrevised version). The system manager's copy of the original AGERD has penciled in the required A version data, and a reduction of quantity recommended from 54 to 27. This AGERD was approved by the Depot Provisioning Committee on June 22, 1973 and by the SPO on September 12, 1973 both without comment. Revision A was submitted April 15, 1975 adding only the dimensions of the item and retaining the non-A revision configuration. The SPO approved revision A on August 6, 1974 with instructions to use the A version, its NSN, and the reduced quantity instructions above. Revision B was submitted by the contractor September 20, 1974. This AGERD contained slightly more descriptive information, the addition of an associated test set (AGERD 1011) and for the first time the A version. However, a mistake was made in the NSN on the figure 1B. The quantity recommended remained 54. Revision C was submitted February 20, 1975 although only one page of it was found by LMI. In this revision the associated item had changed from a common to a peculiar item.

The non-A version of this item is contained in MIL-HDBK-300D dated April 1, 1971 (8 days before the ECP for the A version). The A version is not in MIL-HDBK-300D. San Antonio ALC MMSS informed LMI that an entry had been ordered through the A-10 program, however, through the revision A approval, this order had not reached the ASD Form 0-169 directing the contractor to prepare an entry. The prime contractor stated that he learned of the A version through telephone contact with the manufacturer.

Prime items tested by this item are currently experiencing reduced range of identification capability due to lack of calibration equipment. Calibration equipment was identified as required as early as the 1969 AIMS AGERD. A peak power source and meter are required for this and several other items which the Air Force has been unable to procure for over two years. The first procurement ended with the bankruptcy of the contractor. The second procurement was overturned by a successful protest of the award. The third award appears to be successful with deliveries planned for mid-1975.

Radar Test Set is item name code 03661 of the Defense Integrated Data System contained in Federal Item Identification Guide T228 scheduled for implementation in December 1975. Thus in the future further means will be available to the Air Force to identify this item.

This case study illustrates several points. The AGE Illustration did not reach MIL-HDBK-300D until 19 months after the Air Force needed the item. Furthermore a major revision is not noted in MIL-HDBK-300D to this day, even though the revision is four years old. The data was available from several sources but not communicated to several others. Undue numbers of AGERDs were submitted with minor revisions which had to traverse the entire AGERD flow process. This required manpower that was better spent elsewhere. Finally, the Air Force's failure to obtain calibration equipment cannot be traced to policy and procedure problems. Rather it rests with the Air Force's acceptance of excess risk in procurement.

CASE 22 - SIMULATOR-VERIFIER, DRC SIMULATOR

Defense System:	DSP - Satellite Readout System
Type:	Electronic Signal Simulator
Functional Area:	Communication
Level of Use:	Intermediate
Method of Procurement:	CFE

This item is AGERD B290, NSN 1830-00006-5336 and Philco-Ford Western Division Laboratories part number 99-229974-01. The purpose of this item is to simulate signals required to verify the functions of the Communications Buffer Interface Unit.

The requirement for this item can be traced to the AGE Plan dated December 18, 1970 which listed this item in section 3.3.4.3 Data Handling Subsystem under the title, "Command simulator," as one of 16 items required at the intermediate level. The contractor stated that this item was required to meet availability requirements since other means of testing took excessive amounts of time.

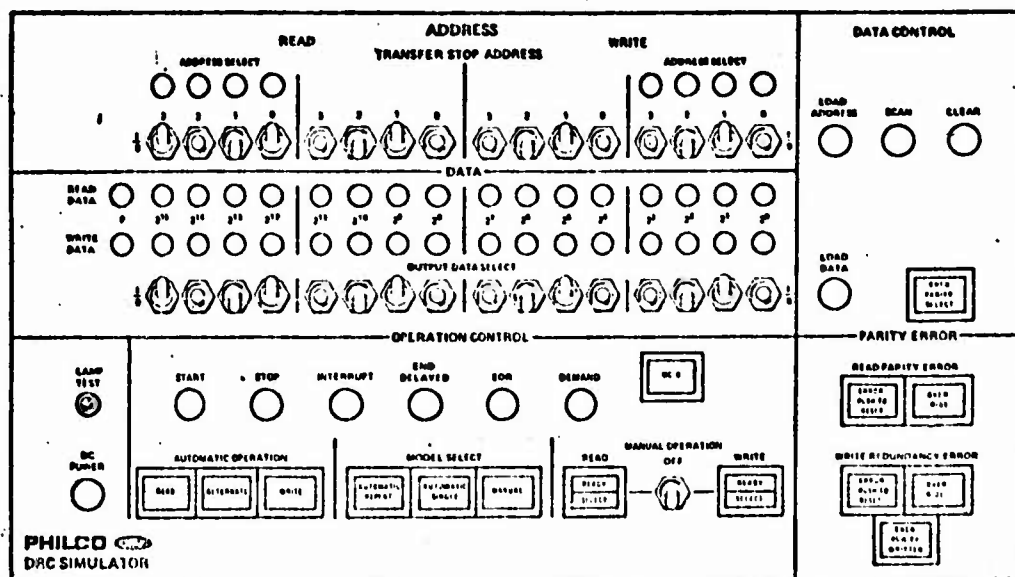
The original AGERD was submitted over a year after the AGE Plan on April 19, 1972 under the same contract number. The functional analysis and recommended solution were excellent. The need date, total cost, and proposed source were blank. The development cost and unit cost were both \$10,000, and a quantity of one was recommended. This item was identified as procurement critical to the Air Force. Penciled in on the system manager's copy was a quantity of two and the FSC 1830 and MMC VE. This AGERD was approved August 25, 1972.

Revision A of this AGERD was submitted September 11, 1972. This AGERD contained the need date August 15, 1972, ten days before the approval of the original AGERD. The contractor stated that the Air Force planned to accomplish this requirement through other means and so gave them development go ahead only after the need date. The quantity recommendation of two was included on this AGERD but the FSC and MMC were not. The development cost was not added into the total cost, the proposed source was GFE, and a note had been added stating ERRC NF2. The GFE source was because the contract did not include AGE items even though all were eventually included as supplementary items. Handwritten notes on both AGERDs requested Recoverable Item Breakdowns.

Initial delivery was made of a production line simulator with single channel capability. The Air Force subsequently decided dual channel capability was required to meet availability requirements and directed the contractor to develop this further capability. This modification was accomplished using a separate set of data submittals without AGERDs. The first dual channel simulator was delivered in late-1973. Three are presently in service. The total cost was approximately \$177,000. No other modifications were required, however, subsequent uses have required changes in the interfaces between this item and the prime equipment.

This item is not contained in MIL-HDBK-300D or the D097 system. In fact, no items of FSC 1830 Space Vehicle Remote Control Systems are in MIL-HDBK-300D at all.

This case study illustrates how an item can be forced into being late by delay in the decision to use the maintenance method that requires it. No procedural change could have improved the delivery performance unless this decision would have been reversed. No documentation could be found to support the requirement for this item to meet availability requirements. Nor were single or dual channel alternatives mentioned in the AGE Plan or the AGERDs.



CASE 22 - SIMULATOR-VERIFIER, DRC SIMULATOR

CASE 23 - UHF RECEIVER TRANSMITTER TEST SET

Defense System:	AF Satellite Communications
Type:	Complex Manual Test Equipment
Functional Area:	Communications
Level of Use:	Intermediate and Depot
Method of Procurement:	CFE

This item is AGERD 1, preliminary stock number 6625-ND433-469P, and Collins Radio part number 622-1636-001. Its purpose is to test and fault isolate failures in approximately 18 items of the Receiver-Transmitter Group.

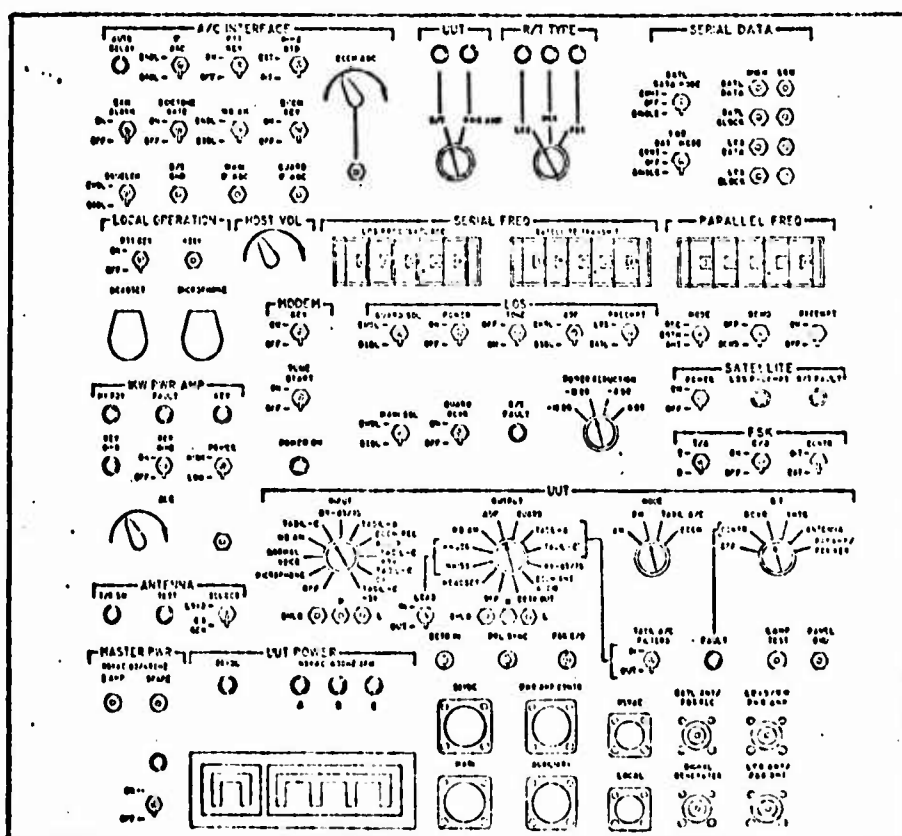
The requirement for this item can be found in the AGE Plan revision C dated May 31, 1974 paragraph 3.5.1.2, which included the AGERD number and part number and 14 prime items identified as tested. The original AGERD was submitted August 24, 1973. The requirement for this item was approved September 24, 1973 and design concurrence was given March 21, 1974. Revision B of this AGERD was submitted September 30, 1974.

This AGERD was quite extensive including 24 pages. The reason for revision could not be determined. However, the page numbering indicated one page with 12 dash numbered pages containing details of design features and another with 4 dash numbered pages containing schematic diagrams. The above AGE Plan paragraph was referenced. This AGERD further stated that more detailed data was contained in C.I. Specification 5973615001. Two lists of equipments tested are in this AGERD. The first lists 18 items, the second 19 with two changes, one of which is apparently a typographical error. The first list references 3 aircraft models, the second, 4, including the first 3. The illustration contained in this AGERD did not include the dimensions which were contained in the AGE Plan.

The Figure 1B of this AGERD contains blank development and unit costs. The unit cost included in the contractor's ORLA was \$11,336. The need date contained on this AGERD is January 6, 1974, nine months before the submission date. This need was delayed due to schedule slip for other reasons. Only one item was recommended. This is for development testing since no plans for deployment were included on AGERDs in this program. The AGERD states that MIL-HDBK-300 was screened.

This item completed its compatibility testing seven months after the original stated need date on August 15, 1974. It was estimated to be delivered February 23, 1975.

This case study illustrates how original need dates could not be met due to the time required to process approval and the development time required thereafter. Delay in the schedule for other reasons, however, relieved most of the impact that would have been felt. This occurred despite the fact that requirement approval came only one month after initial AGERD submission.



CASE 23 - UHF RECEIVER TRANSMITTER TEST SET

CASE 24 - 1 KILOWATT RADIO FREQUENCY AMPLIFIER

Defense System:	AF Satellite Communications
Type:	Electrical
Functional Area:	Communications
Level of Use:	Depot
Method of Procurement:	CFE

This item is AGERD 97, and Collins Radio part number 622-1569-001. It is a piece of prime equipment as well as support equipment which was planned to be used as a hot mock-up at the depot. Its purpose was to provide power and stimuli for testing failed cards under load.

Evidence of this item can be found in the AGE Plan Revision C dated May 31, 1974 but it has been struck out as deleted by that date. Four articles were identified for Phase I as prime equipments in this AGE Plan. The original AGERD was submitted October 31, 1973 and approved December 12, 1973. The functional analysis and recommended solution of this AGERD contained no quantitative data. The figure 1B contained blank development cost and match code blocks. The unit cost estimate was \$9,750 and the need date was May 1, 1974. The contractor's ORLA used a unit cost estimate of \$12,532.

No documentation could be found of the original decision to use a hot mock-up to repair this item. ORLA performed by the contractor resulted in an optimum policy of discard of the defective modules. Therefore the requirement for this item ceased to exist. This ORLA is being redone and coordinated with using commands and the final determination may be different. However, this item is currently not planned for use. AGERD revision A dated September 30, 1974 deleted this item. Since this is also a prime item, development funds have not been expended meaninglessly.

This case study illustrates the importance of the ORLA study to support equipment. The need for this item remains in the process of being determined fully a year-and-a-half after initial acceptance of the AGERD. Over 30% of the support equipment items on this program were similarly deleted. Early accurate decisions from these studies would aid on-time delivery of these support equipment items.

CASE 25 - SAT. COMM. CONTROL

Defense System:	AF Satellite Communications
Type:	Electrical
Functional Area:	Communications
Level of Use:	Intermediate and Depot
Method of Procurement:	CFE

This item is AGERD 120 and Collins Radio part number 622-3267-002. It is a prime item used as a hot mock-up for testing. Its purpose is to provide at the depot level, voltages, loading, timing, and mode controls to failed units in order to fault isolate the removable assembly. At the intermediate level it provides a means to assure operability of removable assemblies received through the spares pipeline.

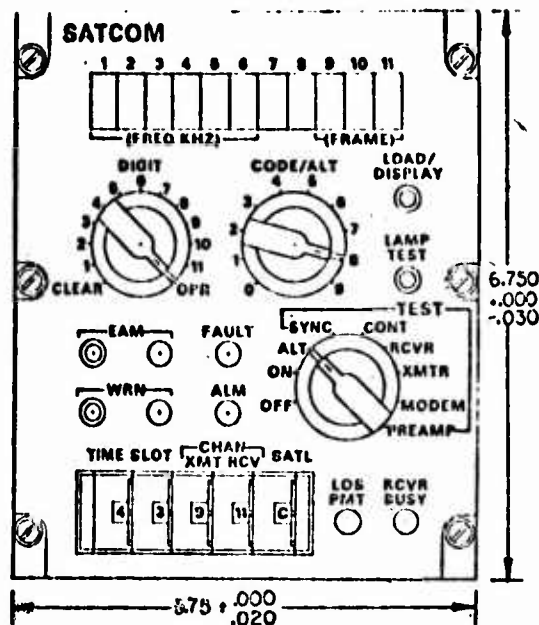
This item is listed as both a prime item and a support equipment item in the AGE matrix of the AGE Plan Revision C dated May 31, 1974 but is not described in the text. Seven other items are checked as used to test this item. No documentation could be found to support the use of a hot mock-up.

The original AGERD was submitted March 1, 1974. No quantitative technical data was given, however, since this was a prime item and the use of extender cards was identified, a search for existing item would have been unreasonable.

The figure 1B of this AGERD contained blank development and unit cost estimate blocks. Penciled in on the SPO copy was the unit cost estimate \$12,000. The contractor's ORLA used a unit cost estimate of \$3,000. The need date given was December 1, 1974. This AGERD was approved May 1, 1974.

The completion of the contractor's ORLA led to cancellation of this item. The depot level of repair was found to be optimum for all cards contained in this item. Therefore, no intermediate requirement remained. SPO personnel stated that another test set would be able to meet the requirement at the depot. This test set was one of the other seven items identified in the AGE Plan as required. The establishment of need for this item originally, therefore, seems suspect. On September 30, 1974 Revision A of this AGERD was submitted deleting the item. Final resolution of the need for this item is awaiting coordination of final level of repair plans with using commands.

This case study illustrates the impact ORLA can have on support equipment. Since this item was also prime equipment no development expenditures were risked. However, earlier resolution of the level of repair even with the inaccurate cost estimates observed would enhance early Air Force support posture.



CASE 25 - SAT. COMM. CONTROL

CASE 26 - MESSAGE PROCESSOR TEST SET

Defense System:	AF Satellite Communications
Type:	Complex Manual Test Equipment
Functional Area:	Communications
Level of Use:	Depot
Method of Procurement:	CFE

This item is AGERD 22, preliminary NSN 6625-ND433-762P, and Collins Radio part number 622-1642-001. Its purpose is to provide inputs, monitor outputs, and provide controls during depot test, in order to verify operability and fault isolate the Message Processor Unit.

The Message Processor Test Set can be found in the AGE Plan Revision C dated May 31, 1974 section 3.5.23.2 which refers to this item by AGERD number and contractor part number. This section has three subparagraphs describing the operation of different parts of the test set. Seven prime equipments are identified as tested by this test set.

The original AGERD for this item was submitted August 24, 1973 and approved September 24, 1973. Design concurrence was given March 21, 1974. Revision B of this AGERD was submitted September 30, 1974. The reason for revisions A and B could not be determined but two sections of this 17-page AGERD were numbered as dash numbers to other pages. These sections contained details of tests accomplished and drawings of the 10 adapters used with this test set. AGE Plan section 3.5.23.2 is referenced by this AGERD.

The functional analysis and recommended solution contained adequate quantitative technical data for selection of the item. Further details are referred to in C.I. Specification 597-3618-001.

The figure 1B contained blank development and unit cost estimate blocks. The contractor's ORLA used a unit cost of \$59,800 for this item. This is the highest unit cost item contained in the ORLA. The need date contained on this AGERD is December 1, 1974. This item was scheduled for compatibility testing February through April 1975 with delivery scheduled April 24, 1975. This illustrates that even with short processing times for Air Force approval, unexpected delay in engineering design causes support equipment to be late.

CASE 27 - ILS HOT MOCK-UP

Defense System:	AIMS/TRACALS
Type:	Electronic Hot Mock-up
Functional Area:	Landing System
Level of Use:	Depot
Method of Procurement:	CFE

This item is AGERD 169 for the AN/GRN 27(V), NSN 5825-00138-4814ZK, specification number 404L-701-5005, and Texas Instruments part number 911880. It is a hot mock-up of the entire prime system for depot fault isolation and corrective maintenance under simulated operational conditions.

Only revision B of AGERD 169 could be located. The original was approved on May 24, 1971. Revision B was submitted December 14, 1971. The reason for revisions A and B could not be determined. An AGE Plan reference was listed on the revision B AGERD. The functional analysis and recommended solution contained no quantitative data. The existence of no known test equipment capable of satisfying the requirement is noted as is the recommendation of a hot mock-up. No trade-off study could be found documenting the choice of a hot mock-up over use of other test equipment. SPO personnel stated however that they believed the hot mock-up choice saved \$0.5M. Furthermore 59% of the AGERDs submitted for support items for this item were disapproved. This indicates thorough review given support equipment items by this SPO. However, LMI noted that 17 separate AGERD numbers were all for the same oscilloscope and 10 more were for the

same multimeter. These 27 AGERDs were all rejected. In addition 9 items had been added to the list of support equipment items for this item between June 1973 and January 1975.

The figure 1B of this AGERD contained the development cost estimate \$15,000 for those items added for the hot mock-up, and the unit cost estimate of \$150,000. This unit cost estimate also appears in the June 30, 1973 AIMS/TRACAL AGE list. The Air Force Management Data List contains the unit cost \$15,000 which is in error. The need date is June 1971. One article is recommended for depot use and 47 are identified as prime equipments. The item is identified as both procurement and engineering critical.

Since approval took place two months before the need date, it must have been impossible to deliver this article on-time. However, since this is the prime item as well as the support equipment item it had to be delivered with the system it supports. Nevertheless this item was classified as late due to late definition of the requirement since the AGERD was so close to the need date.

CASE 28 - TEST TRANSLATOR

Defense System:	485L
Type:	Complex Manual Test Equipment
Functional Area:	RF Transmission
Level of Use:	Depot
Method of Procurement:	CFE

This item is AGERD 1 of the AN/GSQ-119/120(V) Communication and Radar Data Transfer System procured on contract F19628-71-C-0235. A NSN is yet to be assigned. It is Defense Communication Division of ITT part number 1471394. The purpose of this item is to checkout, and fault isolate subassemblies of the Microwave Radio portion of the prime item.

AGERD 1 is contained in Contract Data Requirements List item A061 AGE Recommendations. This document was originally submitted September 1, 1972, and revised December 8, 1972 and July 30, 1974. The table of contents contains incorrect part numbers for all items in this document. The part number listed incorrectly for this item is 1471384. AGERD 1 is 11 pages long each dated July 30, 1974 but some are numbered original, some revision A, and some revision B. No AGE Plan is referenced. The functional analysis contains extensive technical data about the prime equipment but the relationship to the support equipment is not clear. The recommended solution contains the statement that no known test set meets the required capabilities. However, it is not clear what these required capabilities are from this AGERD. A list of 57 standard electronic items used to test the same prime item is included in the recommended solution. Figure 1A and 1B for each of these follows in the document. AGERD 1 also includes an untitled schematic drawing of the test translator. The figure 1B of AGERD 1 contains blank match code and development cost blocks. The proposed source was CFE.

The need date is July 1, 1975. A date of approval is shown of November 29, 1972. The unit cost is \$20,062. One article for the depot is recommended under organizational requirements but 4 are recommended under total quantity with the note that this is "Per USAF Cat II requirements list." The Federal Stock Number block contains the FSC 6625 and the MMC ZR. As of November 1974 the AGERDs in this document had been rejected in their entirety because of the confusing incoherent presentation.

MIL-HDBK-300D contains no entries under the nomenclatures Test Translator, Translator Test, Translator Test Set, or Test Set Translator.

This case study illustrates an extreme in lack of understanding of how to explain test requirements on AGERDs to permit Air Force evaluation of the requirement and the solution.

CASE 29 - DIGITAL DATA COMPUTER SET

Defense System:	Minuteman III
Type:	Operational Ground Equipment
Functional Area:	Computers
Level of Use:	Organizational
Method of Procurement:	CFE

This item is identified by Minuteman III program Figure A number 400 and is also known as the Weapon System Controller. It is part of the Launch Control Facility Processor, Figure A 14058. Its two components, the processor and memory, are NSNs 1430-00500-6677AH, and 1430-00069-6021AH, respectively. The purpose of this item is to provide the additional data processing capability required by the Command Data Buffer Program to remotely retarget Minuteman III missiles. The unit resides in the Launch Control Facility and is loaded by an operational executive program tape. It performs automatic controlling and monitoring of the launch facilities of interest.

The original requirement document SAMSO Exhibit 68-42 is dated November 1, 1968. The approved version being fielded is the second revision SAMSO Exhibit 68-42B dated March 1, 1970. The Form C detailing further makeup of the system is dated October 14, 1970. The development contract for this item, number FO4701-69-C-0111, was signed April 15, 1969 half-way through the definition process.

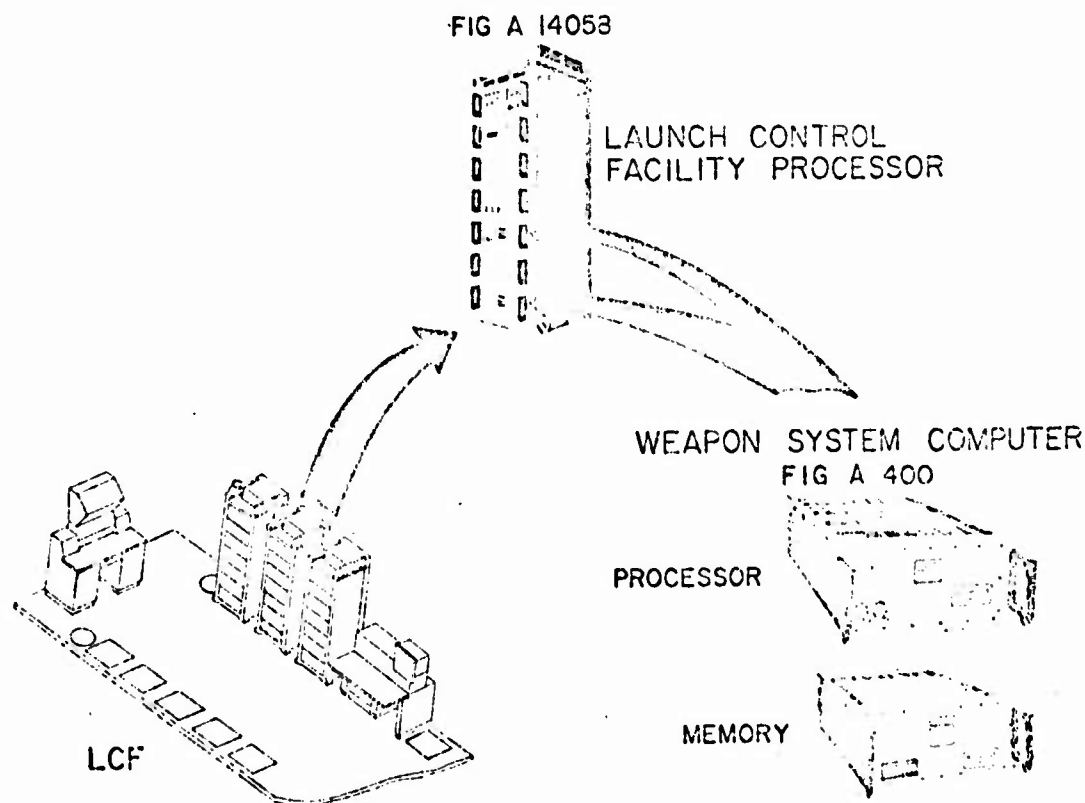
The initial delivery took place simultaneously with Air Force test completion and acceptance on February 28, 1973. This was one month before the Air Force need date of March 30, 1973. The production contract, number FO4701-71-C-0091, had been signed seventeen months earlier on September 1, 1971. These contracts called for a development cost of \$17.3M and a unit cost of \$624,000 with 106 articles procured. Thus Air Force expenditure for this item will be \$83.4M, the largest acquisition cost for one item studied by LMI.

Two trade-off studies were initiated by ECPs 20P and 26 in 1973. The former was a monolithic line driver study which concluded that it would be cost effective to change the type of line driver. The latter was a common force study which concluded it would be cost effective to field identical controllers for the Minuteman AM and B series weapon systems and maintenance support.

There have been 31 proposed ECPs against the delivered system. Four (numbers 4, 14, 18, and 21) were of a minor corrective nature, one (29) was for waived parts and three (20, 26, 30) were directed by the SPO to improve the system capability. The remaining 23 ECPs were paperwork changes or changes to the maintenance equipment.

The most difficult problem encountered by this item is that represented by ECP 30. The area of protected memory reserved for the operational executive program was not as large as desired being restricted by the area required for retargeting computations. This was solved by a new targeting program requiring less memory.

This case illustrates a complex expensive piece of operational ground equipment for which trade studies were accomplished however major change activities occurred. The Air Force successfully acquired this item on time; however, contracts for development and production were signed before the item was fully defined and tested.



