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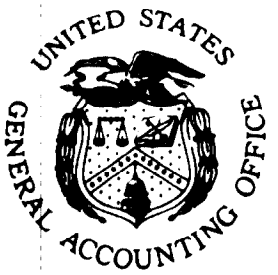
BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Increased Standardization Would Reduce Costs Of Ground Support Equipment For Military Aircraft

Substantial savings could be realized if military aircraft ground support equipment could service more than one aircraft. The Department of Defense needs to emphasize standardization of this equipment and improve systems for reducing duplication of equipment. The Department should seek to provide incentives to contractors to use existing aircraft support equipment in the design of new weapon systems.



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FEBRUARY 7, 1980

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-196770

To the President of the Senate and the
Speaker of the House of Representatives

This report describes how substantial savings could be realized if military aircraft ground support equipment could service more than one type of aircraft. It illustrates that the Department of Defense needs to emphasize support equipment standardization and suggests ways to improve Defense's current systems for reducing unnecessary equipment proliferation.

We initiated this review to determine whether more commonality of support equipment was feasible and whether earlier planning during the design phase could reduce the number and kinds of this equipment entering military inventories. This review is an important aspect of our continuing efforts to recommend logistics management improvements in the Department of Defense.

We are sending copies of this report to the Director, Office of Management and Budget; the Secretary of Defense; and the Secretaries of the Air Force and Navy.

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Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

INCREASED STANDARDIZATION WOULD REDUCE COSTS OF GROUND SUPPORT EQUIPMENT FOR MILITARY AIRCRAFT

D I G E S T

Each new aircraft developed for the military services causes the development of thousands of ground support equipment items costing hundreds of millions of dollars. Much of this new equipment performs the same function as equipment already in service. For example, Department of Defense (DOD) inventories contain

--129 varieties of aircraft tow bars,

--71 kinds of aircraft boarding ladders, and

--111 different aircraft engine maintenance stands.

The Air Force and Navy spend more than $1.2 billion annually for this equipment which is used for ground servicing and maintenance. The estimated value of such equipment already in Air Force and Navy inventories is $13 billion.

Substantial savings could be realized in research and development, procurement, and logistics costs if ground support equipment could service more than one type of aircraft. Commercial airlines, although they operate in a different environment from the services, stress standardization to such a degree that most of their support equipment can be used for more than one airplane.

DOD does not stress support equipment standardization. There is no organization within the Office of the Secretary of Defense responsible for issuing policy and guidance to the services on managing and standardizing support equipment or coordinating its development.

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Most support equipment research and development is geared to meeting one type of aircraft's program schedules and performance requirements. Developing standard items is not the program manager's primary concern. The services need to formally coordinate early development efforts to ensure that, where practicable, support equipment is designed for greater application among aircraft systems. (See pp. 15 to 22.)

To avoid duplication in equipment requirements, data systems need to be upgraded and used effectively to assist contractors and the services in compiling data on the description, reliability, capability, and application of items already in military inventories. Currently, most sources contain inaccurate or outdated information.

In some cases, the recommended, or most reliable, data sources do not include large quantities of support equipment available in Air Force and Navy inventories. Other sources include a wide range of equipment items but do not list all their characteristics. Therefore, decisionmakers have no single source that can give them all the information they need to decide whether inventories already have similar equipment. (See pp. 24 to 27.)

Timely and thorough reviews of support equipment recommended by contractors are also necessary for proper equipment identification and selection. Contractors suggest new equipment and the services must decide whether to follow their suggestions or rely on existing equipment. Weaknesses in these reviews have led to the development and selection of items of marginal value in supporting an aircraft's mission. (See pp. 30 to 32.)

To meet program schedules, the services have little time to review contractor-recommended equipment lists and have often encountered difficulty in meeting their time goals. Service officials believe that the large volume of items recommended by contractors at one time, insufficient staff to review them, and the complexity of the review and approval process all contribute to hasty reviews. (See pp. 33 to 35.)

Although the services have made progress in standardizing certain types of equipment, they could take advantage of other opportunities if they had a better view of the entire range of support equipment. Management needs information from all maintenance levels, from acquisition to use, to enable it to correct problems which arise. (See pp. 41 to 44.)

Air Force and Navy officials feel that the greatest drawback to more standardization is the requirement in the Defense Acquisition Regulations that procurements be competitive whenever possible. Under this requirement, follow-on procurements may go to a different contractor which may deliver an item meeting the same performance standards as the original but having different subsystems and components. This occurs because the services often use performance standards rather than design specifications.

The services can overcome some of this problem by

--specifying critical design features;

--making greater use of multiyear contracts to reduce the number of contracts awarded; and

--making greater use of their authority to negotiate contracts for equipment, if negotiated procurement is necessary to ensure standardization and interchangeability of parts. (See pp. 37 and 38.)

RECOMMENDATIONS

GAO recommends that the Secretary of Defense

--vigorously pursue a policy supporting standardizing aircraft ground support equipment,

--establish a focal point in the Office of the Secretary of Defense to guide and direct the services on carrying out the policy,

--systematically review the services' activities in implementing the policy, and

--develop and implement incentives to contractors to use existing aircraft support equipment in the design of new weapon systems.