CASE 29 - DIGITAL DATA COMPUTER SET

CASE 30 - TOWBAR, NOSE WHEEL, TYPE MD-1

Defense System:	A-10 and F-15
Type:	Handling Equipment
Functional Area:	Airframe
Level of Use:	Organizational
Method of Procurement:	GFE

This item is NSN 1730-00640-8080, AGERD 1141 of the A-10 program and AGERD 173 of the F-15 program. It is a standard Air Force inventory item. There are approximately 811 in service and 49 on order.

The original AGERD for the F-15 was submitted September 17, 1970 and approved by the SPO November 23, 1970. Revision A was submitted October 1, 1973 and approved December 17, 1973. This revision added the system area index for the Attitude and Heading Reference Set. Revision B was submitted November 9, 1974 and added the system area index for the Instrument System-General. The F-15 CAGEL shows 39 recommended and 5 ordered as of November 1974. The basis of issue is 5 per squadron.

The A-10 GFE AGE List includes this as item 2. The A-10 AGE Plan not only includes this item but also described the tension load required to tow the A-10 and the capability of this item. The original A-10 AGERD was submitted June 11, 1974, approved by the Depot Provisioning committee July 29, 1974 and by the SPO October 22, 1975. This AGERD had a blank unit cost estimate, a need date of September 1975 and a quantity recommended of 102. This AGERD did not state the tension load required or the load capability of this item. The SPO approval included identification of a dash-one part number as preferred, but did not include blocks for approved basis of issue for planning purposes which had appeared on all such forms since November 1973. The A-10 GFE AGE List shows two of this item on hand at flight test and a third delivered in May 1975.

The Air Force Management Data List showed a unit cost of \$866.70 for this item, however the item manager identified a more recent unit cost as \$927 including 3% for transportation. This item has been in the inventory since 1959 and at least 5 suppliers have been used. It is a master item in the D097 Interchangeability and Substitution System with 28 alternates listed. A search of this system revealed 15 master item groups including 62 NSNs containing the nomenclature tow bar in Federal Stock Class 1730. Two of these groups contained the nomenclature, "Universal," including the studied item. Only these classes had more than 2 alternates.

This item is not contained in MIL-HDBK-300D although it clearly qualifies on the basis of nearly three quarters of a million dollars invested in it by the Air Force. The contractor stated that he identified this item because of its use on his earlier product, the F-105. Four other aircraft tow bars and one missile tow bar are in MIL-HDBK-300D.

Only one of these four items coincides with the 15 master items in the D097 System. The matching item is not the other universal tow bar. The RPV program list of operational AGE shows two tow bars, one of which is telescoping.

The A-10 program encountered a minor problem with this item when their subcontractor for landing gear delivered unauthorized out of specification axles to which this item could not mate. An adapter was required to be designed which must be carried with or available to the early aircraft until specification axles can be retrofit.

The Defense Integrated Data System was examined to determine if this item would be identifiable in it. Federal Item Identification Guide T286 Towbars and towing equipment is scheduled to be implemented in this system by October 1977. This will contain Item Name Code 17520 "Aircraft Tow Bars." Examination of the required characteristics showed that tension load towable was not included. This finding is supported by the lack of tension load on the Federal Item Logistics Data Record, DD Form 146, for this item. DIDS personnel stated that the tension load could be included under other characteristics.

This case study illustrates that even when the Air Force has done an extensive job of standardizing on an item, a large number of similar items still remain in the inventory. The preferred items must be communicated by word of mouth or contractors prior knowledge since available data systems identified confusing information. AGERDs were procured that did not contain essential technical data even though the data was in the AGE Plan. Two AGERD revisions were submitted for minute reasons. Finally, future data systems will continue to neglect essential data which will necessitate great care in their use.

CASE 31 - AERIAL STORES LIFT TRUCK

Defense System:	A-10
Type:	Material Handling Equipment
Functional Area:	Armament
Level of Use:	Organizational
Method of Procurement:	GFE

This item is NSN 1730-00921-8571 and AGERD 1013 of the A-10 program. It is a standard Air Force inventory item identified also by the designation MJ-4 (MHU-83/E). It was item 26 on the A-10 GFE AGE list which was initiated before the Validation Phase flyoff. The purpose of this item is to transport and install aerial stores at the organizational level.

This item was listed in the AGE plan as was the MJ-1 Aerial Stores Lift Truck which has approximately half the maximum lift capacity. The MJ-1 is item 87 on the A-10 GFE AGE list. No documentation of why two types were justified could be found. The original AGERD for this item was submitted June 5, 1973. It was approved by the Depot Provisioning Committee on June 22, 1973 and by the SPO September 12, 1973, both

without comment. Revision A of this AGERD was submitted by the contractor April 15, 1974. The only difference between this revised AGERD and the original was the addition of a note that an additional item was interchangeable with two out of 17 adapters used with the item, and the addition of the item size, weight, and volume. All 18 adapters are contained in the A-10 GFE AGE list. The revised AGERD failed to incorporate the NSN of the preferred master item in the D097 Interchangeability and Substitution Data System, which had been penciled in on the system manager's copy of the original AGERD. The master NSN had been incorporated however, in the June 1974 revision of the A-10 GFE AGE list as an alternate. Both AGERDs contained blank unit cost estimates, quantity of 170 recommended, and need dates of September 1975.

The unit cost in the Air Force Management Data List is \$12,315. The original AGERD was screened by San Antonio ALC/MMSS and no AGE Illustration was requested even though neither this item nor the preferred item is contained in MIL-HDBK-300D. The June 15, 1974 A-10 GFE AGE List for DT&E showed this item as undelivered to flight test although needed in March 1974. SPO personnel stated that the August 1974 A-10 AGE LIST showed this item delivered on time.

The case study illustrates that AGERD revisions are often submitted for little reason, and that MIL-HDBK-300D does not contain all the items available to be used as standard support equipment.

CASE 32 - HIGH VOLTAGE PROBE

Defense System:	DSP-User Display System
Type:	Simple Electrical
Functional Area:	Displays
Level of Use:	Organizational/Intermediate
Method of Procurement:	CFE

This item is AGERD 037 and Computer Power Systems Inc. part number HVP-250. Its function is to extend the range of instruments to extremely high voltages so such voltages can be measured during maintenance of the Large Screen Color Display. At the time of this study this probe had not been stock numbered.

The requirement for a high voltage probe with the User Display System can be found in the AGE Plan dated May 24, 1971, paragraph 3.2.3.34.2 Electronic Power Supplies MGE. No data beyond the statement of need for this and 5 other items is contained in this paragraph. The original AGERD for this item was not submitted until 3 years later on June 3, 1974, and under a different contract number from the AGE Plan. This AGERD contained the quantitative functional data that 50 Kilovolts + 1 Kilovolt had to be measured and was designated as procurement critical for the Air Force. It referenced section 3.2.3 of the AGE Plan which is 34 pages long. It did not include the remaining paragraph designators 34.2. The functional analysis stated this item was for organizational maintenance; however, figure 1B recommends one for intermediate use and none for

organizational use. The above described commercial off-the-shelf item was recommended but the proposed source was designated as GFE and a development cost estimate of \$210 was included. No explanation was given of what was being developed. The contractor stated the GFE listing was because AGE items were not at that time included in the contract, although they were all added as supplementary agreements later. The unit cost estimate was \$550, and the need date was July 1, 1975. Penciled in on the system manager's copy of the figure 1B was the recommendation of an existing inventory item including the NSN, contractor, and part number.

In a letter dated September 26, 1974 the contractor stated that the Air Force recommended item has a maximum voltage range of 30-Kilovolts and therefore could not meet the test requirement of 50 Kilovolts. This letter confirmed telephone directions to leave the item as originally recommended.

The next day, September 27, 1974, Revision A of this AGERD was submitted. The only differences in this submission were, deletion of the prescreening match code H, shortening of the description of the multimeter used with this item, and change of initials in the designation of the prime item from DDS to PDS. As of March 1975 this item had not been delivered to the 2044th Communication Group maintaining the system at the Pentagon.

This case study illustrates the conflicting data and long delays that can be associated with AGERD submissions. Further the lack of an Air Force data base to assess the capability of inventory items and compare to the stated requirements delayed approval slightly.

CASE 33 - VECTORSCOPE

Defense System:	DSP-User Display System
Type:	Electrical Instrument
Functional Area:	Displays
Levels of Use:	Intermediate
Method of Procurement:	GFE

This item is AGERD 024, NSN 6625-00390-3843 and Tektronix part number 520A. Its purpose is to display for analysis, the color video composite signal during maintenance of the Television Encoder.

The requirement for a vectorscope can be identified as early as the May 24, 1971 AGE Plan section 3.3.4. This section contains no data, only the statement of need for a vectorscope and 22 other items for intermediate maintenance. The original AGERD for this item was submitted 3 years later on June 3, 1974 under a different contract number from the AGE Plan. The NSN in this AGERD was for the original (part number 520NTSC) version of this item. AGE Plan section 3.3.2 was referenced which contains the concepts for this item rather than the specific requirement. Although the source was GFE, a

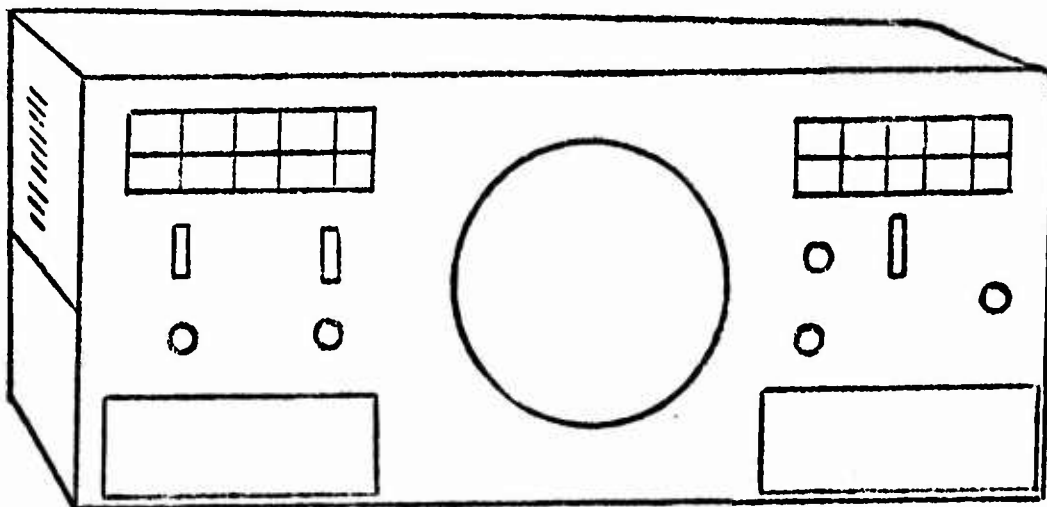
development cost of \$1,015 was included on this AGERD. The unit cost estimate was \$3,025, the item was identified as procurement critical for the Air Force, the need date was July 1975 and a quantity of 2 was recommended.

Penciled in on the system manager's copy was the recommendation to use the A version with its preliminary NSN, 6625-NC605177P and an estimated delivery date of December 1974. The contractor did not recognize this number as a standard Air Force preliminary numbering system assigned at the beginning of the NSN process. In a letter dated September 26, 1974 he stated the NSN he had located for the item did not agree. In fact he had identified the result of the stock numbering process. If the Air Force could have identified the final stock number or the contractor known of the NC numbering system this misunderstanding would have been avoided. The Air Force also numbers items ND when they are in use for research and development only. Conflicting descriptions of these numbering systems were given by Air Force personnel to LMI during the course of the study. A revised AGERD containing the 520A NSN was submitted September 27, 1974. The only other changes contained on this AGERD were the match code had changed from J to H, the last digit was omitted from the Federal Manufacturers Code, and the initials designating the prime system changed from DDS to PDS. This item had been delivered and was in use by the 2044th Communication Group in March 1975. They listed the unit cost as \$2236.

The original 520NTSC item is contained in MIL-HDBK-300D dated November 15, 1973. The 520A is listed as a master item in the DO97 Interchangeability and Substitution System with the 520NTSC as an alternate. Therefore even though the contractor used the data source provided for common AGE he did not follow up to find the master item. Further the Air Force did not identify the final stock number even though it was in one of their systems.

No item name code for vectorscope could be found in the Defense Integrated Data System.

This case study illustrates the number of data systems and numbering systems that must be coordinated to locate and procure the item desired by the Air Force. Even though technical data was adequate, management data created difficulty.



CASE 33 - VECTORSCOPE

CASE 34 - NETWORK ANALYZER

Defense System:	DSP Satellite Readout System
Type:	Electrical Instrument
Functional Area:	Antenna
Level of Use:	Intermediate
Method of Procurement:	GFE

This item is AGERD BO74, NSN 6625-00351-0031YA, and Hewlett-Packard part number 8410A. The purpose of this item is to fault isolate in the Antenna subsystem to restore operational capability upon failure.

The original AGERD could not be located. Revision A of this AGERD is dated April 30, 1971 on figure 1A and May 28, 1971 on figure 1B. This AGERD referenced the Satellite Readout System AGE Plan dated Dec 18, 1970, section 3.3.4.1. However no network analyzer is listed among the 31 items of Antenna Subsystem support equipment listed in this paragraph. This AGERD and AGE Plan were both submitted under the same contract number FO4701-69-C-0331. The reason a revised AGERD was submitted could not be determined. The functional analysis contains three detailed quantitative technical requirements none of which are specifically reproduced in the characteristics contained in the recommended solution. Neither is the statement made that the recommended equipment can fulfill the specifications. The item is identified as procurement critical for the Air Force. The unit cost estimate is \$1800, two are recommended, and the need date is July 15, 1971. The proposed source is blank however the SPO is identified as the responsible agency. The SPO reported that all items in this class were delivered on time.

This item is not listed in either MIL-HDBK-300D or the DO97 Interchangeability and Substitution System. The Air Force Management Data List shows a unit cost of \$2295. MIL-HDBK-300D does not list a single network analyzer. However several similar nomenclatures such as signal analyzer and spectrum analyzer show numerous entries.

This case study illustrates the confusing data that the Air Force must deal with to determine need and preferred solutions for support equipment recommendations.

CASE 35 - PULSE GENERATOR

Defense System:	DSP-Ground Comm. Network
Type:	Simple Electrical
Functional Area:	Communications
Level of Use:	Organizational
Method of Procurement:	GFE

This item is AGERD BO44, NSN 6625-00113-6353YA, and Data Pulse Inc. part number 110B. The purpose of this item is to simulate wavetrains at the input of the Error Detection Unit during corrective and scheduled maintenance.

The requirement for this item can be traced to the AGE Plan dated Dec 18, 1970 section 3.2.3.2.3.2 Required MGE. The original AGERD could not be located. Revision A is dated April 30, 1971 on the figure 1A and May 28, 1971 on the figure 1B. This AGERD referenced AGE Plan section 3.2.3.2.3.1 Maintenance Requirements. The functional analysis is marginal. It contains quantitative technical requirements but does not state clearly their relationship to the support equipment. The recommended solution also contains quantitative data which overlap those of the functional analysis. This AGERD does not state that the item will meet the requirement, nor cover all the data in the functional analysis. This item is identified as critical for Air Force procurement. The need date is July 15, 1971 and the unit cost estimate is \$1250. A total quantity of 7 is recommended of which 4 are recommended for procurement by this AGERD with the remainder deferred. Penciled in on the system manager's copy of this AGERD is a quantity recommendation of 9 and then a further adjustment to 14. This item was delivered on time to meet the Air Force need.

This item is contained in MIL-HDBK-300D dated November 15, 1973. Nineteen other pulse generators are also listed. The DO97 Interchangability & Substitution System lists this item as a master item with four alternates. The Air Force Management Data List shows a unit cost for this item \$948.60. Therefore, it seems reasonable to conclude that while MIL-HDBK-300D was processing in this item the unit cost dropped below the qualifying level.

This case study illustrates several Air Force systems working properly. The AGE Plan and AGERD lead to on-time delivery. The data on this item was entered in Air Force data systems. The price has reduced over a period of years. There was no documented data, however, on which of the numerous pulse generators in the Air Force inventory is preferred for reuse.

CASE 36 - OSCILLOSCOPE

Defense System:	AF Satellite Communications and A-10
Type:	Electrical Instrument
Functional Area:	Communications
Level of Use:	Intermediate and Depot
Method of Procurement:	GFE

This item is NSN 6625-00892-5251, and is covered by Military Specification MIL-0-9960C. It is AGERD 46 of the Air Force Satellite Communication System and item no. 511 of the A-10 Program. Its purpose is to visually monitor electrical signals in order to check out and fault isolate approximately 45 prime equipments of the Air Force Satellite Communications System. This item and case 37 were chosen because oscilloscopes are known to be required universally throughout the Air Force including all 8 defense systems chosen for study. Numerous oscilloscopes were known to be in the Air Force inventory. Therefore these two oscilloscopes were selected for study to assess the support equipment acquisition process as it relates to this type of item.

The requirement for this item can be found in the AF Satellite Communications AGE Plan revision C dated May 31, 1974. Numerous sections refer to this item both by AGERD number and by military specification number. The matrix of support equipment items in this document identifies 47 prime equipments on which this oscilloscope is used.

The original AGERD for this item was submitted Oct 31, 1973 and the requirement was approved Dec 11, 1973. Revision A of this AGERD was submitted Sept 30, 1974 although the figure 1A was undated. AGE Plan section 3.5.1.9 was referenced as the first of its numerous entries. The functional analysis addressed three areas. Two of these contained quantitative data. The recommended solution listed numerous quantitative characteristics of this item. These characteristics covered all but the frequency range requirement on which it said nothing. The remainder of the recommended solution contained a list of 41 prime equipments on which this item is used. Two other AGERDs used with this item are listed. All the items shown in the AGE Plan used with this item, however, are not listed. The latter two lists seem to be the reason for the revision since they are on dashed page numbers.

The figure 1B includes a need data of Jan 6, 1975, and a unit cost of \$2500. This is one of the two GFE AGERDs with a unit cost estimate encountered in the entire study. The ORLA used the same unit cost but the Air Force Management Data List showed a unit cost of \$1036. A quantity of one is recommended for development test. This item was delivered on time to the Air Force Sat. Comm. program.

The A-10 GFE AGE list shows the requirement for this item was met on time by use of an alternate item. It also shows a calibration period which is not noted in the AGERD above.

The AF Satellite Communications AGERD stated that MIL-HDBK-300 had been screened. This item is not listed in MIL-HDBK-300D although 33 other oscilloscopes are listed under the nomenclature, "Scope." This item is contained in the DO97 Interchangeability and Substitution System as a master item with 6 alternates. In fact a search of the DO97 System revealed 25 oscilloscopes that are master items in FSC 6625. Further the Index of Military Specifications lists 18 specifications for oscilloscopes beginning with MIL-0-9960C. Within the 8 defense systems studies at least 19 types of oscilloscopes can be identified without exhaustive search.

A further means of identifying oscilloscopes in the DoD inventory will be the Defense Integrated Data System. Oscilloscope is item name code 00357 included in Federal Item Identification Guide T320 scheduled for implementation in July 1975. This item itself is included in the DIDS. The DD form 146 Federal Item Logistics Data Record lists 34 characteristics of this oscilloscope. These will be retrievable by the system automatically.

San Antonio ALC/MMD related efforts in the past to reduce the number of oscilloscopes in the Air Force inventory, ultimately to six. Unfortunately no knowledge of this program was found in the offices identifying oscilloscopes in the defense systems studied. Even when Air Force preference has been established, therefore, the promulgation of this preference is difficult to establish because of the size and geographic remoteness of the offices involved.

CASE 37 - OSCILLOSCOPE

Defense System:	485L
Type:	Electrical Instrument
Functional Area:	Command and Control
Level of Use:	Organizational, Intermediate, and Depot
Method of Procurement:	GFE

This item was originally submitted as AGERD 1040 but resubmitted as AGERD 7 for the TACC Auto project. It is NSN 6625-00167-9863, and Tektronix Inc. part number 454. The purpose of this item is to display electrical signals in order to checkout and fault isolate the units under test. It was selected for study for comparison to case 36, which contains all data located about oscilloscopes in general in the Air Force inventory and will not be repeated here.

AGERD 7 revision A figure 1A is dated January 25, 1974 but figure 1B is dated Feb. 8, 1974. No AGE Plan is referenced. The functional analysis contains the requirement for a dual trace, portable unit to display signals up to 20 MHz with a variable sweep delay of unspecified amount. The recommended solution contains the technical capabilities of the item which meet all requirements. In addition input requirements and associated equipment are listed. The figure 1B contains blank match code, need date, and unit cost blocks. Thirty-six articles are recommended at all three levels of use. The

AGERD notes that MIL-HDBK 300 has been screened. The system manager's copy contains the pencil notation, "Inventory Item, 6625-170-5896, NB-2, \$1955," but does not state whether this is an alternate or a replacement.

Both these items are contained in MIL-HDBK-300D and in the DO97 system. The noted item is the master item and the case study item is one of its alternates. The entry of the noted item in MIL-HDBK-300D, however, is dated only 40 days before the submission of the revision A AGERD. The Air Force Management Data List shows a unit price for the case study item of \$2754. Therefore, the master item will save approximately \$800 per item. In Jan. 1975 approval of this item was being held pending resolution of Case 9.

This case study illustrates the lack of communication of preferred items for reuse to the personnel making support equipment recommendations.

CASE 38 - ATTENUATOR

Defense System:	AF Satellite Communications
Type:	Simple Electrical
Functional Area:	Communications
Level of Use:	Intermediate and Depot
Method of Procurement:	GFE

This item is AGERD 56, NSN 6625-00888-8714, and Joint Electronics Part Designation System number CN-1239/U. The purpose of this item is to simulate the load of the antenna for tests on the Receiver-Transmitter Group.

The requirement for this item can be found in the AGE Plan Revision C dated May 31, 1974 in section 3.51.15 which refers to both the AGERD and part numbers above. Eight prime items are identified which use this item for test.

The original AGERD for this item was submitted Oct 31, 1973 and approved Dec 11, 1973. Revision A was submitted Sept 30, 1974 although the first page was undated. AGE Plan section 3.5.1.15 was referenced. The reason for the revision appeared to be the inclusion of a list of the items which use this attenuator. The functional analysis and recommended solutions were excellent. The figure 1B of this AGERD contained the unit cost estimate of \$12. This cost is in agreement with the Air Force Management Data List and the contractor's ORLA. It is one of two AGERDs for a GFE item found in the entire study which contained a cost estimate. The need date shown was Jan 6, 1975. As of late January this item had not been delivered due to lack of available assets and insufficient time for additional procurement. The need had been delayed, however, due to schedule slippage for unrelated reasons.

This case study illustrates that even with over a year from approval to need the Air Force has difficulty delivering some simple low cost items due to lack of time for procurement or lack of priority to obtain as asset in use.

CASE 39 - BOLOMETER

Defense System:	AIMS
Type:	Simple Electronic
Functional Area:	Antenna
Level of Use:	Intermediate
Method of Procurement:	GFE

This item is AGERD 191 of the AN/GRN-27(V), NSN 6625-00710-7270, and Narda Inc. Model 560B. Its purpose is to be inserted into the antenna waveguide to provide a means of measuring the power of radiated signals in conjunction with a Standing Wave Ratio Meter. A bolometer is also called a Barretter or Thermister Mount. Bolometers are standard items used in radio frequency measuring. This item was selected to illustrate the Air Force support equipment acquisition process as it relates to such items.

The original AGERD for this item was submitted Dec 14, 1971. Reference was made to the AGE Plan for the AN/GRN-27(V) paragraph 3.3.2.2. The functional analysis contains some technical data but its relation to the bolometer is not clear. The frequency range of signals to be measured is not included. The recommended solution stated only that a bolometer should be used with the Standing Wave Ratio meter. Identification of the item is left to the item name block and the figure 1B data.

The figure 1B contains blank match code and need date blocks. The unit cost estimate is \$75. The Air Force Management Data List shows a unit cost of \$77. Forty-six articles are recommended on this AGERD, however, SPO personnel stated that 134 were procured. The NSN submitted on this AGERD was 6625-00838-9438. However, this number is struck out and the number above, which also appears in the AIMS AGE document of June 30, 1973, is pencilled in.

Several other Bolometers and Thermister Mounts were found in the Air Force inventory. The A-10 uses NSN 6625-00580-0772. The Air Force Satellite Communications System uses the Hewlett-Packard HP 478A. The case study item and at least two other bolometers can be found in T.O. 33K-1-101 Calibration Standards and Associated Equipment dated August 15, 1973. This is the standard reference for inventory calibration equipment used by the Air Force Guidance and Metrology Center. This document lists the frequency range of this bolometer as 20-1500 MHz, and five other quantitative technical characteristics of this unit. Nowhere was there found an identification of bolometers preferred for use in the Air Force inventory arranged by technical parameter for selection by new defense systems.

This case study illustrates the lack of technical information submitted on small GFE items, and the lack of feedback of favorable field experience to SPOs procuring documented new items.

CASE 40 - SPECTRUM ANALYZER

Defense System:	AIMS
Type:	Electronic Instrument
Functional Area:	Support Equipment for Support Equipment
Level of Use:	Intermediate and Depot
Method of Procurement:	GFE

This item is AGERD 38 for the AN/UPM-137 Radar Test Set, NSN 6625-00164-6564YA, and Hewlett Packard part number HP 1405. Its purpose is to display the spectrum of electrical signals as amplitude versus frequency on a cathode ray tube for analysis.

AGERD 38 could not be located. This item is listed in the AIMS AGE list document number 123 dated June 30, 1973. Two other NSNs are listed with this item which turned out to be plug-in electronic units. Intermediate and depot maintenance are identified and the source is GFE. The Air Force Management Data List shows a unit cost of \$950 for this item, and \$3623 and \$2360 for the plug-in units.

Spectrum Analyzers are a common Air Force inventory item. The item manager identified over 100 types of spectrum analyzers in the Air Force inventory. Some of these are over 25 years old and some have unit costs as high as \$30,000. A typical recent unit price is \$8000. Unit costs of spectrum analyzers have been reduced both by the inclusion of solid state electronics and by competitive procurements by the Air Force. None of these procurements have been on a life cycle basis.

This item is not contained in MIL-HDBK-300D either under the spectrum analyzer NSN or under either plug-in NSN. Seventeen other spectrum analyzers are listed, however, under the nomenclature, "Analyzer, Spectrum." Of these seventeen only seven are listed in the DO97 Interchangeability and Substitution System and none are master items. Only two of these seven have the same master item.

The case study item and the two plug-in units are all in the DO97 system but none are master items. The spectrum analyzer's master item is different from all those described above.

Other defense systems found to be procuring spectrum analyzers include the A-10, RPV, and DSP. None of these were the case study item, or any of the items in MIL-HDBK-300D. One plug-in unit was found in common with the DSP. One of the spectrum analyzers in MIL-HDBK-300D had been submitted for the AN/GRN-27(V) ILS, another prime item of the AIMS/TRACALS program, but had been rejected.

This item has been necessitated by the changes incorporated in ECP 9 which converted the AN/UPM-137 to the AN/UPM-137A (see case study 21). The SPO had avoided the requirement for this item and a white noise generator until that time. Neither item was mentioned, however, in the ECP itself.

This case study illustrates the lack of published feedback of Air Force preferred items based on field experience. The great quantity of spectrum analyzers should be reduced by establishing and proliferating a family of equipments that can handle most requirements. Further this case illustrates the addition of test equipment items by changes to prime equipments.

CASE 41 - VARIABLE CALIBRATED RF ALTERNATOR

Defense System:	AIMS
Type:	Simple Electrical
Functional Area:	Support Equipment for Support Equipment
Level of Use:	Intermediate and Depot
Method of Procurement:	GFE

This item is AGERD 6 for the AN/APM-268A Interrogator Test Set(AN/APX-268A in one listing), NSN 6625-00927-4466, and Weinschell Engineering Company, part number 64A. This article is a laboratory instrument used to simulate attenuation of circuit components in the 0 to 64 DB range over frequencies of DC to 2GHz.

AGERD 6 for this prime item, which was submitted by Hazeltine Co., could not be located. This item is listed, however, in the June 30, 1973 AIMS AGE List, document number 123. Intermediate and depot use are specified. The unit cost listed in \$1950. The GFE source is also noted.

This attenuator is the updated version of the Weinschel Engineering Co. model 64 NSN 6625-00676-3667 which was first produced in 1965. Manufacturer personnel were unable to recall the capability update associated with the model change. The most recent unit price, however, is \$2900 and approximately 900 of the 64A model have been sold to the three services. The Air Force item manager stated that this item was so common that, "Every lab has one." No problems were identified by either manufacturer or Air Force personnel.

This item is listed in MIL-HDBK-300D and is a master item in the D097 Interchangeability and Substitution System with two alternates including the earlier model 64. The entry in MIL-HDBK-300D is dated 1974, nine years after production began on this item. The Air Force Management Data List showed a unit cost of \$1956. The NSN could not be found, however, in the tri-service Master Cross Reference List nor in T.O. 33K-1-101 Calibration Standards and Associated Equipment.

This case study illustrates a successful item of commercial-off-the-shelf test equipment. It was listed in most data systems although quite late in MIL-HDBK-300D. The unit price has, however, increased 49%.



CASE 41 - VARIABLE CALIBRATED RF ALTERNATOR

CASE 42 - TS-443/U VOLTMETER

Defense System:	Minuteman III
Type:	Electrical Instruments
Functional Area:	Electrical
Level of Use:	Organizational and Intermediate
Method of Procurement:	GFE

This item is Minuteman III Figure A number 3067, NSN 6625-00193-7187, and Weston Instruments Division of Weston, Inc. (formerly Daystrom, Inc.). Model I part number 182216. It is Joint Electronics Part Designating System number TS-443/U, and is listed in the 1972 Boeing CAGEL for Minuteman maintenance ground equipment. The purpose of this voltmeter is to display direct current voltages for test and checkout of the environmental control power supply, battery charger, and alarm set systems at the launch facility and the launch control facility of the Minuteman III system. Voltmeters are extremely common in the Air Force. This case study was selected to illustrate the Air Force acquisition process as it applies to such items. Unfortunately only limited data could be located.

The requirement for this item was submitted to the Air Force first on April 13, 1962. It was one of 20 items of maintenance ground equipment whose figure A's were included in the Boeing Company specification S-133-121-3-1-19. This figure A was examined by LMI. The technical requirements and recommended solution were excellent. Detailed quantitative data including accuracies are contained in both sections clearly showing the item to be an acceptable alternative. Management data are good; however, basis of issue is given by X's rather than quantities at desired locations and the unit price is blank. This form achieves in one page what the AGERD process sometimes fails to achieve in several. The title, "Technical Requirements," instead of, "Functional Analysis," leads to better contractor understanding of desired data. This figure A was approved in draft form May 5, 1962 and in final form March 26, 1963. The approval date on the figure A is Nov. 1962.

No date of need or delivery data could be located. Data as of Nov. 1969 indicated that 28 were required and all had been provisioned. The unit cost noted by the system manager was \$350. The Air Force management data list shows a unit cost of \$100. No problems were reported in the use of this item.

In May 1967 the Minuteman system changed all new voltmeter requirements to the voltmeter submitted on Figure A number 4739. This change was supported by an item reduction, cost savings, and increased capability arguments.

This item is not contained in the D097 Interchangeability and Substitution System. It does not qualify for entry in MIL-HDBK-300; however, Mil-HDBK-300D contains 35 voltmeters many of which meet the technical requirements described for this system. Lists encountered during this study contain voltmeters under-30-NSNs with 14 different nomenclatures excluding multimeter nomenclatures. No preferred family of in-inventory voltmeters listed by technical requirements was found.

The Defense Integrated Data Systems will provide additional capability to identify in-inventory voltmeters. Federal Item Identification Guide A310 Multimeters, Meters Electronic/Electrical Various will contain the characteristics required to locate voltmeters in the desired ranges.

This case study illustrates the acquisition of a low cost simple electrical item. Extensive items were found in the Air Force inventory without feedback of an experience based family of preferred items to support equipment procurement personnel for consideration. Requirements data was excellent and Air Force cost and item reduction efforts resulted in change to another voltmeter due to state-of-the-art improvement.

CASE 43 - TELETYPEWRITER TEST PANEL

Defense System:	AF Satellite Communication
Type:	Electronic Test Equipment
Functional Area:	Communications
Level of Use:	Intermediate and Depot
Method of Procurement:	CFE

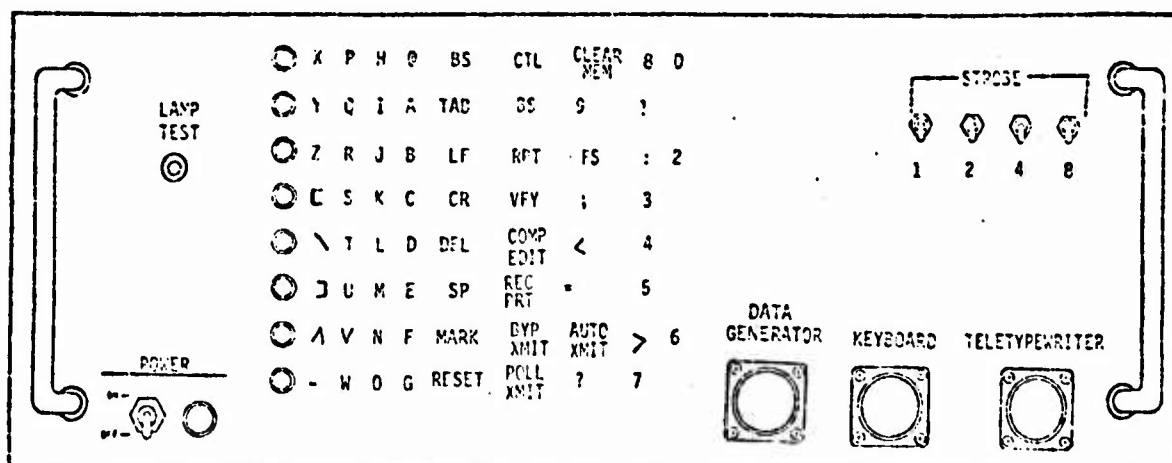
This item is AGERD 101, and Collins Radio part number 622-2045-001. Its purpose was to supply power, special signals, and interfacing for use in checking and fault isolating the Teletypewriter Set.

This item was contained in but has been deleted from the AGE Plan Revision C dated May 31, 1974. Two prime items originally used this piece of support equipment. The original AGERD for this item was submitted March 1, 1974 but was never approved. Quantitative technical data in the functional analysis consisted of voltages and frequencies of the power supplied only. Four other requirements were stated without data. Ten provisions of the item to be designed were listed in the recommended solution of which only three contained technical data. The two items to be tested were both listed; however, one was at the beginning and one at the end.

The figure 1B of this AGERD contains blank development and unit cost estimates. The contractor's ORLA used a unit cost of \$6000 for this item. The need date is Dec. 1, 1974, and one article only is recommended since deployment quantity plans were not included in the AGERDs of this program. A hand-written note on the SPOs copy stated this item was deleted May 1, 1974, however, this note is crossed out and a hold in abeyance note written in beside it.

The contractor's ORLA led to cancellation of this item. The study concluded that depot repair only was optimum for the prime equipment involved. Therefore, the intermediate requirement was eliminated. Further the Message Processor Test Set (case study 26) could support the teletypewriter at the depot level. This test set was already listed in the AGE Plan to support both items supported by this item. The figure 1A data for the Message Processor was not adequate to determine if it could meet the functional analysis for this item. Although no development cost was identified any expenditures would have been lost due to the cancellation of this item. Revision A of AGERD 101 was submitted Sept 30, 1974 cancelling this item. This AGERD listed the wrong AGERD number for the Message Processor Test Set.

The original AGERD for this item states that MIL-HDBK-300 was screened. MIL-HDBK-300D contains no Teletypewriter Test Sets. However, Teletypewriter Test Set is item name code 03682 of the Defense Integrated Data System. This name is covered in Federal Item Identification Guide T228 scheduled for implementation in Dec. 1975. Thus in the future additional tools will be available to identify items of this type.



CASE 43 - TELETYPEWRITER TEST PANEL

CASE 44 - PILOT TONE DETECTOR TEST SET

Defense System:	485L
Type:	Electronic Test Equipment
Functional Area:	RF Transmissions
Level of Use:	Depot
Method of Procurement:	CFE

This item is AGERD 62 of the AN/GSQ-119/120(U) Communications and Radar Data Transfer System procured on contract F19628 71-C 0235. A NSN is yet to be assigned. It is Defense Communications Division of ITT part number 1471505. The purpose of this item is to check out and fault isolate the pilot tone detector portion of the prime system.

AGERD 62 is contained in document A061 of this contract (for details of this document see case 28) AGERD 62 is 7 pages long. Some of these pages list revision A, some revision B, and some revision C. All are dated July 30, 1974. The functional analysis contains only limited data on the prime equipment which cannot be related to the support equipment. The recommended solution states that no known test set has the required characteristics. However, these characteristics cannot be determined from the AGERD. Three untitled schematic drawings and a list of 15 standard electronic items required with this tester are included.

The figure 1B of AGERD 62 contains blank match code, development cost and proposed source blocks. The unit cost estimate is \$8011. The Federal Stock Number block contains only the FSC 6625 and the MMC ZR. The need date is July 1, 1975 and an approval date of Nov. 30, 1972 is listed. One article only is recommended for depot use. As of Nov. 1974 the AGERDs in this document had been rejected in their entirety because of the confusing incoherent presentation.

MIL-HDBK-300 contains no entries under the nomenclatures Pilot Tone Detector Test Set, or Test Set, Pilot Tone Detector.

This case study illustrates an extreme in lack of understanding of how to explain test requirements on AGERDs to permit Air Force evaluation of the requirement and the solution.

CASE 45 - RADIO ORDERWIRE TEST SET

Defense System:	485L
Type:	Electronic Test Equipment
Functional Area:	RF Transmissions
Level of Use:	Depot
Method of Procurement:	CFE

This item is AGERD 126 of the AN/GSQ-119/120(V) Data Transfer System procured under contract F19628-71-C-0235. No NSN is yet assigned. It is Defense Communication Division of ITT part number 1471519. The purpose of this item is to checkout and fault isolate the orderwire portion of the prime equipment.

AGERD 126 is contained in document A061 of this contract (for details of this document see case 28). No AGE Plan is referenced. All pages are dated July 30, 1974 but both original and revision A are listed. The functional analysis contains extensive data about the prime system but no details relating this data to the test set. The recommended solution details the interconnections performed by the test set with all technical data placed on an untitled schematic drawing. Eight standard electronic items used with this test set are listed.

The figure 1B contains blank match code, approval date, and development cost blocks. The unit cost estimate is \$3209 and the need date is July 1, 1975. One article is recommended for depot use. The Federal Stock Number block contained only the FSC 6625. As of Nov. 1974 all AGERDs in document A061 had been rejected because of their poor presentation.

MIL-HDBK-300D contains no entries under the nomenclatures Radio Orderwire Test Set, Orderwire Test Set, Test Set Radio Orderwire, or Test Set Orderwire.

This case study illustrates an extreme in lack of understanding of how to explain test requirements on AGERDs to permit Air Force evaluation of the requirement and the solution.

CASE 46 - A/M32A-60A GENERATOR SET

Defense System:	F-15 and A-10
Type:	Electrical Generating
Functional Area:	Electrical
Level of Use:	Organizational and Depot
Method of Procurement:	GFE

This item is AGERD 217 of the F-15 program contract F33657-70-C-0300 with McDonnell Aircraft Co., and A-10 System Manager's Item Number 3. The NSN is 6115-00420-8486, and its Joint Electronic Type Designating System number is A/M32A-60A. It is designed to Specification MIL-G-38195. This item is currently in use on 11 aircraft systems and is the preferred generator in the Air Force inventory. This heavy demand plus the bankruptcy in 1974 of a major supplier have created over 1000 backorders for this piece of support equipment.

The purpose of this item is to supply high frequency 3 phase electrical power and high temperature, high pressure air to aircraft on the ground to prevent having to run the aircrafts' engines for organizational checkout of onboard systems in 37 different system areas.

As of Jan. 24, 1975 18 AGERDs had been submitted to the F-15 program under the number 217. Between Jan. 15, 1971 and July 26, 1971 revision submissions included changing a letter appended to the 217 as well as the revision letter. This created a confusing numbering system. Ten of the seventeen revisions were principally to add additional system areas which used electrical or pneumatic power. Six other revisions were solely to cancel earlier revisions. All eighteen AGERDs traversed the entire cycle of offices prescribed in AFLCM 65-3/AFSCM 65-2. Table 1 below shows the numbering system, submission date and SPO action dates of those 18 AGERDs in the order submitted. These data are extracted from the F-15 CO13 AGE Acquisition and Control System as of Jan. 24, 1975.

Table 1: SUBMISSION AND SPO ACTION HISTORY OF F-15 AGERD 217

<u>Number</u>	<u>Revision</u>	<u>Submitted</u>	<u>SPO Action</u>
217		December 17, 1970	March 1, 1971
217A		January 15, 1971	February 10, 1971
217B		February 11, 1971	
217C		February 11, 1971	April 21, 1971
217D		March 10, 1971	May 14, 1971
217E		March 22, 1971	June 1, 1971
217F		April 14, 1971	June 9, 1971
217	A	July 26, 1971	
217A	A	July 26, 1971	
217B	A	July 26, 1971	
217C	A	July 26, 1971	
217D	A	July 26, 1971	
217E	A	July 26, 1971	
217F	A	July 26, 1971	
217	B	December 14, 1971	February 29, 1972
217	C	May 12, 1972	July 25, 1972
217	D	November 17, 1972	January 25, 1973
217	E	June 4, 1973	August 29, 1973

The earliest AGERD neglected the electrical capabilities of this generator for the pneumatic capabilities. This was quickly corrected, however, resulting in excellent functional analysis and recommended solutions. All AGERDs referenced AGE Plan paragraphs 6.3.4 and 6.3.6.

The figure 1Bs of these AGERDs all contain blank unit costs. The need dates vary from January 1972 to April 1972. The organizational basis of issue varies from 1 to 8 and finally reached 12 per squadron in Table of Allowance 289. The Material Management Code YV is ultimately suffixed to the NSN. The inventory item specification number is CR76301A328 999.

The A-10 requirement for this item can be traced to the November 17, 1972 AGE Plan which lists the A/M32A-60 version NSN 6115-00225-7663. This item has been in the Air Force Inventory approximately 9 years. The A-10 System Manager's GFE support equipment list shows that of six requirements for tests beginning in July 1974 only 2 articles were available as of June 15, 1974. Both these were the A/M32A-60 less preferred item. Arrangements were shown to transfer these between bases to meet requirements.

This generator set is also in use on the C-141, C-5A, A-7D, B-52, KC-135, F-4E, F-5E, F-111, and B-1 aircraft systems. Foreign military sales of this item have created further demand. The resources available to allocate to these users as of March 1975 were 1252 A/M32A-60 models and 582 A/M32A-60A models. Since that date an unknown quantity were abandoned in Southeast Asia.

A principal manufacturer, Hogart Inc., declared bankruptcy with 378 of its contract for 812 articles undelivered. This bankruptcy occurred notwithstanding the fact that the Air Force restructured their contract to give Hogart Inc. significant relief of their cost obligations in January 1974.

The result of these factors is an inventory position of over 1000 backorders. A competitive procurement to relieve this condition should be awarded in early Summer 1975. One impact of this shortage has been to force the F-15 to use the A/M32A-60 version at Luke Air Force Base, the first squadron of operational F-15s. This has not reduced capability yet due to the use of an alternate air conditioner as well.

The cost of this generator set is listed in the Air Force Management Data System as \$7949 and the DoD Management Data List as \$40,887. The item manager stated that both were in error. The lowest price ever paid was \$10,326. This price also appears in the F-15 CO13 System. The most probable explanation is the inclusion of only the gas turbine engine price without the cart into which the engine fits. The most recent unit price is \$45,700. At this price the F-15 investment in this generator will be \$98.7M.

A safety shroud modification is planned to be retrofit to this item because of expelled parts following a small number of failures. This modification will cost \$1100 and will be installed in the field on all 582 in-service A/M32A-60As. No other problems have been encountered with this articles.

This case study illustrates an extremely well built piece of support equipment which nevertheless had major problems. These problems were the result of unforeseeable circumstances such as corporate bankruptcy, wartime losses, and heavy demand due to the desirable characteristics of the item itself. No adjustments to the support equipment acquisition process can address these variables except in planning terms. A reduction in the number of AGERDs due to minor revisions would, however, free Air Force manpower to pursue higher priority tasks. This can best be accomplished by including a brief reason for revision block on the AGERD.

CASE 47 - COMPUTER TEST SET

Defense System:	DSP-Data Reduction Center
Type:	Simple Electronic Test Equipment
Functional Area:	Computers
Level of Use:	Intermediate
Method of Procurement:	GFE and CFE

This item is AGERD 0154, NSN 6625-00902-8926YN, and IBM part number 452400. Its purpose is to test offline and in conjunction with other items, 9 of 20 periferal devices used with the IBM 360/75 Computer System of the Data Reduction Center.

The requirement for this item can be traced to the AGE Plan dated October 30, 1970 which calls for this item by manufacturer's part number in seven sections under the nomenclature, "I/O Tester."

The original, revision A, and revision B of this AGERD could not be located. Revision C was submitted May 18, 1973 under the same contract number as the AGE Plan. This AGERD referenced 9 sections of the AGE Plan two of which did not exist in the October 30, 1970 document. The functional analysis contained no quantitative data at all. The recommended solution contained no data on the capabilities of the recommended item. There was no statement of the results of a search of the inventory. This AGERD contained a unit cost estimate of \$2458 and a quantity recommended of 8. Three dates required were listed corresponding to the activation of DRC I through III. The latest of these dates is two months before the date of approval given for this item on this AGERD, and 16 months before the submission of the revision C AGERD. The SPO reported that these dates actually occurred approximately 8 months later than the dates listed for other reasons and that these items were delivered on time. Nevertheless revision C was submitted 9 months after the latest actual activation date. The proposed source listed on this AGERD is GFE/CFE and the remarks contain detailed listings of which were GFE and which CFE.

This item is not contained in MIL-HDBK-300D or the DO97 Interchangeability & Substitution System. The Air Force Mangement Data List shows the same unit cost as revision C. MIL-HDBK-300D lists two items which contain the nomenclature Computer Test Set but no I/O Testers. The Defense Integrated Data System lists an Item Name Code for Computer Test Set (#03626). This code is described in Federal Item Identification Guide T228 which is scheduled for implementation in December 1975.

This case study illustrates how inadequate data prevents the Air Force from effectively analyzing a recommended solution. Further lateness of approval forced a CFE procurement for early activations even though they were delayed 8 months. The DIDS would have to be searched by the contractor since the Air Force was given insufficient data, and no other data system was effective in identifying this item.

CASE 48 - AN/APM-245 SIMULATOR TEST SET

Defense System:	AIMS/TRACALS
Type:	Electrical Transponder
Functional Area:	Identification
Level of Use:	Intermediate and Depot
Method of Procurement:	CFE

This item is AGERD 4 for the AN/APX-76 Interrogator and AGERD 6 for the AN/APX-86 Interrogator. It is covered by AIMS Specification 64-840A and is Hazeltine Corporation part number 117733. The NSN of the original version is 6625-00087-1227, and of the A version is 6625-00164-6551. The purpose of this item is to simulate signals and returns for mode 4 testing of interrogators with the AN/UPM-98A Test Set, Radar.

The specification number 64-840A implies that this item was originally designed in 1964 for the AN/APX-76 Interrogator. The earliest AGERD that could be located, however, was AGERD 6 for the APX-83 Interrogator dated February 28, 1969. This AGERD referenced three paragraphs of an earlier AGE Plan. The functional analysis and recommended solution were adequate for the selection of the item.

Figure 1B of this AGERD contained blank development and unit cost estimates and blank quantity recommendations. Although the manufacturer was the same as the prime item developer a GFE source was proposed. The need date was March 1969, one day after the submission date. Both figure 1A and 1B clearly stated that this item was not required if the AN/UPM-137 (case study 21) Radar Test Set is used.

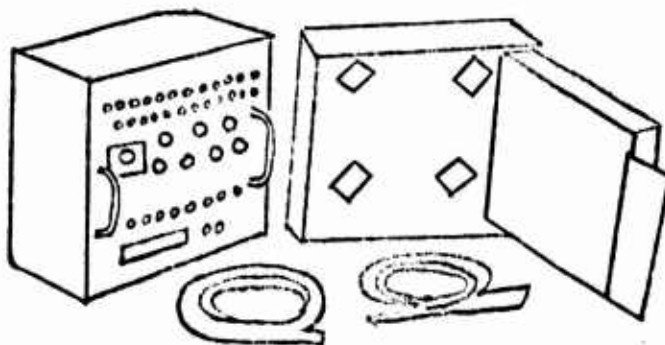
Revision A of this AGERD was submitted July 22, 1969. The reason for this revision was the addition of additional technical data in the recommended solution to exactly duplicate the functional analysis.

In 1971 two contracts were placed with Hazeltine Corporation for a revised version of this simulator numbered AN/APM-245/A. The technical improvements of this version could not be determined, however 1684 Test Sets of this A version were procured of which 736 were for the Air Force.

The AIMS AGE list of June 30, 1973 lists this item under both interrogators with the non A version first and the A version as an alternate without the A version NSN. The note, "Not required with AN/UPM-137" does not appear on this item even though it does on others. The unit cost listed in this document is \$2000. The Air Force Management Data List shows a more recent unit cost of \$817.80. The DO97 Interchangeability and Substitution System lists the A version as the master item with the original as alternate, just the opposite of the AIMS document. AIMS document 139 End Item Requirement/Delivery/Allocation Forecast dated July 31, 1973 contains a one digit error in the NSN of the original item.

The original item is listed in MIL-HDBK-300D. The A version is not. This entry is dated October 15, 1970 and lists only the APX-72 as the unit tested. Three pages of technical characteristics are included encompassing all those of the AGERD.

This case study illustrates the diversity of conflicting data available in Air Force data systems. Further the definition of the requirement late in the month preceding the need for the article made impossible the delivery of the article on time.



CASE 48 - AN/APM-245 SIMULATOR TEST SET

CASE 49 - AN/GGM-16 DIGITAL DATA ANALYZER

Defense System:	485L
Type:	Electrical
Functional Area:	Command and Control
Level of Use:	Organizational and Depot
Method of Procurement:	GFE

This item was originally submitted as AGERD 1160 of the TACC Auto project then resubmitted as AGERD 11. It is NSN 6625-00236-4019 and Digitech, Inc. part number DT 9553. The purpose of this item is to generate and monitor nine digital message forms with controllable distortion for checkout and fault isolation of six items of prime equipment.

The figure 1A of AGERD 11 revision A is dated January 28, 1974 while the figure 1B is dated February 20, 1974. No AGE Plan is referenced. The functional analysis and recommended solutions contain excellent quantitative data for making the procurement decision. The figure 1B contains blank match code, need date, and unit cost blocks. The Air Force Management Data List gives the unit cost of this item as \$3800. AGERD 11 further states that MIL-HDBK-300 was screened. Twenty-six articles are recommended. This AGERD was held in abeyance in January 1975 pending resolution of case study 9.

This item is listed in MIL-HDBK-300D. However, the nomenclature for this NSN is, "Test Set, Teletypewriter" (see case 43 for data on Teletypewriter Test Sets in the DIDS). The entry is dated January 15, 1974, two weeks before the AGERD, so could not have been where the contractor located the item. This entry further states that this item is interchangeable with NSN 6625-00928-2822. The DO97 Interchangeability and Substitution System lists the latter item as the master item and the case study item as an alternate. The master item is not contained in MIL-HDBK-300D. Technical order T.O. 33A1-14-12-1.4 was procured in support of this item.

This case study illustrates the conflicting information in Air Force data bases. Here both nomenclature and preference were in conflict although technical requirements were adequate.

CASE 50 - AN/GRM-103 RECEIVING SET, RADIO

Defense System:	AIMS/TRACALS
Type:	Electronics
Functional Area:	Communications
Level of Use:	Organizational/Intermediate
Method of Procurement:	GFE

This item is AGERD 171 for the AN/GRN-27(V), NSN 6625-00495-3467ZK, specification number 404L-701-5007, and Joint Electronics Designating System number AN/GRM-103. Its purpose is to measure radiation from the localizer to determine whether they are within tolerance. This item was selected because of its high price (\$125,000) and GFE designation in the AIMS/TRACALS AGE list of June 30, 1973.

The original AGERD for this item could not be located, however, revision A submitted May 27, 1971 was examined. Reference is made on this AGERD to an earlier AGE Plan paragraph 3.3.2.2. No quantitative technical data is contained in the functional analysis or the recommended solution of this AGERD. In fact only the designation AN/GRM-103 is given to identify the item on this AGERD.

The Federal Manufacturer's Code, match code, and development and unit cost estimates are all blank on the figure 1B. The need date is June 1971 and the date of approval is May 27, 1971, the same as the date of submission. Eighteen articles are recommended, seventeen for the intermediate level and one for training. Pencilled in on this AGERD is the NSN above.

The June 30, 1973 AIMS/TRACALS AGE list shows this item as used for organizational maintenance, and a production cost estimate of \$125,000. The NSN is not listed.

LMI kept a log of autovon calls required to locate the item manager of this item from the NSN only. Thirteen calls were required. The item manager stated that 165 of these items had been bought beginning in 1971 with delivery completed March 6, 1973. The unit cost of this item is actually \$2500. Thus the AIMS/TRACALS AGE list is grossly in error and the unit price is not great for a GFE item after all. Seven back orders currently existed for items being repaired. This item is replacing an earlier item, NSN 6625-00086-1131ZK which is being declared excess. One material improvement program was noted to improve response in extreme climatic conditions.

This item is not contained in MIL-HDBK-300D. Neither is the item it is replacing. It is, however, a master item in the DO97 Interchangeability and Substitution System with the item being replaced as its one alternate. The nomenclature identified in the DO97 system is "Receiver Tester" rather than "Receiving Set, Radio" which appears on the AGERD and the AIMS/TRACALS AGE list.

This case study illustrates the great diversity of data found in Air Force data systems for the same item. In this case unit cost, nomenclature, number procured, and level of use were all in conflict in the information available.

CASE 51 - WIDEBAND MODEM TEST SET

Defense System:	AF Satellite Communications
Type:	Manual Test Equipment
Functional Area:	Communications
Level of Use:	Intermediate and Depot
Method of Procurement:	CFE

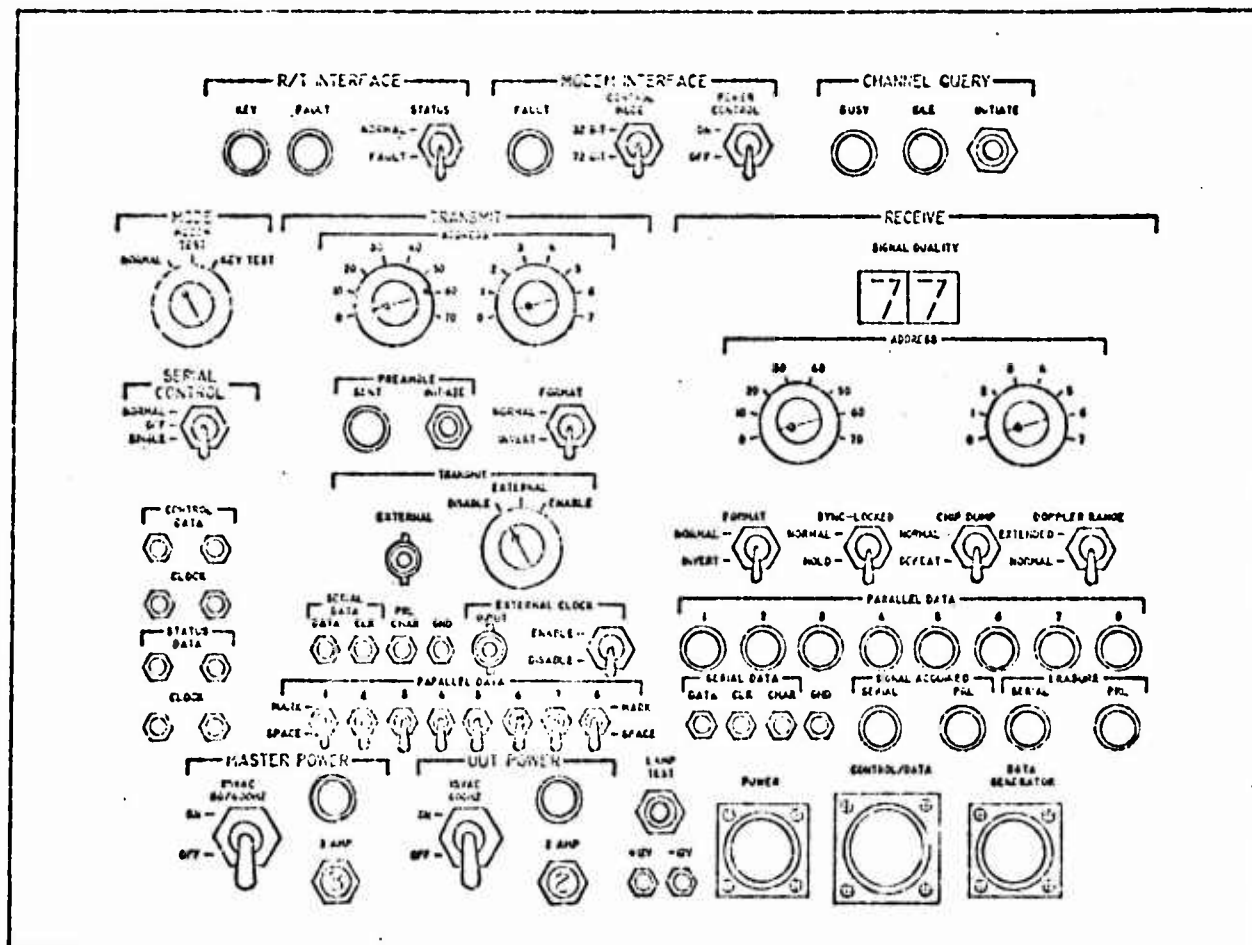
This item is AGERD 23, Preliminary stock number 6625-ND 433760P, and Collins Radio part number 622-1645-001. The purpose of this item is to test and fault isolate failures in the Telegraph Modem (Modulator/Demodulator).

The requirement for this item is contained in the AGE Plan Revision C dated May 31, 1974. The AGERD number and contractor part number are included as are those of 16 other common and peculiar items required to maintain the Wideband Modem prime equipment.

The original AGERD was submitted August 24, 1973 and the requirement approved September 24, 1973. AGERD revision B was submitted September 30, 1974 and included reference to the above AGE Plan paragraph. The reason for revision could not be determined. This AGERD was quite extensive, encompassing 14 pages including nine pages numbered as dash numbers to one page of the original numbering scheme. This section contained detailed technical characteristics of the item. C. I. specification 622-1645-001 (identical to the part number) is referenced, however, the AGE Status Report lists C. I. specification 597-3621-001 for this item.

The figure 1B of this AGERD contained blank match code, development cost, and unit cost blocks. The ORLA trade-off study, however, listed the unit cost of this item as \$5646. The need date shown is December 1, 1974, however, actual need did not occur until January 6, 1975. Only one article is recommended. This is for development testing since no planning for deployment was included on the AGERDs of this program. The AGERD states that MIL-HDBK-300 was screened. This item was 85% complete on December 4, 1974 with compatibility testing scheduled for February 14-28, 1975 and delivery March 19, 1975.

This case study illustrates that even with approval time reduced to one month the contractor could not deliver this item on time. Therefore concentration on reducing processing time will probably have little effort on on-time delivery of support equipment.



CASE 51 - WIDEBAND MODEM TEST SET

CASE 52 - SQUIB SHORTING TEST KIT

Defense System:	RPV - AQM-34 series
Type:	Simple Electrical
Functional Area:	Pyrotechnic
Level of Use:	Organizational
Method of Procurement:	CFE

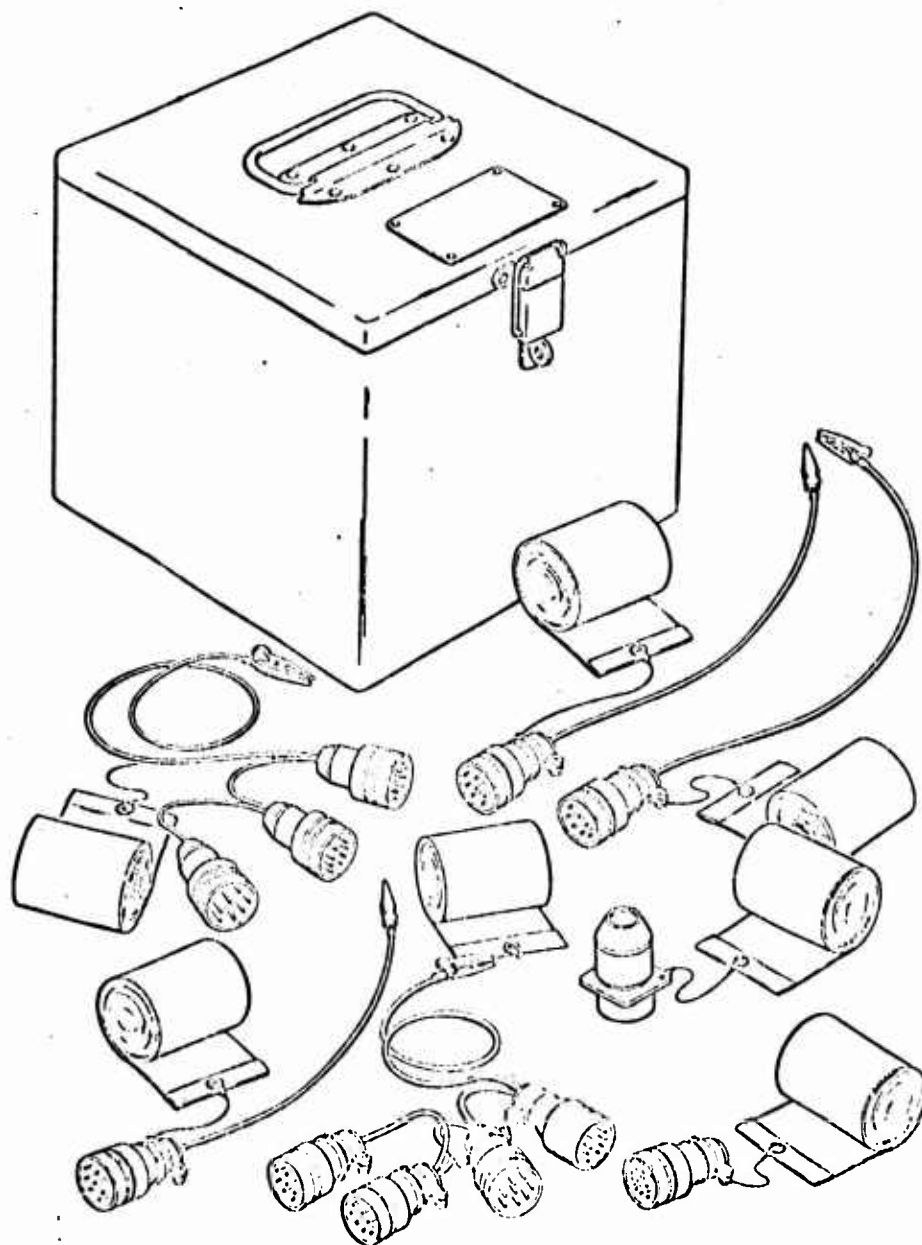
This item is NSN 5180-00228-1973KH and Teledyne Ryan Aeronautical part number 147G155-11. It has been procured on 5 Air Force contracts dated as early as February 1965. Twenty-six have been delivered at a unit cost of \$655. This item was selected to represent a low cost item from the RPV inventory. The purpose of this item is to prevent accidental firing of on-board explosive charges while the vehicle is on the ground.

This article was procured under the "Big Safari," concept of acquiring rapid capability by avoiding normal procedures. Delivery times of less than 4 months were achieved. The early contracts for this item were cost-plus-fixed-fee while later ones were fixed price including two basic ordering agreements. Technical order T.O. 33D5-G155-2 was procured in support of this item. This item is not included in the Combat Angel Update list of existing support equipment although it has existed for 10 years.

The nomenclature, "test kit," is misleading in that the item has no test function at all. Rather it is a safety device. This nomenclature caused LMI to compare this item to case study 53, "Squib Test Set," in order to determine the reason for its 5 times greater unit cost. In fact, they serve different functions altogether. A better comparison would have been to the "Plug Set, Squib Shorting" for the Model 154 series with unit cost of \$1683 and NSN 4920-00360-1663MT. Note that these three items all have different Federal Supply Classes and each FSC applies to all items.

The item manager stated that manufacturing of this item would be done by the Air Force in the future to reduce cost. The contractor noted that, of course, he could not be liable for any defect in such government manufacture that resulted in explosion damage. The 4 criteria set forth in AFR 800-12 for local manufacture of support equipment do not include consideration of safety directly. Air Force policy on safety of locally manufactured items should be considered in the next review of AFR 800-12.

This case study illustrates that confusing nomenclature and different use of FSC can lengthen analysis by creating misunderstanding. It also points out a need for Air Force policy in regard to local manufacture of potentially hazard causing material.



CASE 52 - SQUIB SHORTING TEST KIT

CASE 53 - SQUIB TEST SET

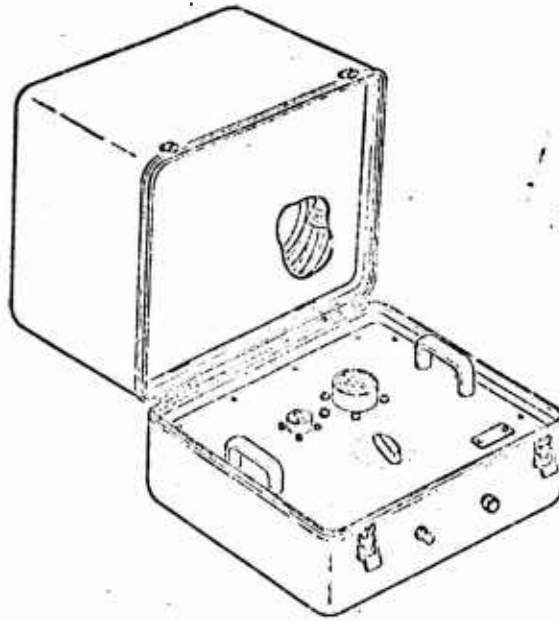
Defense System:	RPV - AQM-34 series
Type:	Simple Electrical
Functional Area:	Pyrotechnic
Level of Use:	Organizational
Method of Procurement:	CFE

This item is NSN 4925-00782-4640KH and Teledyne Ryan Aeronautical part number 147G2005-1. The purpose of this item is to perform resistance and continuity safety checks on the pyrotechnic devices and mid-air-release switch of the AQM-34 series remotely piloted vehicle.

This item has been procured on two Air Force contracts dated August 22, 1971 and October 3, 1974. Eight have been delivered and three remain on order pending delivery beginning in August 1975. Contract to delivery time of seven months was achieved. The unit cost of this item is \$3620. The first contract was cost-plus-fixed-fee, the second was fixed price. This item is not contained in MIL-HDBK-300D or the D097 System. In fact no squib test sets are in MIL-HDBK-300D at all. The Model 154 series vehicles use an item called "Test Set, Pyro. Continuity," NSN 4925-0080-0683NT with a unit cost of \$18,000. On the other hand two items exist on the RPV operational AGE list both called "Tester, Squib" with unit costs of \$500 and \$700. One of these appears on the Combat Angel Update list of existing AGE with an error in the part number.

This item became necessary when the number of squib circuits on AQM-34 vehicles became too great for manual checking within reasonable time and with sufficient safety. There is no documentation of the decision to add this item of support equipment. Time to test, however, was reported to be reduced to one-thirtieth its original value. In addition, no modifications were required of this item to use it on five different letter designations of the AQM-34 vehicle.

This case study illustrates the diversity of equipment that is available to do simple electrical tasks. This requires technical data to analyze available items. This data, however, is not centralized and documented for convenient use. Therefore, contractor and Air Force personnel commodity knowledge becomes the only source of data to locate common items.



CASE 53 - SQUIB TEST SET

CASE 54 - WIRING HARNESS

Defense System:	DSP-Ground Comm. Network
Type:	Simple Electrical
Functional Area:	Communication
Level of Use:	Intermediate
Method of Procurement:	CFE

This item is AGERD B250, NSN 1830-00003-2044VE, and Philco Ford part number 87-229481-01. Its purpose is to connect the Error Detection Unit to input and readout devices during intermediate maintenance. This item was selected for study to investigate the Air Force's methods for determining desirability of government manufacture.

The requirement for this item can be found in the AGE Plan dated December 18, 1970 section 3.3.4.1 MGE Equipment under the nomenclature "Test Cables," with 20 other items. The original AGERD was submitted January 10, 1972. It included reference to AGE Plan section 3.3.4.1, an excellent functional analysis and recommended solution which duplicated the quantitative technical requirements of the functional analysis word-for-word. The harness was identified as procurement critical for the Air Force. A quantity of one was recommended. The proposed source, need date, and development cost were blank. The unit cost estimate was \$100.

Revision A of this AGERD was submitted June 13, 1972. This submission contained the NSN 1830-NC460682FVE. This preliminary numbering system caused misunderstanding in case study 33 two years later. Penciled in on the system manager's copy was the final NSN and the quantity recommendation of 6. This item was delivered on time with the prime system it supports.

No evidence could be found that the Air Force had considered in-house manufacture of these cables. Depot personnel were new to their positions and unfamiliar with this item. SPO personnel considered the savings possible less than the cost of investigating the in-house manufacture option. This consideration is consistent with the AFR 800-12 requirement that simple low cost support equipment be manufactured in-house only when cost-effective. Nevertheless the GAO reported savings potential of over 60% on cables in this price range even when only two were required.

If the Air Force were to consider large scale in-house manufacture of support equipment, legal technicalities of competition between government and industry require clarification. LMI was unable to evaluate the issues involved in this question.

This case study illustrates how the Air Force acting completely within their own guidelines can place priorities in places other than such issues as local manufacture based on their judgment of return for resources invested.

CASE 55 - CABLE KIT

Defense System:	AF Satellite Communications
Type:	Simple Electrical
Functional Area:	Communication
Level of Use:	Depot
Method of Procurement:	CFE

This item is AGERD 96 and Collins Radio part number 622-2008-001. The purpose of this item is to interface the Signal Data Translator to power supply and measuring devices during depot maintenance. This item was selected to investigate the Air Force capability to evaluate the manufacture of items in-house.

The requirement for this item can be found in the AGE Plan Revision C dated May 31, 1974 section 3.5.8.9 which refers to this item by part number and AGERD number. The original AGERD was submitted October 31, 1973 and approved December 12, 1973. Revision A was submitted September 30, 1974. The functional analysis contained only the voltages required to be carried by the cable. The recommended solution listed in detail the items interconnected, listed the equipments tested, and showed two pages of schematics of the cables. The latter two appeared on dashed page numbers so appear to be the reason for the revision. The figure 1B of this AGERD contained blank development cost, unit cost, and match code blocks. The unit

cost used in the contractor's ORLA was \$500. The need date is January 6, 1975 and a FSC of 5995 "Cable, Cord, and Wire Assemblies, Communications Equipment," is assigned. This AGERD states that MIL-MDBK-300 was screened. As of December 4, 1974 this item was 70% complete with estimated delivery on-time January 6, 1975.

SPO personnel stated that they had not investigated in-house manufacture of this item. This was because only one was required and the item was sufficiently complex to require the contractors capability to meet the schedule. There were no plans to reevaluate this decision later in the program. This judgment is within the guidelines of in-house manufacture of simple low cost items in AFR 800-12.

CASE 56 - CARD EXTENDER

Defense System:	AF Satellite Communications
Type:	Simple Electrical
Functional Area:	Electronics
Level of Use:	Depot
Method of Procurement:	CFE

This item is AGERD 80, preliminary stock number 6625-ND435-901P, and Tracor, Inc. part number 131704-0001. Its purpose is to make electrical connection between the normal socket and the pin connections of a circuit card while extending the card beyond the confines of its normal protective casing to allow signals to be injected, and measurements made on the card. Extender cards are a normal item used in manual testing of electronics. This item was selected to illustrate how the support equipment acquisition process applies to normal items such as card extenders.

The requirement for this item can be found in the AGE Plan Revision C dated May 31, 1974 sections 3.5.25.7 and 3.5.24.4 which list this item by AGERD number and contractor part number. A drawing of a typical card extender is included. The AGE matrix lists five "Electronic Test Extender Sets" and one "Extender Cable" in addition to this item.

The original AGERD for this item was submitted October 31, 1973 and approved December 12, 1973. Revision A was submitted September 30, 1974. The reason for the revision appears to be the inclusion of the names of the two prime items on which this extender is used since they appear on dashed page numbers.

AGE Plan section 3.5.25.7 is referenced on this AGERD. The functional analysis does not contain the length or connector configuration required of the card extender. However, they can be deduced from the drawing included in the recommended solution. The development and unit cost estimate blocks are blank on this AGERD. The need date is January 6, 1975, one is recommended and the statement is made that MIL-HDBK-300 has been screened. The contractor's ORLA used a unit cost for this item of \$200. The five Electronic Test Extender Sets unit costs ranged from \$190 to \$2470. This item was

delivered on time. Two of the Electronic Test Extender Sets were cancelled.

The AGERD states that MIL-HDBK-300 was screened. In fact no card extenders or extender sets are in MIL-HDBK-300D. A search of the DO97 Interchangeability and Substitution system entries in FSC 6625 also located no card extenders. However, the C-5 program lists 123 types of card extender, the DSP AGE Plans list card extenders and the DRC portion alone lists 13 types of card extender in its index of AGE items. No central data could be located on preferred or universal families of card extenders in the Air Force inventory.

This study illustrates how contractors continue to gain acceptance for small items which they can assure the Air Force will fit a need because no individual SPO has sufficient cost incentive to use existing card extenders which are difficult to locate. The Air Force Standard Electronic Module Program will alleviate this situation in the future by creating standard modules which will fit standard card extenders. This will reduce costs by requiring fewer types and lengthening production runs of those that are required.

CASE 57 - AC/DC LOAD ASSEMBLY

Defense System:	AIMS
Type:	Simple Electrical
Functional Area:	Support Equipment for Support Equipment
Level of Use:	Intermediate and Depot
Method of Procurement:	Local Manufacture

This item is AGERD 1 of the AN/APM-268A Interrogator Test Set (AN/APX-268A in one listing). No NSN could be found for this item and since it is locally manufactured no manufacturer's part number exists. The purpose of this item is to simulate the loads of circuit components during laboratory tests. This item was selected to illustrate locally manufactured items in the Air Force inventory. Unfortunately, very little information could be located.

AGERD 1 for this prime item could not be located by the SPO. This item is listed in DOD AIMS/TRACALS document 123, AIMS/TRACALS AGE List dated June 30, 1973. Level of use is identified as intermediate and depot. A unit cost estimate of \$25 is listed and the instructions to locally manufacture the item are included. A Technical Manual is referred to but no number, title, or other reference is given. The source is further defined as GFE. 197 of these Assemblies are in use by the DoD of which 105 are in use by the Air Force.

The decision to locally manufacture this item was made by the item manager at San Antonio Air Logistics Center. There is no documentation of the decision. The guidelines established in AFR 800-12 for local manufacture of simple low cost support equipment were implicitly followed in making the local manufacture decision. No guidelines were violated by this decision and no problems have been encountered with this item.

CASE 58 - RF CABLE ASSEMBLY

Defense System:	AIMS
Type:	Simple Electrical
Functional Area:	Support Equipment for Support Equipment
Level of Use:	Intermediate and Depot
Method of Procurement:	Local Manufacture

This item is AGERD 11 of the AN/APM-268A Interrogator Test Set (AN/APX-268A in one listing). No NSN or manufacturer's part number could be identified. The purpose of this item is to transfer signals between electrical components during tests. It was selected for study because it was locally manufactured. Unfortunately very little data could be located about it.

AGERD 11 for this prime item could not be located by the SPO. This item is listed, however, in DoD AIMS/TRACALS Document number 123, AIMS/TRACALS Aerospace Ground Equipment dated June 30, 1973. Intermediate and Depot levels of use are identified. The unit cost estimate of \$10 is shown, and the instructions to locally manufacture the item are included. A Technical Manual is referenced but no number, title, or other identification is given to identify it. 197 of these cables are in use by the DoD including 92 in use by the Air Force.

The decision to locally manufacture this item was made by the item manager at San Antonio Air Logistics Center. There is no documentation of this decision. The AFR 800-12 guidelines for local manufacture of simple low cost support equipment items were implicitly followed. No guidelines were violated by this decision and the Air Force has had no problems with this cable.

CASE 59 - TEST ADAPTER KIT

Defense System:	Minuteman III
Type:	Simple Electrical
Functional Area:	Connectors
Level of Use:	Organizational
Method of Procurement:	CFE

This item is Minuteman III Figure A number 16260 and NSN 1190-00078-3179CM. Part I of the Figure A for this item is classified. Its manufacturer is the General Electric

Company. Its purpose is to carry complex electrical signals between prime equipment and test equipment and between test equipments. This item was selected for study to investigate the possibility of in-house manufacture of cables by the Air Force.

This adapter kit consists of eight cables with 51 end connectors which fit in a carrying case. It was procured by a supplemental agreement to the Minuteman development contract with General Electric Company awarded in October 1963. The production contract was awarded in November 1971. The specific requirement for this kit was recognized first in General Electric Document 80SD534-1 dated March 31, 1967. Trade-off studies were conducted on the prime equipment between mid 1967 and February 1968 when the preliminary design review was published.

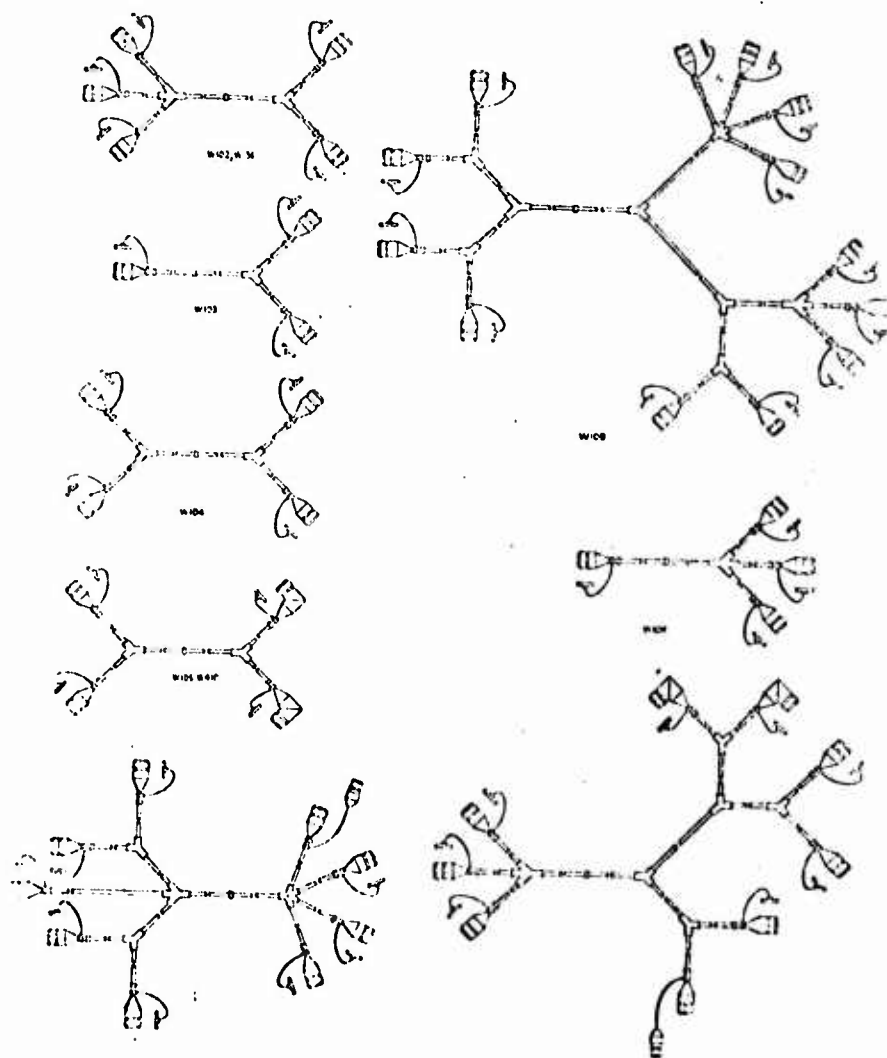
The kit was tested, accepted and delivered to the Air Force on May 7, 1969. The first completed development unit was used in the operational configuration for the Minuteman flight test program. The first item need date was nine months later on January 31, 1970. This item was not delivered to Lowry AFB for use as a trainer until two weeks later on February 14, 1970. Between 1968 and 1974 this item was affected by the twelve engineering changes listed below.

<u>ECP No.</u>	<u>Date</u>	<u>Purpose</u>
B80	Nov 68	Revise environmental requirements.
B164	Jul 69	Changes required to accommodate AVE Block 4 hardware changes.
B337	Sep 70	Tape changes based on test experience at Minot AFB.
B301	Feb 71	General tape changes and cable additions for improvement of checkout operations.
B228	Mar 71	Tape change for compatibility between R/S test set and AVE.
B390	May 71	Tape modification to preclude spurious ejection of chaff wires.
B405	Jul 71	Lengthened two checkout cables to reduce strain when hooked up.
B258	Sep 71	From straight to right angle connectors on certain cables to facilitate attachment.
B432	May 72	Update of technical requirements to be compatible with similar changes in AVE.
B449	Jun 73	Tape changes to reflect tape transport test limits change.
B467	May 74	Change to introduce cable saver adapter.
B452	Jun 74	Tape change to accommodate alternate design of DPT component.

Problems of logistic support of this item have arisen due to the high wear and tear related to high usage in the field. A number of the above ECPs reflect attempts to improve durability of this item.

Development and production cost of this item was \$155,046. This expense was approved by SAMSO on April 30, 1968. The complexity of this item warranted the use of the contractor to manufacture it. Interface requirements to manufacture this item in-house would have been difficult to maintain. This would have increased the risk of incompatible equipment being delivered to the field.

This case illustrates an item of an apparently simple type which became complex because of the extensive number of connectors required. A high degree of change activity marked even this type of item and the cost seemed extremely high. Nevertheless lower cost options such as in-house manufacture were precluded by high interface requirements. In addition the high usage environment was not foreseen requiring durability increase through changes.



CASE 59 - TEST ADAPTER KIT

CASE 60 - PAYLOAD TRANSPORTER

Defense System:	Minuteman III
Type:	Mechanical
Functional Area:	Transportation
Level of Use:	Intermediate
Method of Procurement:	CFE

The Minuteman III Payload Transporter has two parts; the Semitrailer identified by Figure A 4708 and NSN 1450-00857-9330AH, and the Truck Tractor identified by Figure A 4730 manufactured by Mack Trucks, Inc. The purpose of this item is to transport Minuteman missiles between launch facilities, and maintenance facilities, and to erect the missile and place it in the silo.

This item was initially placed on contract April 7, 1965. This contract with the Boeing Company called for design, development, fabrication, and qualification of two articles. The form C Equipment Maintenance Analysis formally recognizing the requirement was not approved until 19 months later on November 3, 1966. First article configuration inspection, test, and acceptance by the Air Force of the serial number 1 item took place January 26-30, 1968. The total expenditure on this contract was approximately \$4.5M.

A contract for the fabrication of 33 units of this item was competitively awarded to Hamilton Standard Division of United Aircraft on September 16, 1968. The first article configuration inspection of the serial number 3 item, the first on this contract, took place on September 12, 1969. At that time the item was delivered to the Air Force. The Air Force need date for assembly and checkout was September 20, 1969. The unit costs on this contract were \$115,800 for the Semitrailer and \$63,240 for the Truck Tractor. Thus the total expenditure on this contract was approximately \$5.9M and the total expenditure for 35 articles was \$10.4M. This is the largest expenditure for a non-electronics item encountered by LMI in the course of this study.

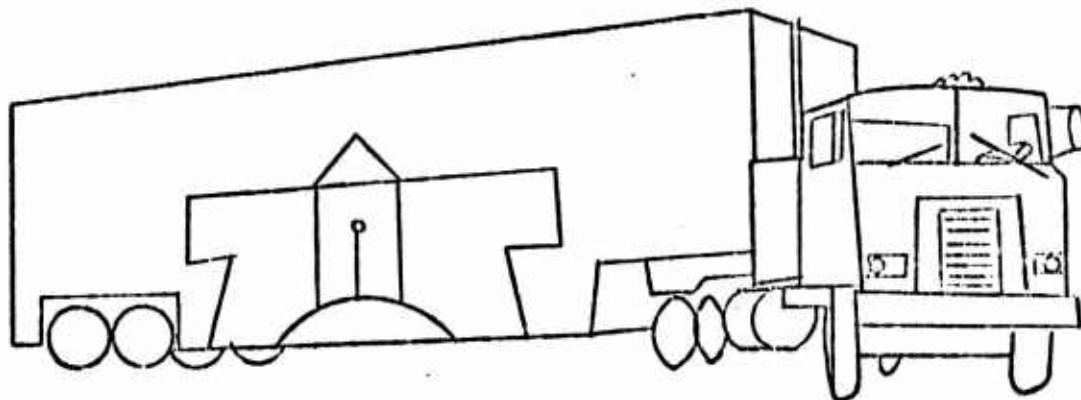
This item is not contained in MIL-HDBK-300D although it qualifies on a financial basis and can reasonably be expected to be reuseable.

A summary of ECPs affecting this item is listed below:

<u>ECP</u>	<u>DESCRIPTION</u>
B317	End Item Specification change for Figure A 4708 Semitrailer.
B318	End Item Specification change for Figure A 4730 Tractor.
B393	Incorporate Air Force requested changes at FACI for both semitrailer and tractor.

<u>ECP</u>	<u>DESCRIPTION</u> (Continued)
B416	Qualification test changes for both semitrailer and tractor.
B458	Comply with 1969 Federal Safety Standards for semitrailers and tractor.
B478	Provide MINUTEMAN II payload transportation capability for Figure A 4708 Semitrailer.
B486	Hoist Electrical Grounding Revisions for Figure 4708 Semitrailer.
B488	Incorporate changes resulting from FACI of serial number 3, first Hamilton Standard manufactured production vehicle. Included retrofit of Boeing manufactured serial number 1 and 2.
B543	Correction of field and manufacturing problems for both Figure A 4708 Semitrailer and Figure A 4730 Tractor.
B560	Hoist and Security System modification for Figure A 4708 Semitrailer.
1386	Modifications required for vehicle compatibility with MINUTEMAN Wing V Upgrade Silo Program. Figure A 4708 Semitrailer only.

This case study illustrates a complex mechanical item which underwent a lengthy definition period but for which no trade-off studies were reported. A high cost design contract led the Air Force to reduce cost by competitive procurement. Delivery was on-time; however, eleven ECPs of a minor nature impacted the final configuration of the item.



CASE 60 - PAYLOAD TRANSPORTER

CASE 61 - NON-MAGNETIC TRAILER

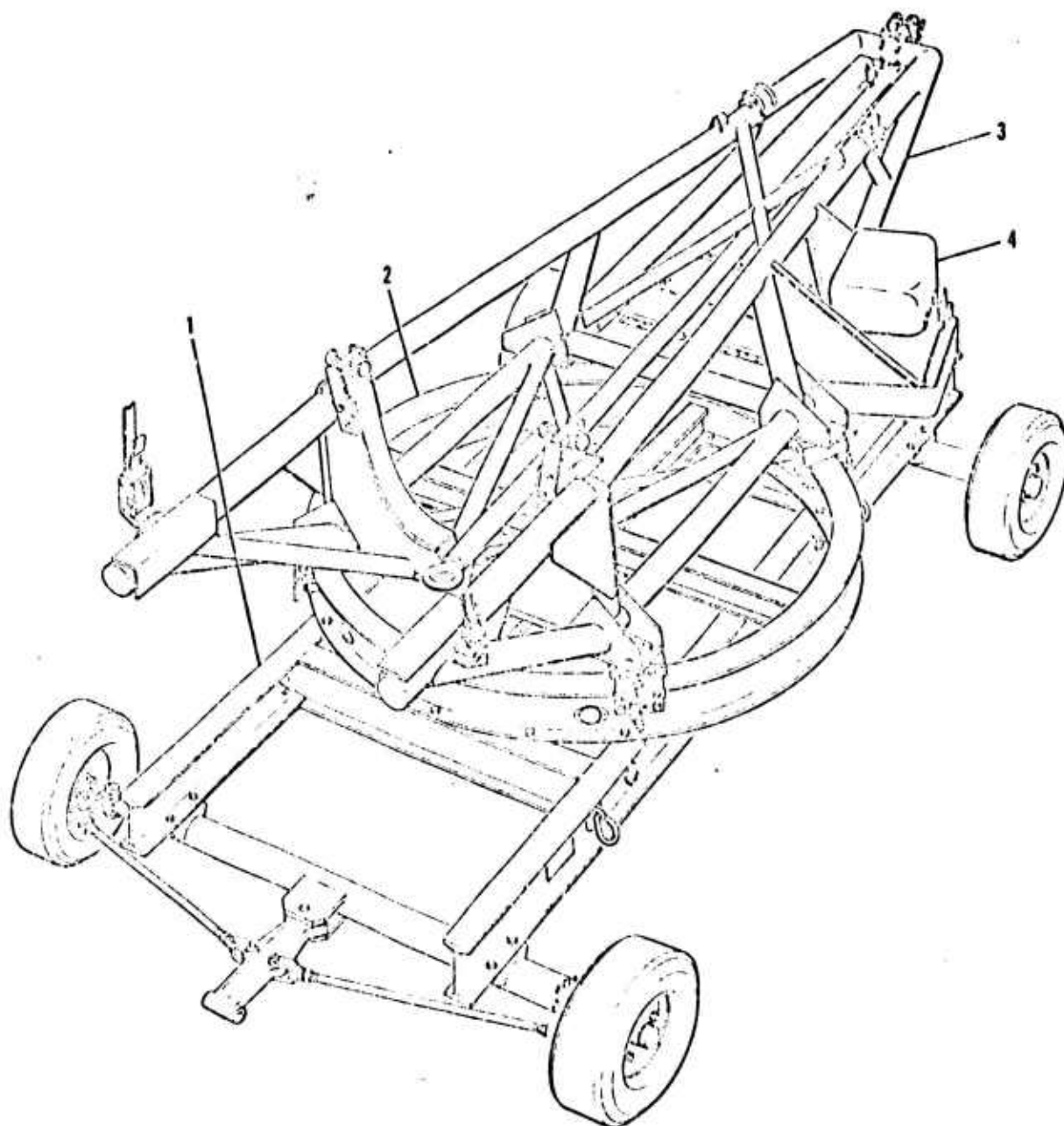
Defense System:	RPV - AQM-34-series
Type:	Test and Handling
Functional Area:	Navigation
Level of Use:	Intermediate
Method of Procurement:	CFE

This trailer is NSN 1740-00291-9510KH and Teledyne Ryan Aeronautical part number 147M144-23. The purpose of this item is to provide transportation to and from compass checkout, a means of turning the vehicle to any desired compass heading, and the test set to fault isolate the compass system. Materials used must not influence the compass's magnetic instruments. This is accomplished by building the trailer of aluminum.

This item has been procured on 7 Air Force contracts dating from February 1965. Contract to delivery time has varied from 3 to 13 months. Four types of contract have procured this item, cost-plus-fixed-fee, cost-plus-incentive-fee, fixed-price-incentive, and fixed price. The unit cost has risen from \$109,000 for the dash 23 to \$117,630 for the dash 25 version. Seven have been procured and one is on order. Two technical orders, T.O. 33D3-M144-2 and T.O. 33D3-G156-2, have been procured in support of this item.

There are four parts to this trailer, the chassis, the turntable, the cradle assembly, and the compass swing test set. Almost all of the eleven changes to this item have been in the compass swing test set. These changes have followed the state-of-the-art of the compass system in the vehicle as it changed from magnetic, to flux, to inertial type, varying interfaces and increasing tolerances as appropriate. As a result the compass swing test set will be assigned its own part number and treated separately from the trailer. In fact this has been done already in the RPV operational AGE list which shows the compass swing test set under part number 147G156-13 at a unit cost of \$24,650 noting that it is part of this trailer. Both items are listed separately on the Combat Angel Update list of existing support equipment. This item is not listed in either MIL-HDBK-300D or in the DO97 System.

This case study illustrates that contractors are able to modify existing support equipment to support a number of vehicles when they have the technical knowledge of the item. This technical knowledge is greatest for their own items as in this case which did not involve DoD Data Systems.



- 1. CHASSIS AND RUNNING GEAR ASSEMBLY
- 2. TURNTABLE ASSEMBLY
- 3. CRADLE ASSEMBLY
- 4. COMPASS SWING TEST SET

CASE 61 - NON-MAGNETIC TRAILER

CASE 62 - BORESCOPE

Defense System:	F-15
Type:	Viewing Instrument
Functional Area:	Engine
Level of Use:	Organizational, Intermediate & Depot
Method of Procurement:	CFE

This item is AGERD 56 of the F-15 program contract number F33657-70-C-0600 with Pratt and Whitney Division of United Aircraft. It is identified by NSN 6650-00782-4519YB and Pratt and Whitney part number PWA 50219. The purpose of this borescope is to view internal engine parts in the gas path and combustion areas by inserting it into inspection ports in the engine and viewing through optics using the internal light source. Borescopes are standard items of engine support equipment used by all engine maintenance locations. This item was selected to serve as an example of the Air Force support equipment acquisition process on this type of item.

AGERD 56 was submitted June 11, 1971. AGE Plan paragraph 3.3.1.1. was referenced on the AGERD. The functional analysis contained the requirement for both viewing and recording of engine part conditions but contained no quantitative technical data such as size or light strength required. The recommended solution was an inspection kit containing borescope, light source, optics, camera, and a carrying case. Required electrical inputs were listed and a description of the use of the tool with an estimate of time in use are included. The figure 1B of this AGERD contains a blank match code block, a need date of February 1, 1972, a development cost estimate of \$1200 for design only and a unit cost estimate of \$8200. Three articles are recommended for Category I and II test and a basis of issue of 2 per organizational unit, 2 per intermediate unit, one for depot use and one for training is recommended. This implies a \$435,000 investment in this borescope if accepted. The total cost block contains \$24,600 which represents test items only and no design cost.

On November 12, 1971 the SPO approved this item for Category I and II testing only. An inventory item was identified (NSN 6650-445-1427YB) which could provide all capabilities except photographing. The need for photographic capability was questioned based on past experience. Therefore, the contractor was instructed to submit an AGERD for the above borescope as GFE for comparison test during Category I and II testing. Further this approval notes conflict between the critical specification and this AGERD over whether the camera is actually part of this item and asks for clarifications. The Material Management Code YB is assigned and five items of data are specified for this item.

The test of this item versus the common borescope took place during testing and the decision was made to use this item for operations but to eliminate the camera from the kit and call on base photo lab facilities on those few occasions when recording was required. The principal reason for this decision was the improved human engineering features of the new item which uses fiber optics thus representing an improvement in the state-of-the-art.

No borescopes are listed in MIL-HDBK-300D; however, one has been submitted by the Navy (NSN 4920-00122-0264) for inclusion in future publications. The RPV program lists borescope NSN 6650-00241-9637MT with unit price \$800 in their operational support equipment list. Neither the case study item, nor the common borescope tested, nor the Navy item, nor the RPV item, is listed in the DO97 Interchangeability and Substitution System. The A-10 CAGEL for peculiar engine support equipment does not list a borescope. This suggests the A-10 successfully located a common item.

This case study illustrates the lack of inventory and experience data available to those specifying small items which are in standard usage throughout the Air Force. Further the Air Force concern for reducing costs and number of items while maintaining maintenance capability is illustrated by their test of two articles for this job and their elimination of the camera requirement through innovation.

CASE 63 - HONEYCOMB STRUCTURE REPAIR KIT

Defense System:	A-10 and F-15
Type:	Mechanical
Functional Area:	Airframe
Level of Use:	Intermediate
Method of Procurement:	GFE

This item is NSN 1730-00601-5156, AGERD 1079 of the A-10 program, and AGERD 480 of the F-15 program. The purpose of this item is to provide explosion proofed heating, holding forces, and consumables required for repairing dents, cracks, tears, holes, and core separations in honeycomb structure contained in control surfaces. This is a standard Air Force inventory item. Its entry in MIL-HDBK-300D is dated April 1, 1970.

The original F-15 AGERD was submitted November 11, 1971 and approved by the SPO January 14, 1972. This approval cycle is the shortest noted for any original AGERD of the F-15 program including all non-case study items and it still exceeds the established standard by 5%. Revision A was submitted August 25, 1972 and approved by the SPO December 14, 1972. The reason for this revision was to incorporate the system area index for the Fire Control System-Radar Set. The November 30, 1974 F-15 CAGEL shows one ordered of eight recommended through the first 7 squadron activations, and none shipped.

This item is included in the A-10 AGE Plan and is item 213 in the A-10 GFE AGE list for DT&E. The original A-10 AGERD contained the date July 2, 1973 although the two subsequent ASD form 0-169s listed the date of the item as June 5, 1973. The recommended solution on this AGERD was the description in MIL-HDBK-300D verbatim. The Depot Provisioning Committee disapproved this item on July 7, 1973 with extensive notes suggesting that required items in the kit be submitted on separate AGERDs. The SPO, however, approved this item on September 17, 1973. Then on November 1, 1973 the SPO revised its decision and listed this item as conditionally approved with a shortened form of

the same note. The contractor's quantity recommendation of 3 per intermediate maintenance squadron was confirmed on this ASD form 0-169. Nevertheless the contractor submitted revision A of this AGERD April 15, 1974. The reason for this revision was to change the work unit code of the item from 110XX to 110XXX. The Depot Provisioning Committee disapproved both the requirement and the solution on May 22, 1974 with specific directions to submit separate AGERDs for required items. The SPO disapproved this item on July 31, 1974 with similar comments. As of February 1975 AGERDs for the separate parts had not been submitted by the contractor.

The need date for this item shown on the AGERDs was September 1975. The A-10 GFE AGE list dated June 15, 1974 lists a need date of December 1974 and none yet delivered. The unit cost on all AGERDs was blank. However the unit cost listed for this item in the Air Force Management Data List is \$5,355.

This case study illustrates that different SPOs reach different decisions on the same piece of equipment even with similar needs, and even when the item is contained in MIL-HDBK-300D. The Air Force procured two AGERDs revised for minute reasons, and two AGERDs whose recommended solution contained text and data supplied to the contractor by the Air Force.

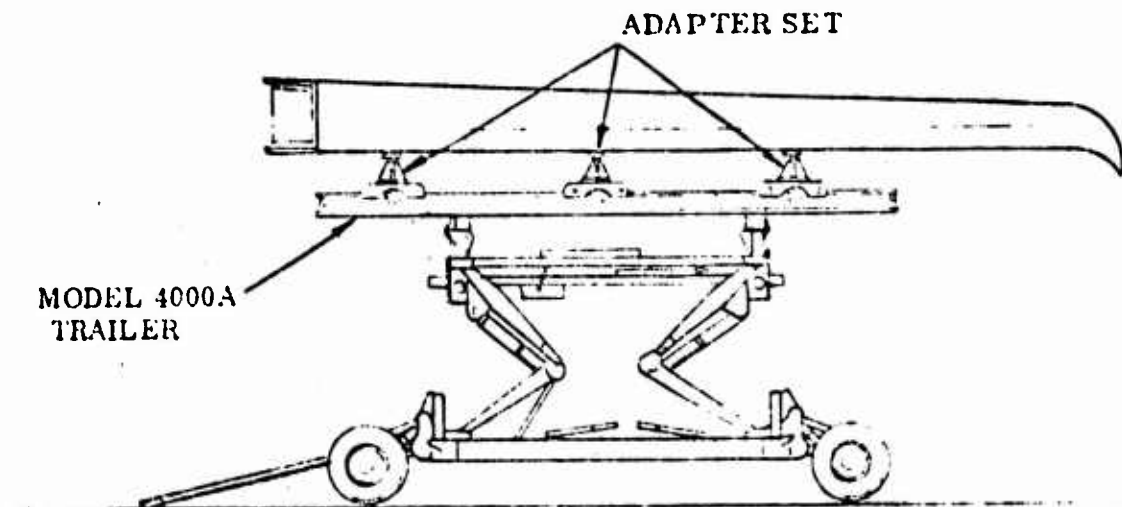
CASE 64 - OUTER WING PANEL ADAPTER

Defense System:	A-10
Type:	Mechanical Tooling
Functional Area:	Airframe
Level of Use:	Intermediate
Method of Procurement:	CFE

This item is NSN 1730-00361-4364 and AGERD number 17 of the A-10 program. It is a set of peculiar supports that mate the outer wing panel to a standard trailer. This article was not included in the AGE Plan. Instead a sling (AGERD 2) was recommended for handling aircraft wings of which the outerwing panel was one of four parts. The original AGERD for this item was submitted on May 3, 1973. The AGERD did not contain information on the tolerance required to mate and unmate the wing parts. The SPO disapproved this AGERD July 6, 1973 with the statement that AGERD 2 would satisfy the function. This decision was supported by the system manager. Subsequent telephone conversations established that the use of the AGERD 2 sling involved high risk of damage to the mating surfaces due to tight tolerances and low expected skill levels of personnel performing the maintenance. There is no documentation of this consideration. Revision A was submitted October 16, 1973 and approved November 14, 1973. Revision B was submitted April 15, 1974 and approved August 28, 1974. Revision B was approved by the depot provisioning committee June 6, 1974.

The contractor estimates the development cost of this item to be \$1,313.00. The contractor's recommended basis of issue was six items per intermediate maintenance squadron. This was reduced to three on the August 28, 1974 ASD Form 0-169. The need date stated on AGERD Revision B is October 1974. Actual delivery took place January 13, 1975. A preliminary Maintenance Engineering Analysis (MEA) covering the outer wing panel and including this item is dated October 18, 1974.

At least one AGERD cycle could have been avoided in procuring this item if the contractor had stated quantitatively the requirements which led him to change from the use of the sling stated in the AGE Plan to this item. The contractor stated that he did not have time to include such data on the AGERD because of the need to submit large quantities of AGERDs in a short period of time.



CASE 64 - OUTER WING PANEL ADAPTER

CASE 65 - INTEGRATED DRIVE GENERATOR ADAPTER

Defense System:	A-10
Type:	Mechanical
Functional Area:	Engine
Level of Use:	Intermediate
Method of Procurement:	CFE

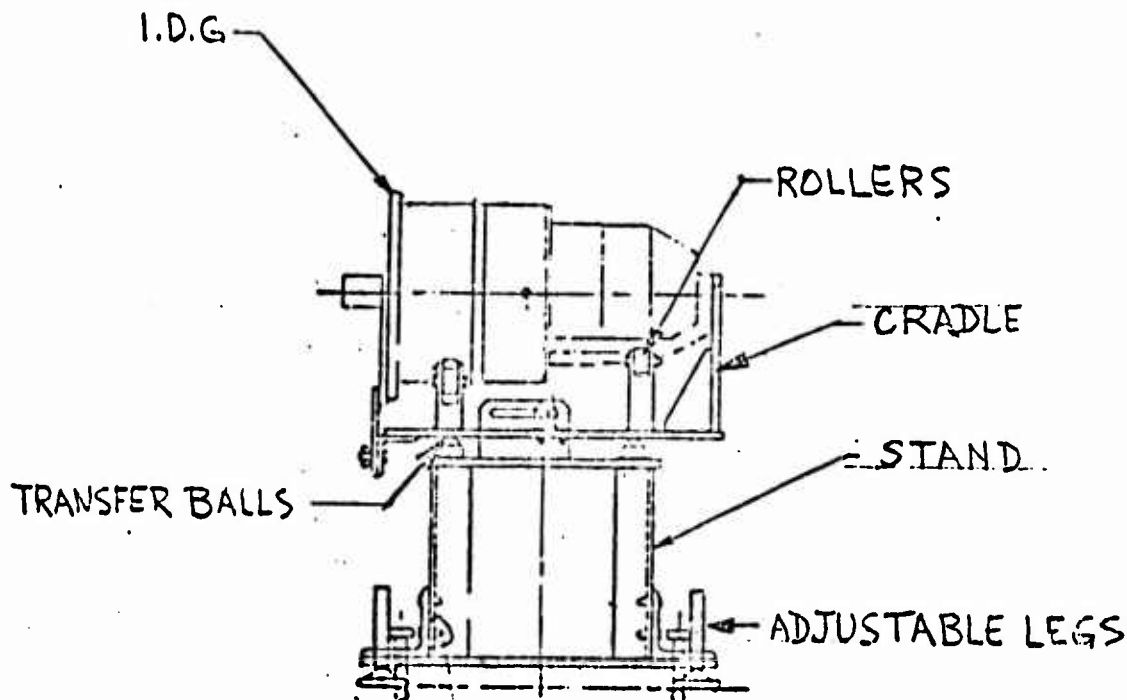
This item is AGERD 54 of the A-10 program. Its intended function is to support the Integrated Drive Generator (IDG) during installation and removal to minimize damage

potential during the operations. This item was identified in the AGE Plan as Contractor Furnished Equipment (CFE). The first AGERD for this item was submitted October 15, 1973. This AGERD stated that the IDG weighed 80 pounds. The requirement for this item was approved but the solution was disapproved on November 12, 1974 by the Depot Provisioning Committee. This action stated that a standard automotive transmission jack could accomplish this function, however none was identified specifically. The SPO disapproved this item on February 1, 1974. No documentation exists of the trade-off of potential damage vs. cost.

On October 25, 1974 the contractor submitted another AGERD for this item. This AGERD stated that the weight of the IDG was 65 pounds. Both these AGERDs were labeled "Original." Further comparison of these AGERDs showed that the need date had changed from June 1974 to November 1974, the unit cost had increased from \$1,400 to \$3,250, the development cost had been estimated at \$2,640 from being blank, and the total buy recommended increased from 52 to 74. The item remained disapproved.

The contractor had developed this item in the time intervening. It is presently in use in performing test and pre-operational support for the aircraft. As of April 22, 1975 a transmission jack had been located by the contractor but not submitted on an AGERD.

This case study and Case 64 illustrate that decisions are not always made on the same side of a trade study question, i.e., risk of damage vs. cost, depending upon the undocumented technical judgment of the SPO personnel with the authority for the decision. This situation happens often in support equipment acquisition because of the large number of items for which decisions are required.



CASE 65 - INTEGRATED DRIVE GENERATOR ADAPTER

CASE 66 - CANOPY RELEASE PIN ASSEMBLY

Defense System:	A-10
Type:	Mechanical
Functional Area:	Ground Safety
Level of Use:	Organizational
Method of Procurement:	CFE

This item is NSN 1730-00272-5776 and AGERD #69 of the A-10 aircraft. Its purpose is to prevent the canopy release sequence from being inadvertently initiated during maintenance.

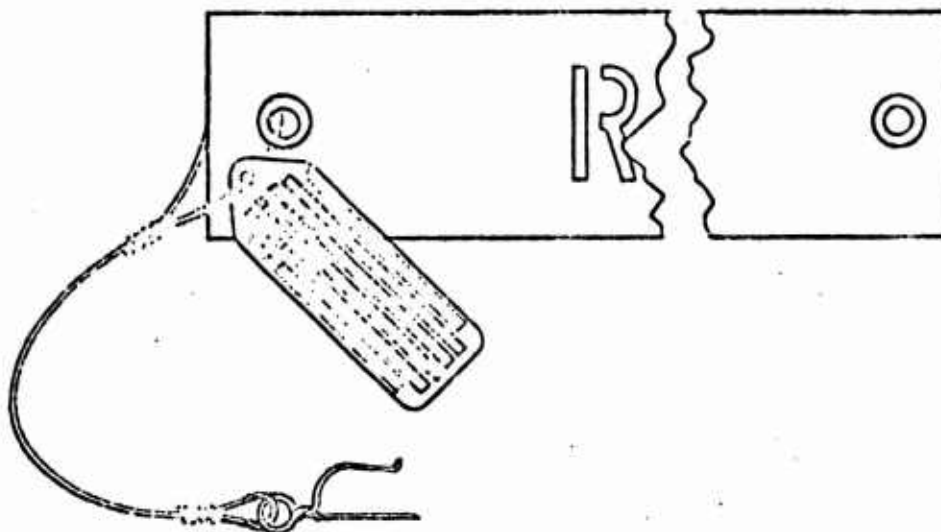
Pins of this nature are common in aircraft maintenance operations. Multiple MIL-SPECs exist for them. The F-15 Consolidated Aerospace Grounds Equipment List (CAGEL) shows four peculiar safety pins with unit costs ranging from \$12 to \$65. The Defense Integrated Data System (DIDS) lists the following three Item Name Codes (INC) under which these items are classified:

<u>INC</u>	<u>Nomenclature</u>
61568	Pin, Aircraft Ground Safety
03509	Pin, Safety
61734	Pin Set, Aircraft Ground Safety

This item is listed in the AGE Plan as an item of CFE. The original AGERD was submitted May 2, 1973. The dimensions of the pin were not included. It was approved by the Depot Provisioning Committee May 14, 1973 with the recommendation of a common item, national stock number 1730-00604-4358. The SPO conditionally approved this AGERD on July 16, 1973 then disapproved on February 4, 1974 when the contractor determined he could use a common pin already submitted on another AGERD. The contractor informed the Air Force of this by submitting AGERD 69 Revision A dated February 1, 1974 noting the deletion. This action was approved by the Depot Provisioning Committee February 15, 1974 and by the SPO on April 16, 1974. Subsequently the contractor determined that he was in error and could not use the common pin. This occurred because of a misunderstanding of contractor personnel as to the position of the pin in the design of the cockpit. A second AGERD labeled revision A was submitted April 15, 1974. The Depot Provisioning Committee approved the April 15, 1974 AGERD on June 6, 1974, and the SPO approved it on August 28, 1974.

The contractor estimates the development cost of this item to be \$880 and the unit cost to be \$50. Although this is a piece of DD780 equipment, i.e., one per aircraft, the contractors quantity recommendation of 25 per squadron was reduced to 24 per squadron on the ASD form 0-169 basis of issue block.

If the contractor had included quantitative data on the size of pin required the system manager would have been able to ascertain the usability of a common pin. This would have prevented the submission of two AGERDs and three ASD form 0-169s.



CASE 66 - CANOPY RELEASE PIN ASSEMBLY

CASE 67 - CRIMPING TOOL

Defense System:	A-10
Type:	Hand Tool
Functional Area:	Electrical
Level of Use:	Intermediate/Organizational
Method of Procurement:	GFE

This item is AGERD 1052 of the A-10 program. The purpose of this simple non-powered handtool is to replace terminals of 18 to 22 gauge wire. This item was selected because the General Accounting Office¹ identified savings available in crimping tools.

¹The Cost of Aerospace Ground Equipment Could be Reduced, General Accounting Office, September 1974, B-177751.

This item is listed twice in the A-10 AGE Plan, first under the heading of Power Distribution System and then again under the heading Electrical System. Eighteen items are duplicated in these sections as recommended for contact removal and splice/terminal installation. Five of these items were not stock listed. This item is item 322 of the A-10 GFE AGE list.

The original AGERD was submitted July 2, 1973, approved by the Depot Provisioning Committee July 30, 1973, and by the SPO September 17, 1973. Pencil notes on the system manager's copy state that the functional analysis was inadequate. This may have been due to the wire size being included in the recommended solution rather than the functional analysis. The gauge range so listed (18-22) matches the wire diameter accommodated as stated on the Federal Item Logistics Data Record, DD form 146, for steel wire. It slightly exceeds this range for non-ferrous wire gauges. The type of wire, wire diameter, and gauge system in use are not stated. The quantity recommended by the contractor was also penciled in to be reduced from 174 to 48. Revision A of this AGERD was submitted April 15, 1974. The reason for this revision was to change the third digit in the work unit code. This AGERD was approved by the SPO August 6, 1974 stating the reduced quantity mentioned above. The item had been delivered to flight test in December 1973.

The unit cost of this item as listed in the Air Force Management Data List, is \$26. General Services Administration, the buying agent for this item, told LMI that the unit cost was \$39.17. They also informed us that the NSN on all the A-10 documents, 5120-00293-2321, had been changed to 5120-00832-76420, that this item has been in the inventory since 1971 at least, and that the item is used by all three services including some sent overseas.

The contractor stated that no funds had been expended for development of crimping tools or crimping tool kits. Five crimping tools (including Case 68) are listed in the A-10 GFE AGE list, however, none of their NSNs is listed in the F-15 CAGEL or the AIMS AGE List, although the former lists 2 crimping tools and the latter 3. The Defense Support Program Data Reduction Center Index of AGE Items dated May 18, 1973 lists 24 crimping tools.

The contractor further stated that in his opinion this and Case 68 should have been entered on the hand tool list instead of being submitted on AGERD.

This case illustrates the contradictory nature of standardization studies in an organization as large as the DoD. Although this item was found to be in tri-service use, no commonality of crimping tools at all was found among studied defense systems. It also illustrates that data can be duplicated in the AGE Plan and two AGERDs processed through the entire cycle, one for a minute revision, while a method exists (the standard hand tool list) to eliminate AGERDs completely. Finally, even on this small standard item quantitative technical data was inadequate in the Air Force's opinion for thorough analysis.

CASE 68 - HYDRAULIC CRIMPING TOOL

Defense System:	A-10
Type:	Hydraulically Driven Tool
Functional Area:	Electrical
Level of Repair:	Intermediate/Organizational
Method of Procurement:	GFE

This item is NSN 5120-00879-8365 and AGERD 1058 of the A-10 program. Its purpose is to splice terminals of #4 and #6 gauge wire. It was selected because of the high unit cost of \$773 noted by the system manager.

This item was contained in the A-10 AGE Plan twice (see Case 67 for details) and is item 327 in the A-10 GFE AGE List. The original AGERD was submitted July 2, 1973, approved by the Depot Provisioning Committee July 30, 1973 and by the SPO September 17, 1973. The unit cost estimate on this AGERD was blank, the need date was September 1975, and the quantity recommendations and their changes were exactly the same as Case 67. The only quantitative data contained in the functional analysis was the gauge numbers 4 and 6. Wire diameter in inches or the gauge system in use (at least 6 systems can be found in technical handbooks) were not specified. Revision A was submitted April 15, 1974 changing only the third digit of the work unit code. This AGERD was approved by the SPO on August 6, 1974. As of June 15, 1974 no deliveries of this item to flight test had been recorded.

The General Services Administration was identified as the buyer for this item by the system manager. They could not, however, identify the NSN and stated that it was nonexistent. LMI located the NSN in the DoD and Air Force Management Data Lists and found a Federal Item Logistics Data Record, DD Form 146, for this NSN. The latter form identified the wire size accommodated as contiguous with Case 67 and the operation method as hydraulic. This hydraulic operation apparently accounts for the high unit cost of the item. The DoD Management Data List showed the unit cost of this item as \$852.50. The Air Force Management Data List showed the unit cost as \$785.30.

This item is not contained in MIL-HDBK-300D although it qualifies financially using the unit cost and contractor's quantity recommendations. In fact no crimping tools, operated hydraulically or otherwise are in MIL-HDBK-300D. Nor is this item listed in the D097 Interchangeability and Substitution System.

This case study illustrates that lack of unit cost and method of operation information, which should have been on the AGERD, can cause the system manager to commit funds greater than he expected. Technical data problems were identified on the AGERD and confusion was noted about the NSN. An AGERD revision was submitted for a minute reason and the hand tool list could have been need to procure this item as in Case 67.

CASE 69 - BELLMOUTH

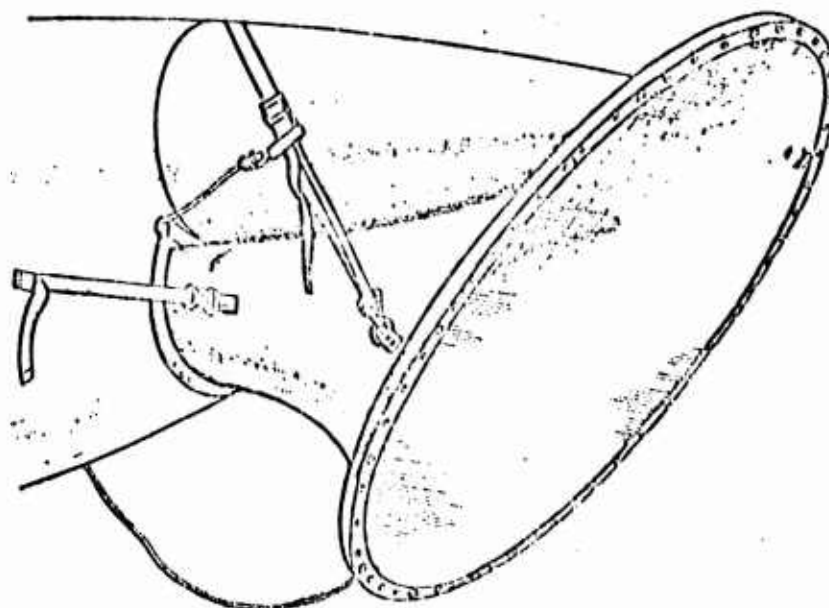
Defense System:	RPV-AQM-34 Series Except V
Type:	Mechanical
Functional Area:	Engine
Level of Use:	Organizational
Method of Procurement:	CFE

This item is NSN 1730-00401-7272KH and Teledyne Ryan Aeronautical part number 147M100-43. It has been procured on 5 Air Force Contracts dating from February 1965. Its purpose is to shape the flow of air to the engine during ground operation to better simulate flight conditions, and to provide a screen to prevent foreign object ingestion.

A bellmouth is a standard item used with all RPVs in conjunction with engine testing. Six bellmouths are listed in the RPV operational AGE list ranging in unit price from \$1,000 to \$10,100. The item studied is the most expensive of these items. Four of these bellmouths are listed in the Combat Angel Update existing AGE list. Nevertheless no bellmouths are contained in MIL-HDBK-300D even though all qualify by unit cost. The study item is also not contained in the D097 Interchangeability and Substitution System. Therefore contractor and Air Force personnel's commodity knowledge is required to assure proper item procurement. For example this item was originally planned for procurement on the AQM-34V vehicle; however, modifications to the vehicle made a less expensive bellmouth usable. This fact was noticed by contractor engineers and procurement was terminated.

This item was procured under the "Big Safari" concept of rapid capability acquisition while avoiding routine procurement channels. The second contract for this item achieved delivery 6 months before the first. Contract date to delivery date has varied from 3 months to 13 months. Four types of contract have been used to procure this item, cost-plus-fixed-fee, cost-plus-incentive-fee, fixed-price-incentive, and fixed-price.

This case study illustrates the lack of centralized data for selection of existing support items even when they are routine mechanical items. Further the lack of a systems engineering plan might have led to procurement of an unusable unnecessarily expensive item if project personnel had not identified the interface change between bellmouth and prime vehicle.



CASE 69 - BELLMOUTH

CASE 70 - ALIGNMENT FIXTURE KIT

Defense System:	RPV-AQM-34 Series
Type:	Mechanical-Tooling
Functional Area:	Airframe
Level of Use:	Intermediate and Depot
Method of Procurement:	CFE

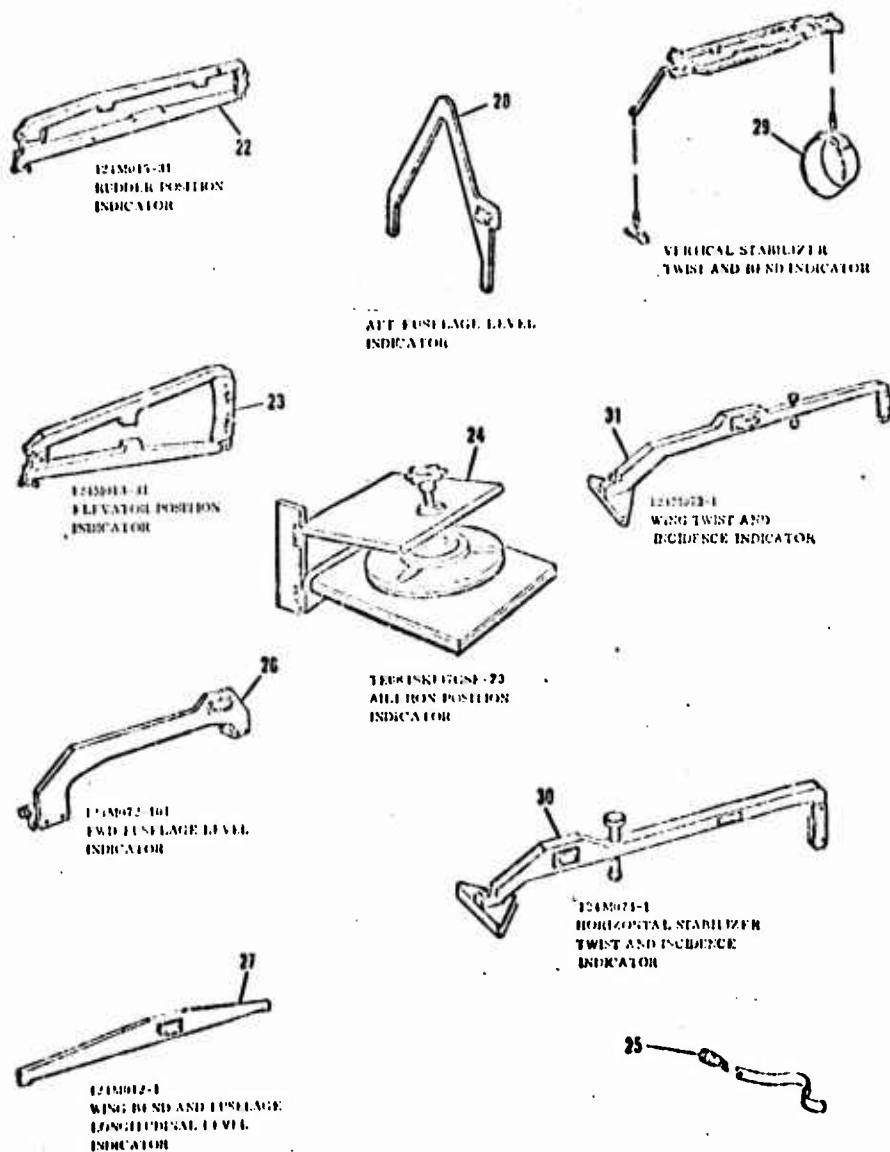
This item is NSN 4920-00358-0644KH and Teledyne Ryan Aeronautical part number 147M146-3. The purpose of this item is to measure bends, twists, and deflections of the airframe and aerodynamic surfaces. Alignment Fixture Kits are used with all recoverable RPVs to determine need for adjustment. The same items contained in this kit are used on the production line to assure correct manufacture.

This item was procured under the "Big Safari" concept of rapid capability acquisition while avoiding routine procurement channels. Six have been procured on 5 Air Force contracts dating from February 1965. The unit cost of this item is \$11,700. Recent

contracts have been fixed price while earlier contracts were cost-plus-fixed-fee. Delivery on the second contract was earlier than the first with contract to delivery times ranging from 6 to 13 months. Technical order T.O. 49A11-13-4 was procured in support of this kit.

This item is not contained in MIL-HDBK-300D, nor the D097 system, nor the Combat Angel Update list of existing AGE. Four of the ten part numbers included in this kit are separately listed in the RPV operational AGE list, and assigned to the same bases as the kits. Their unit costs total \$3,700. A carrying case for one such item and two others not listed in this kit is shown with a unit cost of \$600. Three such cases are used to carry the kit instruments. From this data it appears that the price of the kit is fair considering the price of its components.

This case study illustrates how simple items can be duplicated by inconsistent listing of member items in kits. It points out the lack of central technical data files to identify items of this sort.



CASE 70 - ALIGNMENT FIXTURE KIT

CASE 71 - OPTICAL ALIGNMENT KIT

Defense System:	DSP - User Display System
Type:	Mechanical
Functional Area:	Optical
Level of Use:	Intermediate
Method of Procurement:	CFE

This kit is AGERD 084 and Gretag Co. of Zurich, Switzerland, part number 53.12.55. Its purpose is to precisely align the dual path lamp optics of the Large Screen Wall Display.

The original AGERD was submitted for this item on August 31, 1973. This AGERD was necessitated by ECP 0021 which is referenced both in the revision number of the figure 1A and in the contract number of the figure 1B. No quantitative data is contained in this AGERD although the word, "precise," implies measurable accuracy. AGE Plan section 3.3.2 is referenced however no optical alignment kit is called out either in that section or among the 23 items listed for intermediate maintenance. Although a commercial-off-the-shelf item is recommended, the proposed source is GFE, and a development cost of \$278 is estimated. However, this \$278 is excluded from the total cost shown. The unit cost estimate is \$700, and the need date is March 27, 1974. The item is identified as procurement critical for the Air Force, and the Federal Manufacturers Code given is listed as cancelled in the November 1969 list. The manufacturer's part number differs by one digit from figure 1A to figure 1B. the responsible agency entry has a letter omitted making it unclear which depot is intended. Penciled in on the system manager's copy is the Federal Stock Class 5820 Radio and Television Communication Equipment Except Airborne. This FSC is crossed out and FSC 1830, Space Vehicle Remote Control Systems and the Material Management Code VE written in. This FSC change changes one-third of the routing of AGERDs. This AGERD was approved October 10, 1973.

Revision A was submitted January 4, 1974. The only differences between these AGERDs were the addition of the note ERRCS, (depot non-expendable) the inclusion of FSC 1830 and MMC VE, one digit change in the FMC to a number not listed in the November 1969 list, and the deletion of 5 characters from the end and the change of 1 character in the contractor's part number. The latter corrects the figure 1B entry. Depot personnel reported they were able to obtain detailed specifications on this kit only in German and were denied funds to purchase a technical German dictionary.

This case study illustrates the lack of quantitative data that is submitted under the current AGERD headings. Further it notes the wealth of confusing data submitted by contractors and used by the Air Force.

CASE 72 - DIAL INDICATOR

Defense System:	DSP-Data Reduction Center
Type:	Mechanical Instrument
Functional Area:	Computer
Level of Use:	Organizational
Method of Procurement:	CFE

This item is AGERD 0209, NSN 5210-00946-2130, and Alina Corp. part number M32. Its purpose is to measure the alignment of the capstan hubs of the Recorder/Reproducer Set after replacement or adjustment to the tape transport. This item and case 31 were selected to illustrate how items used together are procured using separate AGERDs.

The requirement for this item can be found in the AGE Plan Dated October 30, 1970 section 3.2.1.1.3.3 which calls out this item by manufacturer's part number. The original, revision A, and revision B could not be located. Revision C of this AGERD was submitted May 18, 1973 under the same contract number as the AGE Plan. This AGERD referenced the above AGE Plan section and contained excellent functional analysis and recommended solution sections. The fact that two dials are required for use with each Case 73 item is identified. Figure 1B of this AGERD listed the same need dates as Case 47 although the latest was a year-and-a-half earlier than the submission date and the actual activation dates were approximately 8 months after those listed. Eight items are called for under organizational requirements but only 6 are recommended for procurement. No explanation of this discrepancy is provided. The unit cost estimate is \$57. The proposed source is CFE, and the prescreening match code is K. A requirement for calibration is noted without further information. Remarks list two purchase orders under which this item was procured and the fact that it is used with case study item 73. This item was approved March 17, 1972. All items in this category were delivered on time. The Air Force Management Data List shows a reduction in unit cost of this item to \$35.50.

Comparison of this study to item 73 shows that although these items are used together they received different Federal Stock Classes, one is material management coded and one isn't, they had different prescreening match codes and one was approved while the other had a blank approval block. Further the quantities do not agree with the stated ratio of number used to accomplish their purpose. Nevertheless, they were procured on time and used successfully by the Air Force.

CASE 73 - CAPSTAN ALIGNMENT FIXTURE

Defense System:	DSP - Data Reduction Center
Type:	Mechanical
Functional Area:	Computer
Level of Use:	Organizational
Method of Procurement:	CFE

This item is AGERD 0200, NSN 5835-00435-3522CI, and Ampex part number 1208100-01. The purpose of this item is to assure that capstan run-out alignment does not exceed its specified maximum. It was selected to illustrate how two items (this and Case 72) required for the same task got different treatment in the support equipment acquisition process.

The requirement for this item can be found in the October 30, 1970 AGE Plan section 3.2.1.1.3.2 which identifies this item by manufacturer's part number. The fact that two Case 72 indicator dials are required is included.

The original, Revision A, and Revision B could not be located. Revision C was submitted May 18, 1973. This AGERD included reference to the AGE Plan paragraph above and the requirement for two dial indicators for use with the fixture. The functional analysis and recommended solution contain sufficient quantitative technical data for selection of the item. The same obsolete need dates of Case Study 47 and 72 are on this AGERD but the approval date is blank. The unit cost estimate is \$204, and the prescreening match code is J. A quantity of 6 is recommended, 2 each at each DRC. Only 4 are ordered including notes on the purchase orders involved. No explanation of the difference between orders and total is included, nor of why the ratio of this item to Case 72 is not 1 to 2 since 2 dials are used with each fixture. The Air Force Management Data List shows a unit cost of \$110 indicating some price reduction. This item was delivered on time to its user.

Comparison of this item to Case 72 shows differences in FSC, in application of Material Management Code, in prescreening match code, and inconsistent ratio of quantity recommended. Nevertheless, both items were delivered on time and used successfully by the air Force.

CASE 74 - REFRIGERATION UNIT SERVICE KIT

Defense System:	AF Satellite Communications
Type:	Mechanical
Functional Area:	Refrigeration
Level of Use:	Organizational and Intermediate
Method of Procurement:	GFE

This item is AGERD 121 and NSN 5180-00596-1474. Its purpose is to fault isolate and repair malfunctions within the air conditioner of the transportable shelters.

This item is contained in the matrix of AGE items in Revision C of the AGE Plan dated May 31, 1974. However, no further mention of the item is made at all although higher numbered AGERDs and other items of GFE are extensively referenced.

The original AGERD was submitted April 15, 1974 and the requirement was approved May 1, 1974. Revision A was submitted September 30, 1974. The reason for this revision could not be determined. Page numbering was continuous. The functional analysis enumerates seven required actions. Only one of these contains quantitative data. The recommended solution contains a list of 80 NSNs contained in the kit which is reproduced from other sources. All seven areas mentioned in the functional analysis are addressed by the tools in the kit. The quantitative data identified is not specifically mentioned as covered but is likely to be from the nomenclature used.

The figure 1B of this AGERD contains blank match code and unit cost estimate blocks. The unit cost used in the contractor's ORLA was \$100, however, the Air Force Management Data List shows a unit cost of \$444. One article is recommended, however this is not illustrative of the number needed since no planning factors for deployment were used in this program. Approximately 250 ground locations are planned.

This AGERD states that MIL-HDBK-300 was screened even though this item is in the inventory and does not qualify on a unit cost basis. The item is not in the DO97 System or MIL-HDBK-300D. The Federal Manufacturer's Code corresponds to the Chief of Engineers, Gravelly Point, Virginia.

The need date shown for this item is January 6, 1975. It had not been delivered in late-January 1975 because of the lengthy cycle required by AFLC to obtain funds and procure additional inventory items. The SPO estimates that this late delivery will not cause schedule delay until August 1975.

This case illustrates that even with lengthy Functional Analysis and Recommended Solution quantitative technical data can be inadequate to analyze even an inventory item. The Air Force is therefore forced to accept the recommendation of the contractor. Further when schedules are tight AFLC has insufficient time to budget funds and make procurements of additional inventory items. It also illustrates the inaccurate cost data included in early trade studies.

CASE 75 - STOPWATCH

Defense System:	AIMS, A-10, and F-15
Type:	Timing Equipment
Functional Area:	Support Equipment for Support Equipment
Level of Use:	Depot and Organizational
Method of Procurement:	GFE

This item is listed in the AIMS AGE list under 6 unique AGERD numbers. It is AGERD 367 of the F-15 program and A-10 System Manager's item number 335. Its NSN is 6645-00250-4680 although two entries list the same FIIN with FSC 6625 and one entry lists FIIN 00250-4780. All represent the same item. The General Services Administration part number is GGS-764 Type I Class II. It is also Minerva Corp. part number 140W. The purpose of this item is to manually time the duration of events occurring during tests as required.

The earliest AGERD found by LMI is AGERD 30 of the TTU-229/E Test Set, Automatic Altitude Reporting Encoders and Altimeters. This AGERD was submitted March 22, 1968. It contained a reference to an earlier AGE Plan paragraph 3.4.2.1. The functional analysis contained technical data relating only to the prime equipment. The accuracy and maximum interval timeable were not listed. The recommended solution contained this data for the recommended item by contractor's part number. This recommended solution was submitted on a separate page dated the same but labeled Revision A. No Revision A is indicated for this AGERD in the AIMS AGE List.

The figure 1B of this AGERD contained blank National Stock Number, Match Code, and date required blocks. The proposed source was GFE and 8 were recommended for depot use. The unit cost estimate was \$50. Fifty dollars appears in the AIMS AGE List in 5 of the 6 entries, and \$58 appears once. The Air Force Management Data List also shows a unit cost of \$50.

AGERD 367 of the F-15 program was originally submitted June 16, 1971 but never acted on it because Revision A was submitted July 19, 1971. This revision was approved September 24, 1971. Four more revisions have been submitted as of January 24, 1975. The latest, submitted October 29, 1974, remained pending as of January 24, 1975. All revisions have been to add additional system areas which use the item. The November 1974 F-15 CAGEL shows 34 stopwatches recommended and 4 ordered for both organizational and depot use.

The A-10 GFE AGE List dated June 15, 1974 shows three required beginning August 1974 and none delivered. An alternate stopwatch is listed which had appeared in the A-10 AGE Plan in which the study item did not appear. This alternate item is listed in T.O. 33K-1-101 Calibration Standards and Associated Equipment.

This item is not listed in the DO97 Interchangability and Substitution System and neither is the A-10 alternate. One stopwatch is contained in MIL-HDBK-300D. It was entered by the Army in 1970 but is not as accurate as the item described in the recommended solution. It cannot be determined whether this item is usable because of the lack of data in the functional analysis.

This case study illustrates the diversity of conflicting data that is contained or missing in Air Force data systems. Standardization, however, was achieved through common use of the GSA catalogs, not through Air Force data systems.

CASE 76 - MAINTENANCE/SUPPLY SHELTER 485L

Defense System:	485L
Type:	Protective Shelter
Functional Area:	Maintenance/Supply
Level of Use:	Intermediate
Method of Procurement:	GFE

This item is AGERD 47 of the TACC Auto project. No NSN or manufacturer's part number are included in its identification. The purpose of this item is to provide protection for the Case 9 tester, repair tools, spare parts, and other intermediate level items.

The original of AGERD 47 was submitted February 22, 1974. No AGE Plan is referenced. The functional analysis does not contain any quantitative data at all. The recommended solution contains the specification number CP550100-D but it is not clear to whose specification this refers. The dimensions of one shelter are given together with the statement that two shelters combined give three times the individual area which will provide the space required. Combining these data implies that at most 265 sq. ft. are required. The figure 1B of this AGERD contains blank National Stock Number, Manufacturer's code and part number, match code, development cost, unit cost, and need date blocks. The proposed source is GFE, even though the program number 485L appears in the name blocks of both the Figure 1A and 1B implying a peculiar equipment. Ten articles are recommended for intermediate use and the statement is made that MIL-HDBK-300 was screened. The specification number on the Figure 1A is not included. As of January 1975 this item was being held pending the resolution of Case 9.

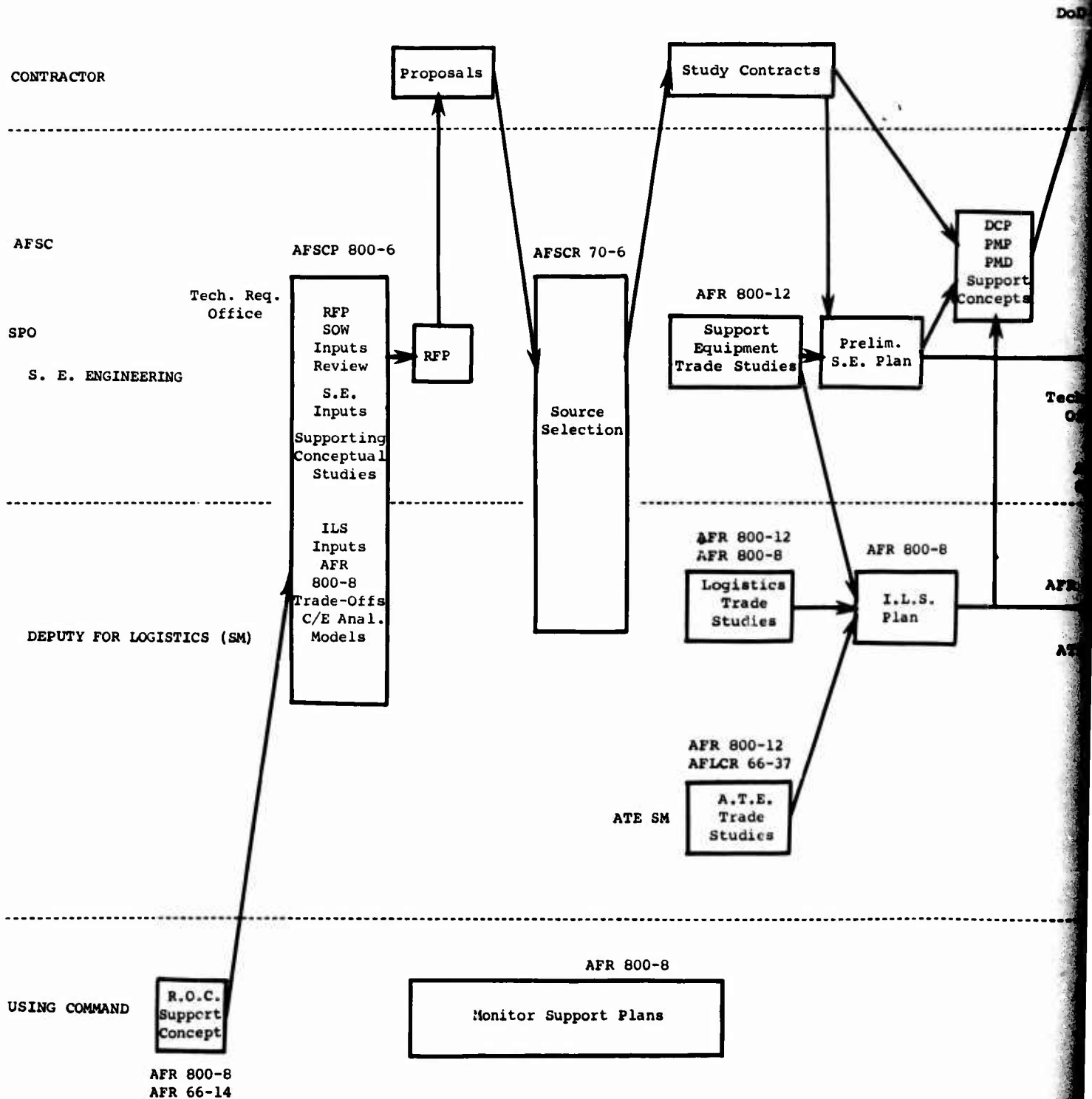
Eight shelters are listed in MIL-HDBK-300D. None display specification numbers remotely similar to that shown. Only one of these could be a candidate for the stated requirement for reasons of non-portability, too small or too tall. The one that does qualify contains electrical equipment which is appropriate but not stated in the

requirement. NSN 8340-00782-3232, a 16 x 16 shelter (4% below the calculated maximum requirement) was recommended by a recent TAC study¹ for other Air force use.

This case study illustrates the lack of data upon which Air Force personnel are required to make decisions. The space requirement had to be inferred from the recommended solution and the identification of the recommended item was inadequate.

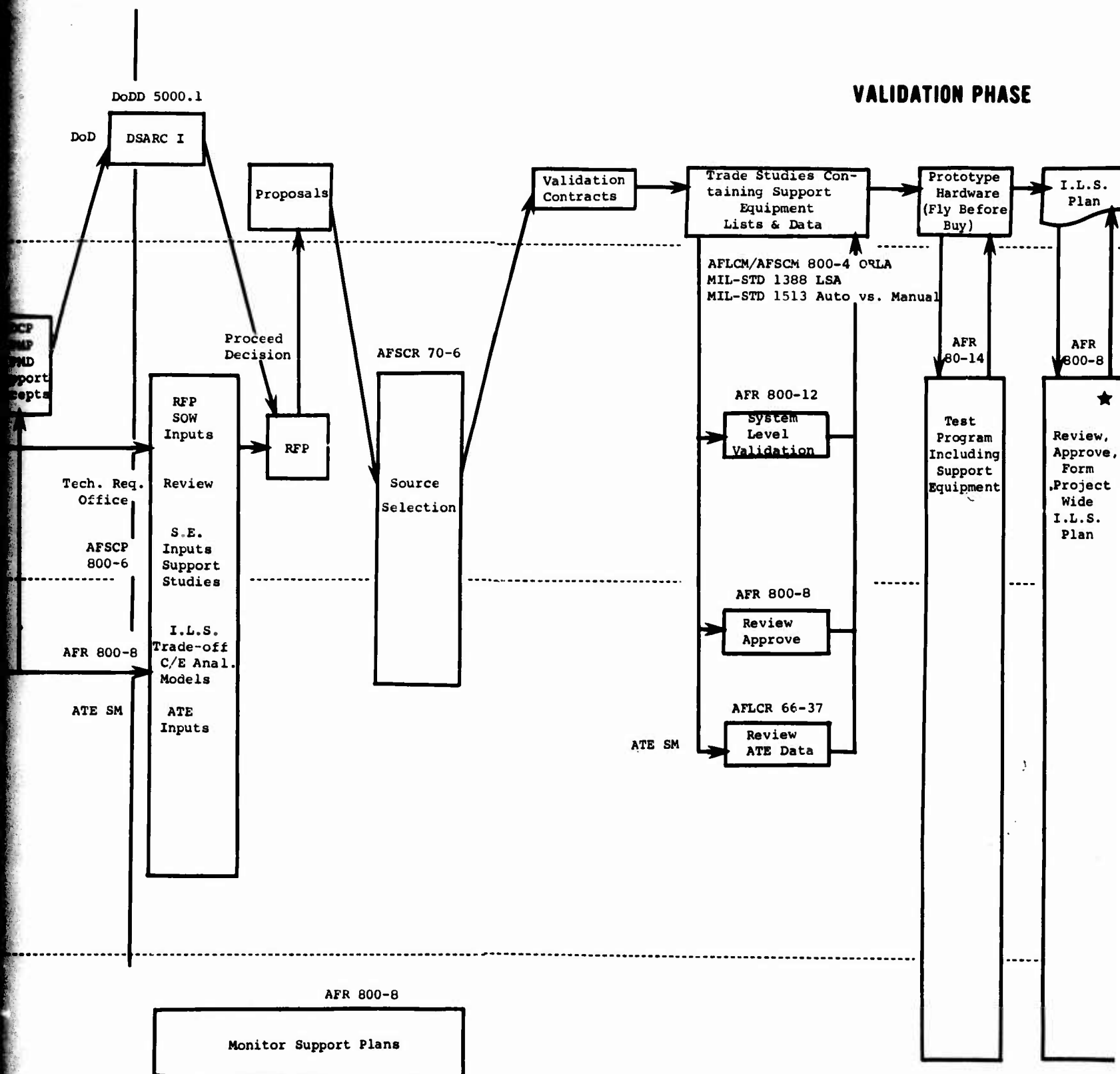
¹Study/Evaluation of Candidate Field Support Equipment for the Tactical Air Control System, Final Report, April 1975, TAC Project 74E-067T, AD B003 509L.

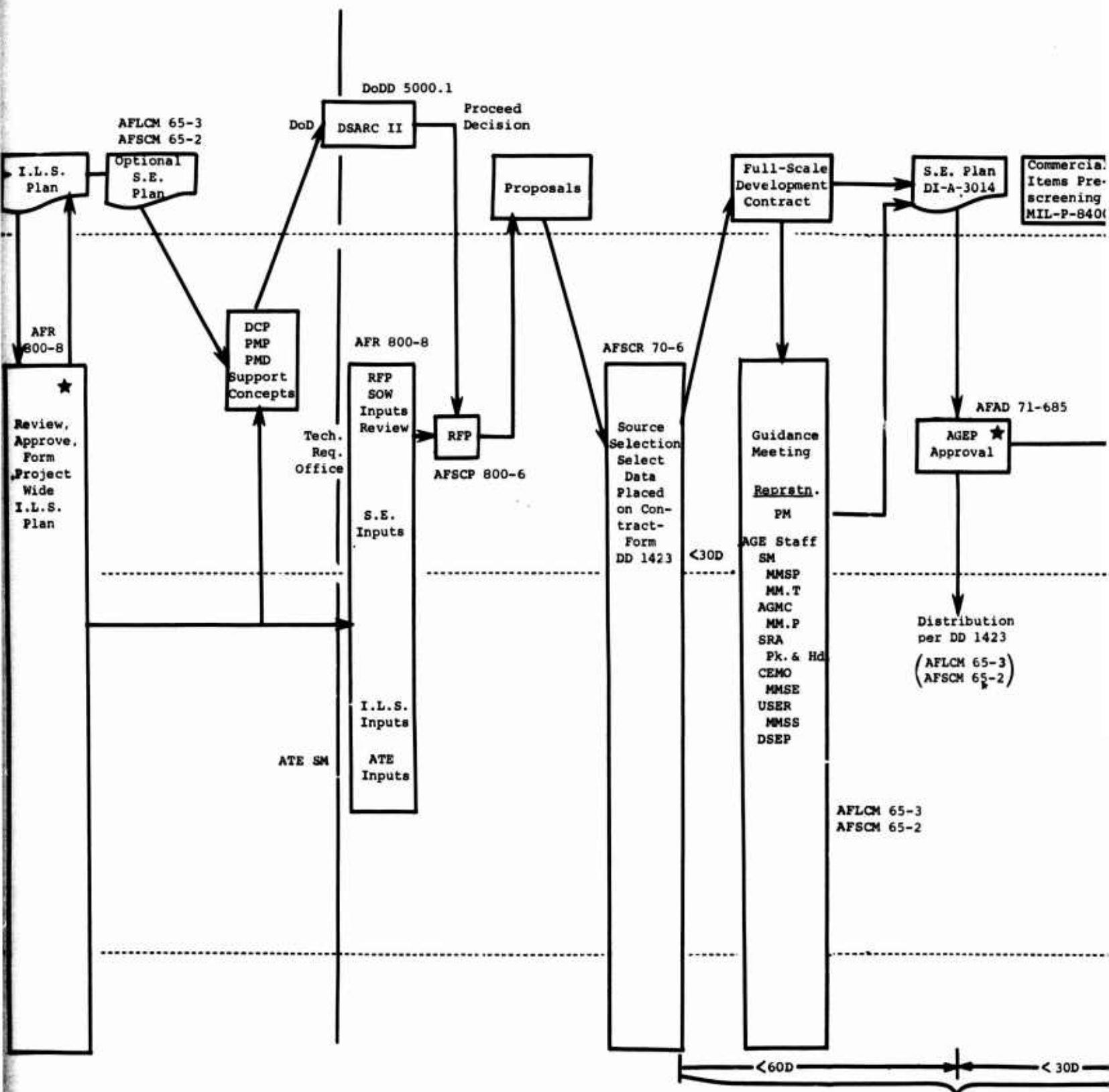
CONCEPTUAL PHASE



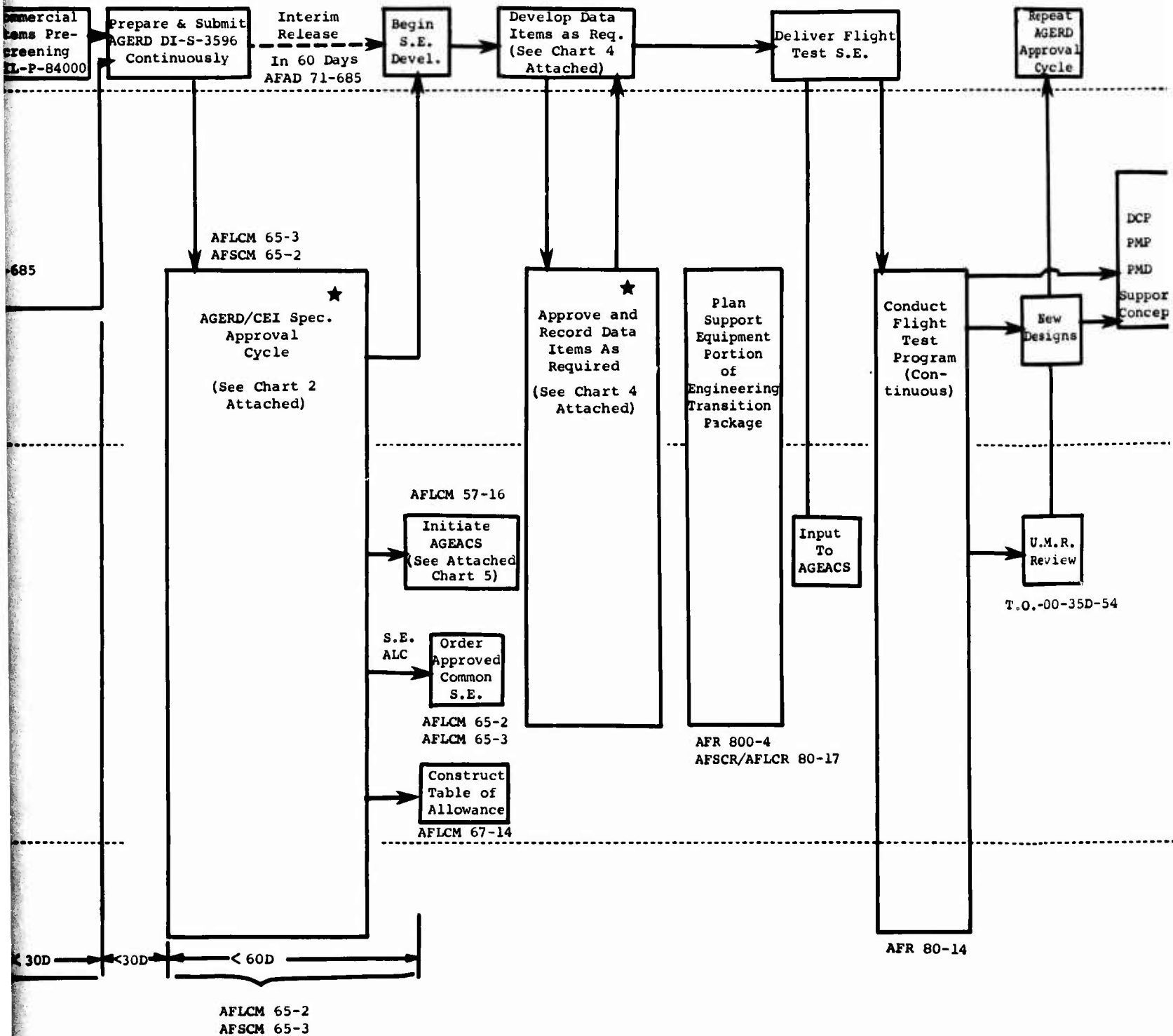
★ Quality Assurance Function

VALIDATION PHASE

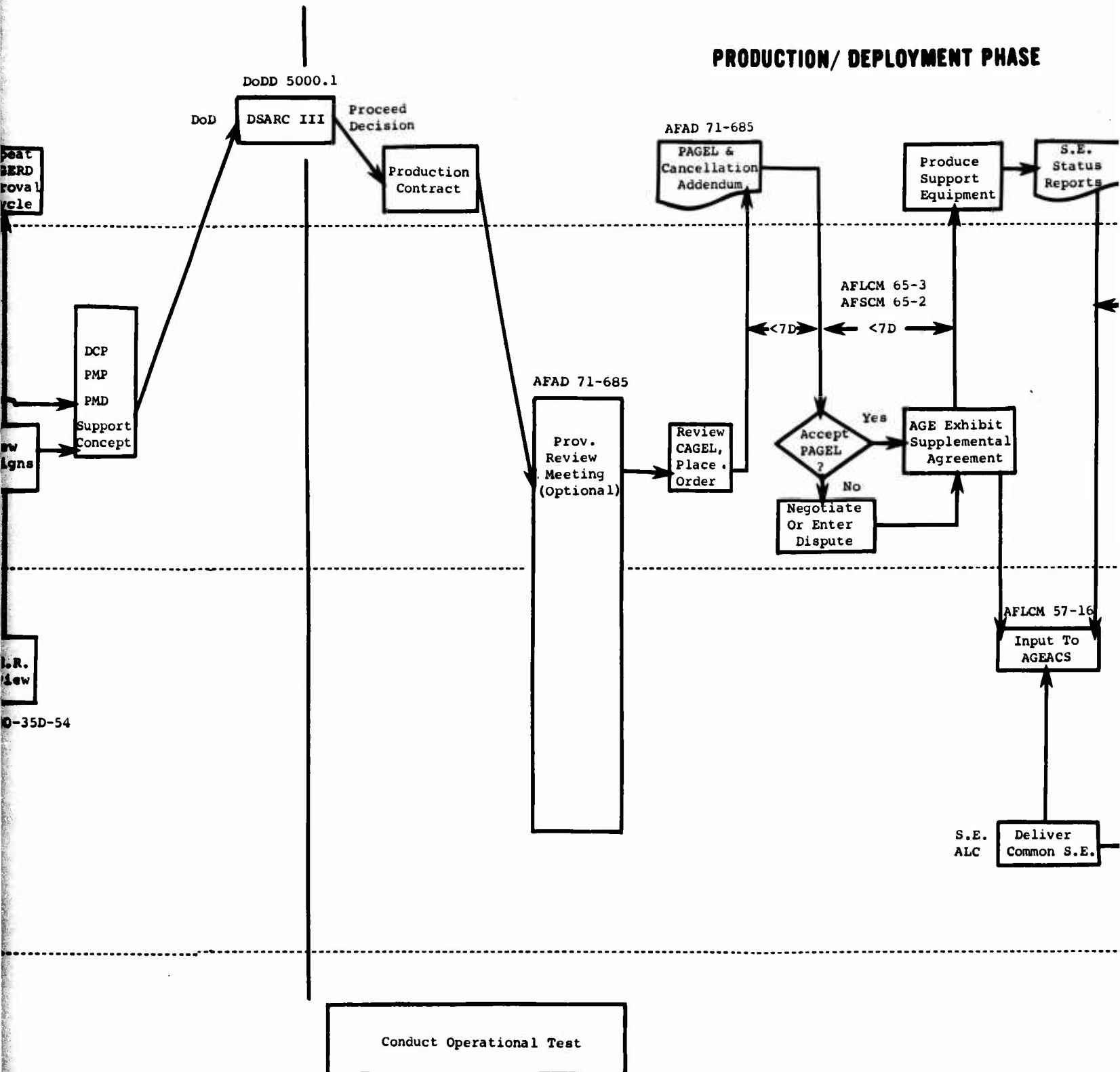


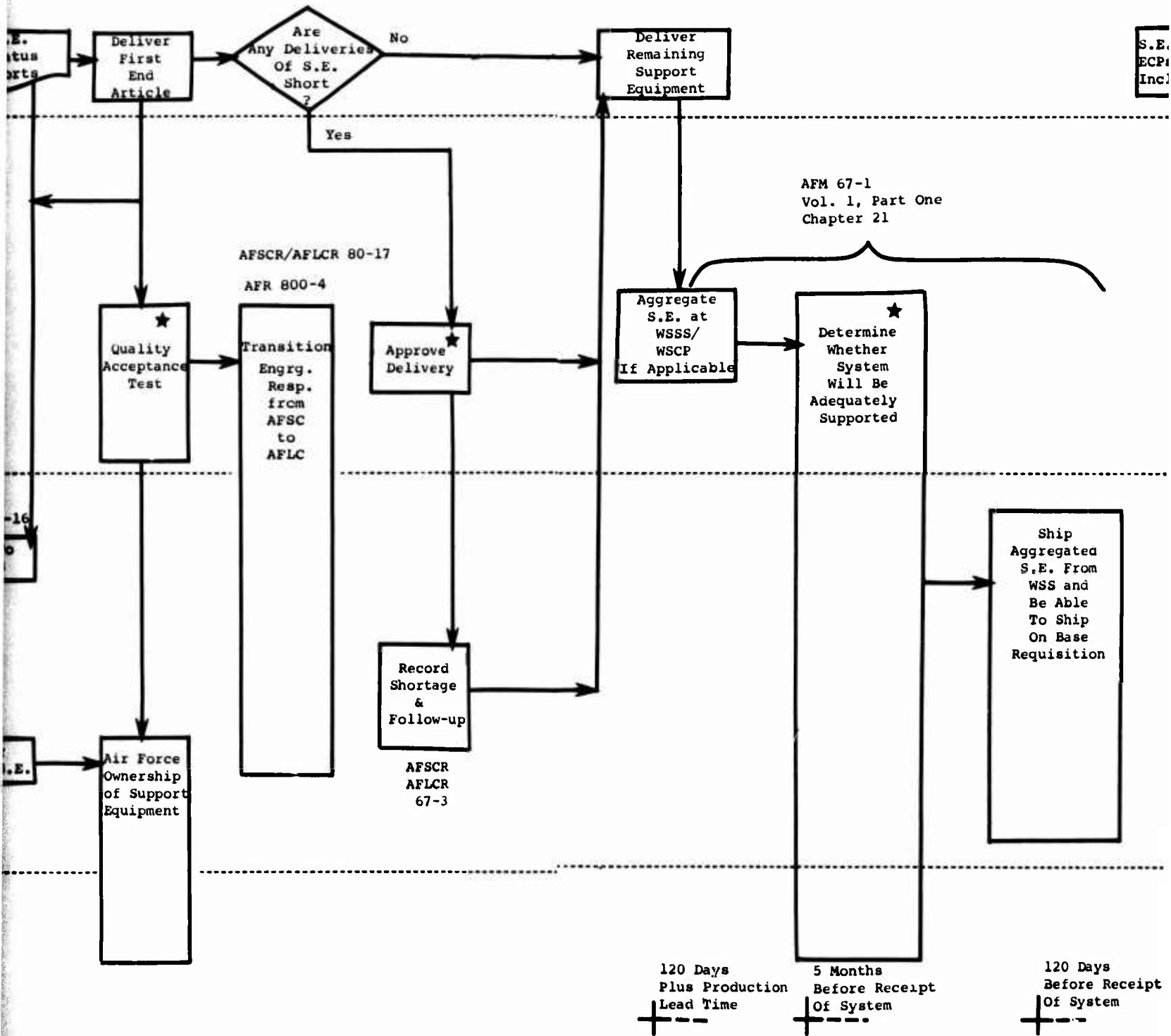


FULL - SCALE DEVELOPMENT PHASE



PRODUCTION/ DEPLOYMENT PHASE





S.E. Changes In
ECPs DI-E-3128
Including AGERD

Incorporate
Changes

Repeat AGERD
Approval Cycle
(See Attached
Chart 2)

Ship
Aggregated
S.E. From
WSS and
Be Able
To Ship
On Base
Requisition

**CHART 1- PROCEDURAL FLOWCHART OF AIR FORCE
SUPPORT EQUIPMENT ACQUISITION PROCESS**

120 Days
Before Receipt
Of System

+---

~

CHART 2 - AGERD APPROVAL CYCLE

AFLCM 65-2
AFSCM 65-3

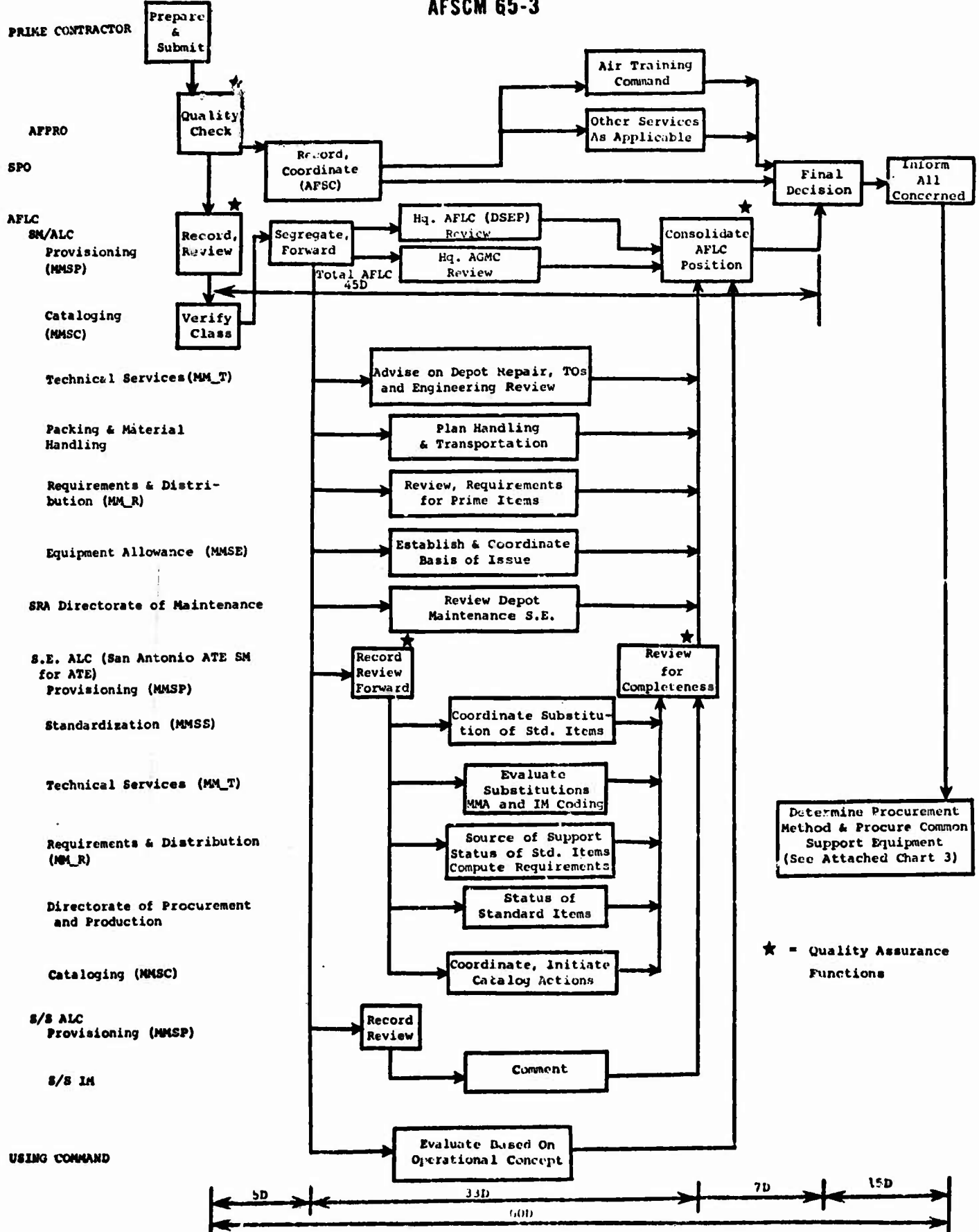


CHART 3 - STANDARD S. E. PROCESSING
AFLCM 65-3 Part 10 Chapter 1 Section 5.f.(4) (e)
AFSCM 65-2

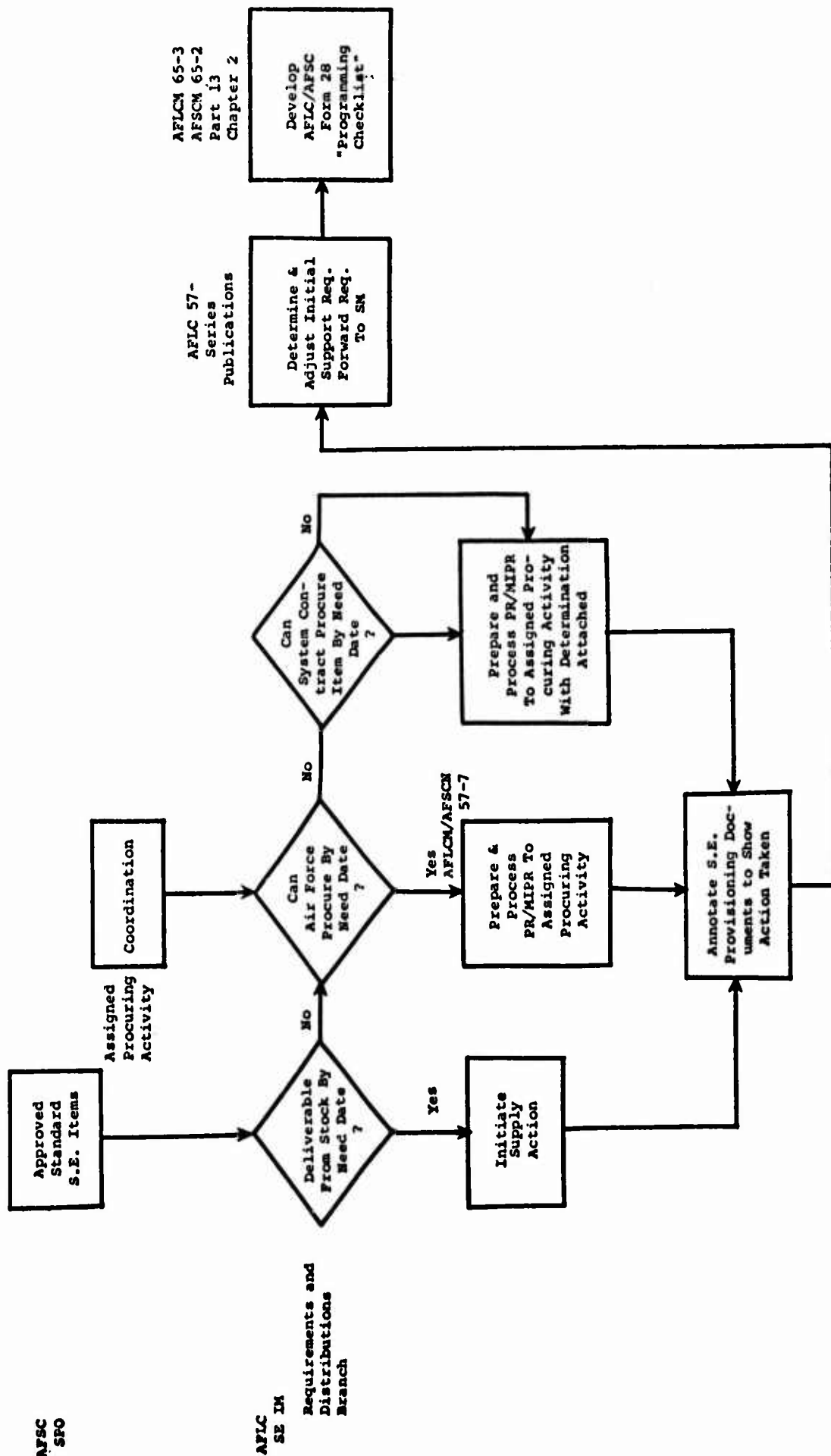


CHART 4 - SUPPORT EQUIPMENT DATA When Selected on DD Form 1423

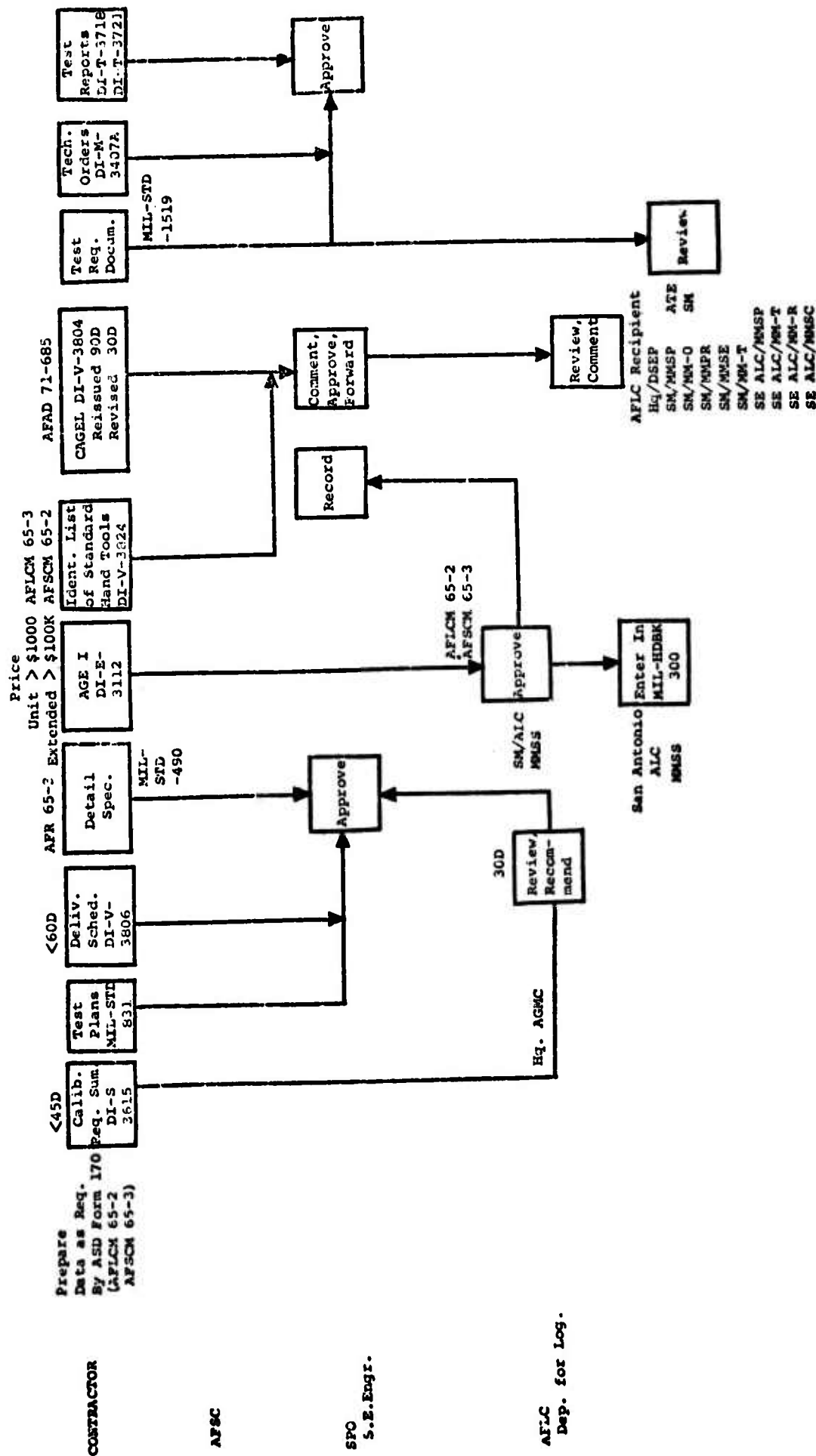
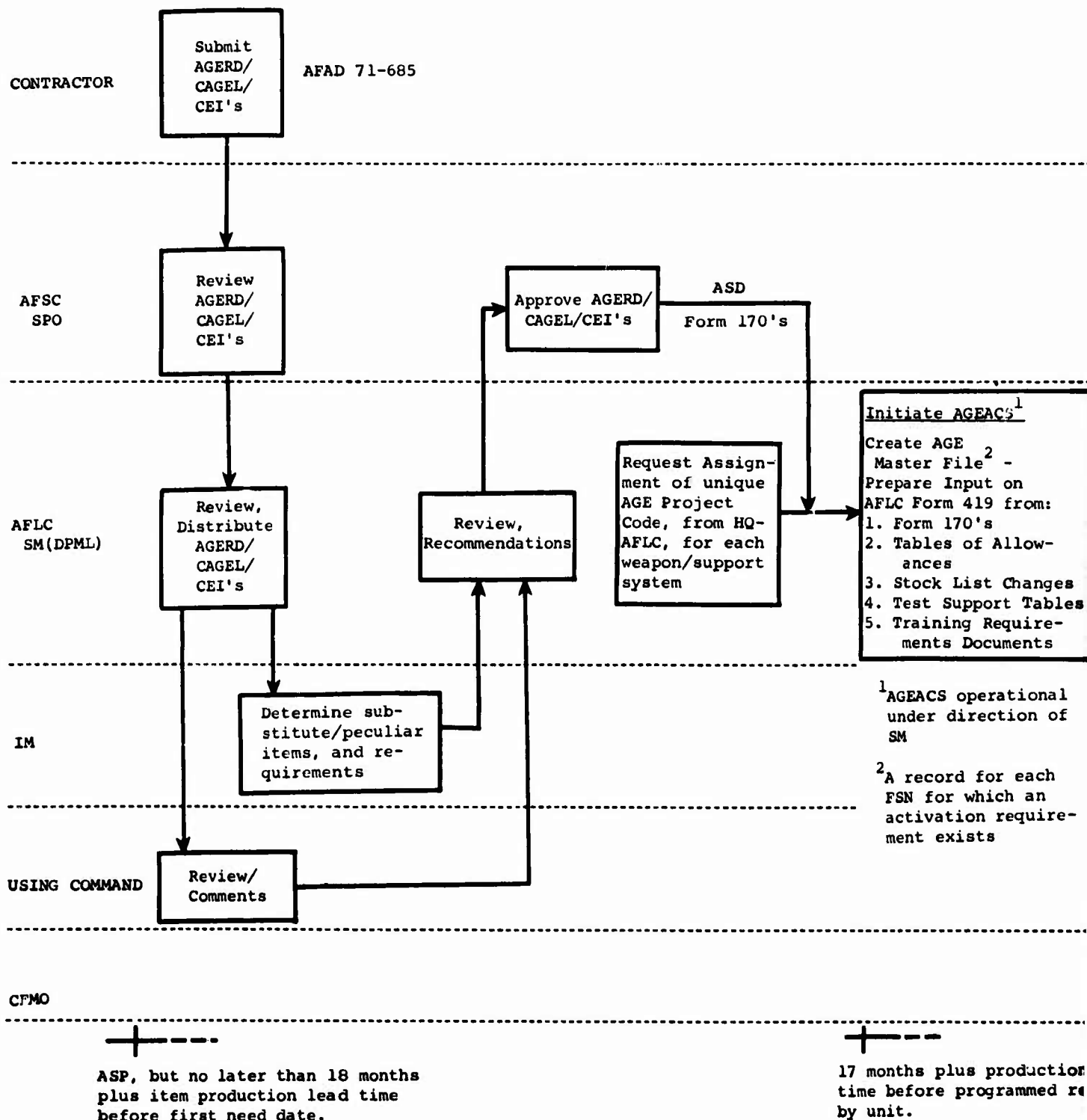
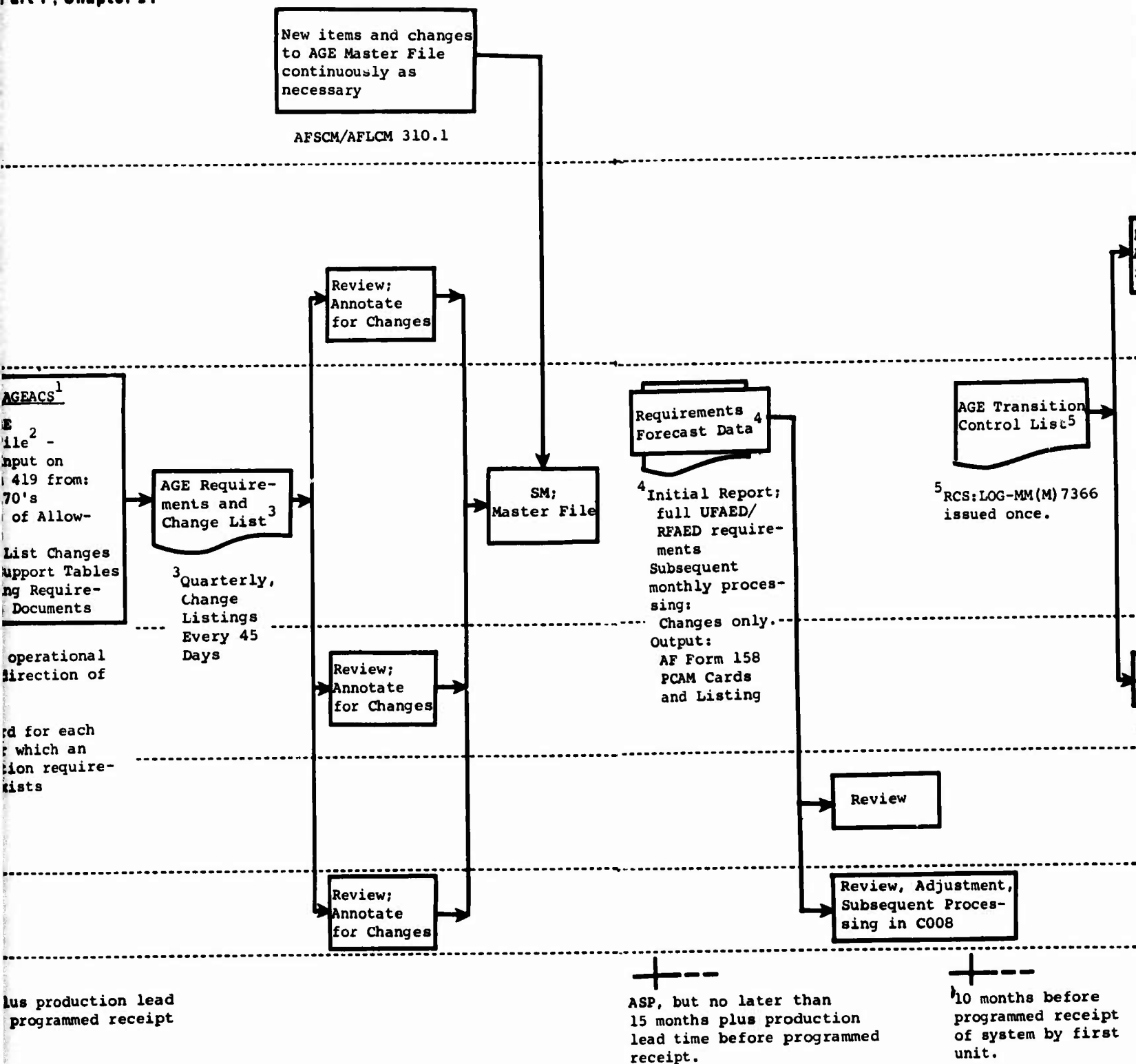


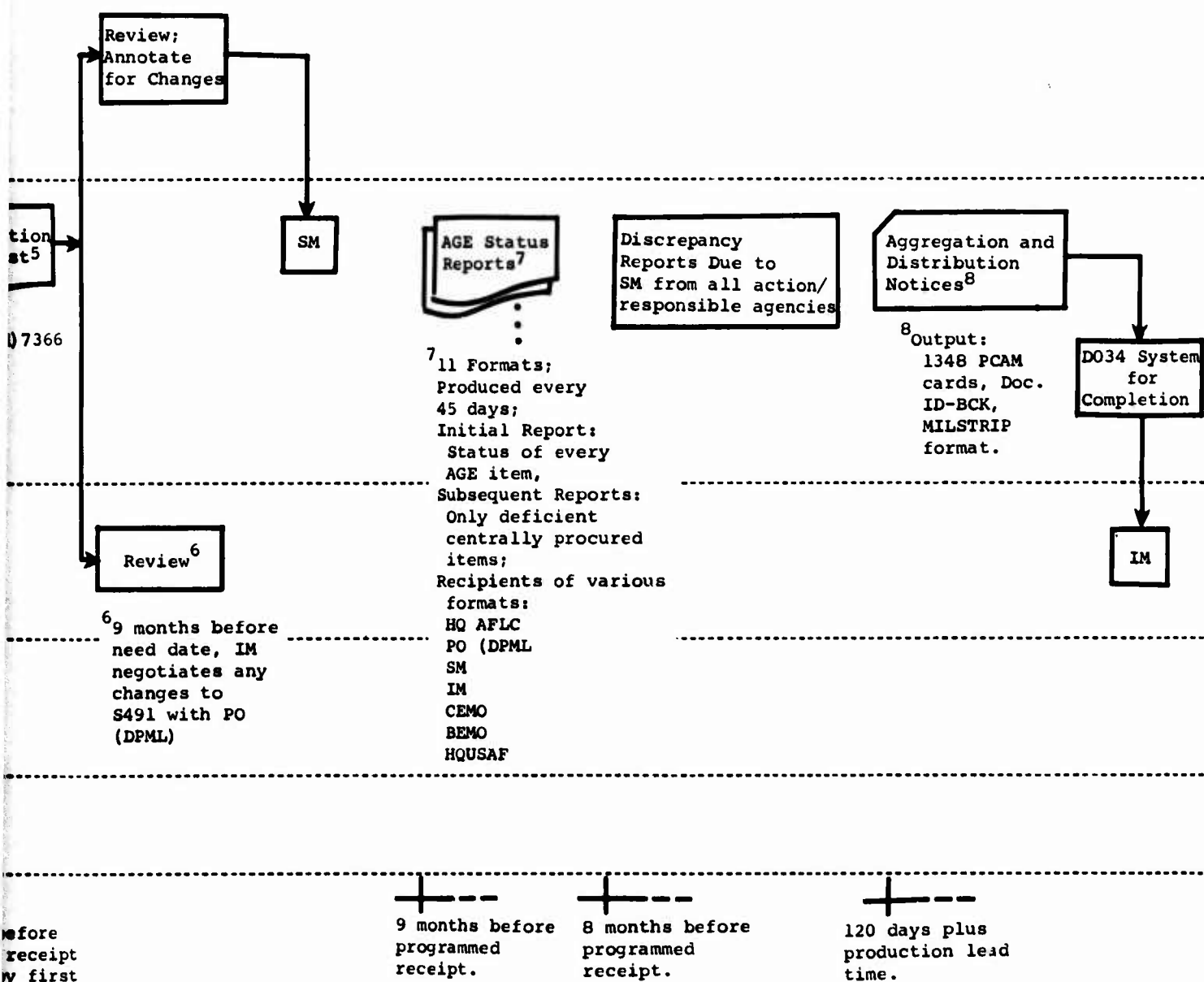
CHART 5 - AGE ACQUISITION CONTROL SYSTEM (AGEA
Data System Designator Code - C013 (AFLC
Time Phasing - AFM 67-1, Vol. One - Part 1, Chapter



SYSTEM (AGEACS)
- C013 (AFLCM 57-16)
Part 1, Chapter 21



2



NOTES TO CHART 5--AGE ACQUISITION CONTROL SYSTEM

- AGE Master File

Contains all detail item management date, factors, authorizations, assets, procurement status, and shipping data applicable to an organization's activation requirements.

- "AGE Requirements and Change List" Report

This report reflects the latest available authorization, asset, and item management data. It is intended primarily as a tool to control requirements by activation, but is also used to obtain or verify specific item information which is critical to operation of AGEACS.

- "Requirements Forecast Data" Report

Provides a full range of requirements forecast data: Unit forecast authorization equipment data (UFAED), and readiness forecast authorization equipment data (RFAED).

- "AGE Transition Control List" Report

Indicates the data on which funding and procurement responsibilities for a particular item transfer from AFSC management to AFLC, in accordance with AFLCR/AFSCR 800-7.

● Additional AGEACS Products

1. AGE Selector File -

SM prepares and submits an SM Selector File, PCAM Cards, and listing to the central processing site for DO39 Equipment Item Requirements Computation System.

2. Selected AGE Management Report -

Produced on an "as-required" or requested basis. It provides SM with a tool to determine the cost of activation. Two formats:

- a) a detailed report by activation code reflecting dollar value of authorized equipment;
- b) a summary report by MAJCOM and MDS reflecting CFE/GFE dollar values.

3. AGE Transaction Error Report -

A list of input transition errors during AGE file maintenance.

4. AGE Table Transaction Error Report -

A list of input errors during AGE Table Files file maintenance.

5. Statistical Data Report (LOG-MMR-M-7110)

Provides item record counts of transactions input during file maintenance cycles. Provides system information and audit trail.

• "AGE Status Reports"

The 11 formats provide the status of every AGE item supporting the system. The report is produced until 100% initial support has been achieved, or it is mutually agreed by responsible activities that the report is no longer required.

Format

Recipient

- | | |
|---|-------------------------|
| 1. AGE Status by System | SM |
| 2. AGE Status by System (LOG-MM(AR) 7358) | SM, AFLC |
| 3. AGE Status of AEE Items (LOG-MM(AR) 7359) | SM, AFLC |
| 4. AGE Status of Lay-in by Organization (LOG-MM(AR) 7360) | Gaining CEMO |
| 5. AGE Status by Base Activation (LOG-MM(M) 7361) | BEMO, CEMO, WSLO |
| 6. IM AGE Status (Doc. ID-BCD) | IM |
| 7. AFSC Procured AGE Status Report | DPML, SPO, ASD(SDM) |
| 8. AGE Shortage Report (Satisfactory Delivery Dates) (LOG-MM(AR) 7363) | SM, AFLC |
| 9. AGE Shortage Report (Unsatisfactory Delivery Dates (LOG-MM(AR) 7365) | SM, AFLC |
| 10. AGE Shortage Report (No delivery dates) (LOG-MM(AR) 7364) | SM, AFLC |
| 11. AGE Status Summary by Organization (LOG-MM(M) 7362) | HQ-USAF, AFLC, DPML, SM |

• Aggregation and Distribution Notices

Provides requisitions for aggregation of assets in the Weapon Systems Support Center (WSSC).

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Case Studies of the Air Force Aerospace Ground Equipment (AGE) Acquisition Management Process		5. TYPE OF REPORT & PERIOD COVERED 14
6. AUTHOR(s) Theodore R./O'Donnell John D./Forster		7. PERFORMING ORG. REPORT NUMBER LMI 74-22 8. CONTROLLING ORIGIN NUMBER(s) 15 SD-321 V
9. PERFORMING ORGANIZATION NAME AND ADDRESS Logistics Management Institute ✓ 4701 Sangamore Road Washington, D. C. 20016		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Office of the Asst. Secretary of Defense (Installations and Logistics)		12. REPORT DATE Dec 75 13. NUMBER OF PAGES 170
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) 12 206 p.		15. SECURITY CLASS. (of this report) Unclassified
16. DISTRIBUTION STATEMENT (of this Report) "A" Approved for public release; distribution unlimited		
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)		
18. SUPPLEMENTARY NOTES		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Support Equipment Management Procedures		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This study was undertaken to determine the effectiveness of Air Force policies and procedures for acquiring support equipment, and to develop recommendations for change. The study approach included two principal tasks: 1) the preparation of procedural flowcharts depicting the support equipment acquisition process; and 2) the analysis of a cross-section of support equipment		

DD FORM 1473

EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

210 475

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

acquisitions against the background of current policies and procedures.

Five flowcharts of the process were prepared and distributed to over 100 Air Force locations during October 1974. Many helpful comments were received, from which the flowcharts were updated. They are republished in Appendix C of this report.

Eight defense systems were selected for study: F-15, A-10, RFV, AIMS, 485L, AF SATCOM, DSP and MMIII. From among those systems, the acquisition of 76 items of support equipment was reviewed in detail. The principle objective of those reviews was to determine 1) the extent to which policy has been implemented and 2) the degree to which policy and implementing procedures are achieving their intended purpose. The 76 items we reviewed are written-up as Case Studies: they are contained in Appendix B.

This study indicates that acquisition policies are sound and comprehensive, and that acquisition procedures are reasonably effective for all types of support equipment except complex electronic test equipment. The Air Force support equipment acquisition process has improved in recent years. Six systems were using similar procedures instead of each having a unique procedure as found in previous studies. The use of similar procedures has improved communications among supporting offices. Some important improvements were noted in drawer/component standardization and in new standardization data bases.

The problems in the complex electronic test equipment area include untimely delivery, high design and acquisition costs, frequent design change activity, low standardization achievement, and incomplete or weak trade-off analysis. The causes of such problems are normally of a highly technical nature and their solution requires technical expertise and analysis which can be enhanced by greater cross-fertilization among aircraft, space and electronic systems. Complex electronic test equipment both requires and warrants increased management attention and technical analysis. The principal recommendation is to establish a centralized Air Force office to provide technical assistance and guidance for the acquisition of complex electronic test equipment to all System Program Offices.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)