GAO has additional recommendations to the Secretary of Defense regarding the specific actions the Air Force and Navy should take to control the proliferation. In summary, the Air Force and Navy should:

--Stress the need for program managers and contractors to give more consideration to standardization during the early design and development stages of aircraft weapon systems. (See p. 23.)

--Direct that the information provided to contractors and service decisionmakers on equipment already in the inventories is accurate, complete, up-to-date, and readily available. (See pp. 27 and 28.)

--Develop specific instructions to guide reviewers through the review and approval of contractor-recommended items and clearly define reviewers' roles and responsibilities so that unnecessary items can be identified more quickly. (See p. 35.)

--Increase management's awareness of support equipment planned or in use so it can better assess whether new items duplicate functions of existing items and whether more standard equipment can be developed. (See pp. 46 and 47.)

AGENCY COMMENTS AND GAO'S EVALUATION

In an October 15, 1979, letter, GAO asked the Secretary of Defense to comment on this report within 30 days. Because written comments were not received within the time requested, GAO is issuing this report without DOD's formal comments. However, GAO met with officials of the Office of the Secretary of Defense, the Air Force, and the Navy, obtained their oral comments, and reflected these comments in the report, where appropriate.

The officials concurred with the recommendations and have taken or planned actions to implement them. GAO plans to follow up on these matters.

Contents

ABBREVIATIONS

DOD	Department of Defense
GAO	General Accounting Office
TACAN	Tactical Air Control and Navigation

CHAPTER 1

INTRODUCTION

The Air Force and Navy spend more than $1.2 billion annually for aircraft ground servicing and maintenance testing equipment. This equipment, generally referred to as ground support equipment, is used to repair, maintain, overhaul, operate, and test aircraft and related subsystems while on the ground. The value of this equipment in Air Force and Navy inventories is estimated at $13 billion.

Basically, aircraft support equipment consists of three types.

1. Test equipment--used to functionally test, calibrate, or diagnostically test weapon systems, support/training aircraft, subsystems, components, and the equipment used in support of these systems. Examples include voltmeters, battery chargers, and computer controlled display test stations.

2. Ground equipment--used to directly assist weapon systems while on the ground. Examples include generators, air compressors, jacks, tow bars, and maintenance stands.

3. Tools, adapters, and other equipment--issued to a work center or an individual for maintaining and inspecting weapon systems. Examples include wrenches, sockets, hammers, bearing pullers, and slings.

Support equipment may be peculiar or common. Peculiar equipment supports only one weapon system and is usually provided by the prime contractor or its subcontractor. Common equipment services two or more weapon systems and is generally preferred over peculiar equipment because it is already in the inventory. Contractors usually identify and recommend which support equipment--peculiar or common--is necessary for various maintenance functions.

The Air Force manages about 125,000 aircraft support equipment items, and the Navy manages about 167,000. Their inventories contain many varieties of support equipment. (See app. I for examples.) This results from the number of different functions which must be performed on new or improved complex aircraft. The trend is toward even more complex equipment and greater multiplicity of items,

which significantly increase the cost for developing, operating, and supporting the aircraft. The illustration on page 6 shows examples of armament handling ground support equipment.

Government and industry specialists generally agree that any serious attempt to reduce the number of different items in defense logistics systems and to reduce logistics costs must begin during the design phase of military equipment. Each time a new weapon enters the inventory it brings with it thousands of new support equipment items. Therefore, controls must be established to prevent the introduction of a wide assortment of similar items--a function of standardization.

Department of Defense (DOD) Directive 4120.3, dated June 6, 1973, established policies and assigned responsibilities for the Defense Standardization Program. The program's objective is to control item proliferation within DOD by

--preventing duplicative and overlapping descriptions of materiels and services;

--fostering the use of existing technology and design features to satisfy new equipment and system requirements;

--establishing uniform type grades, classes, and sizes of items and levels of performance requirements; and

--developing methods for systematically reviewing inventory items to reduce or eliminate unnecessary varieties and sizes.

SUPPORT EQUIPMENT COSTS AND APPROPRIATIONS

Support equipment is very expensive. The costs to support new aircraft entering military inventories far exceed the costs to support aircraft they are replacing. For example, support equipment authorizations for one squadron of F-14 aircraft amount to about $15 million, compared with about $6.4 million for the F-4J. For the F-15, flight line requirements at the base level are less than for the F-4E, but avionics maintenance test equipment is much higher in comparison. The base level support equipment cost for an F-4E aircraft wing is about $20 million, whereas the cost for an F-15 wing is about $40 million, most of which is for avionics test equipment.

Generally, funds requested for support equipment in the Air Force and Navy fall under the budget appropriation entitled "aircraft support equipment and facilities." Funds applied in this area are used to finance (1) support equipment for avionics systems and miscellaneous aircraft and (2) component and ground support equipment which is multiaircraft common or is required by aircraft out of production.

The following table shows the funds budgeted in fiscal year 1979 under this appropriation.

Category	Air Force	Navy
	----(millions)---	
Support equipment	$243.5	a/$152.3
Component improvement program	110.0	56.4
Calibration equipment	(b)	12.5
War consumables	38.1	.6
Support equipment spares	13.3	9.7
Common electronic countermeasure equipment	(c)	19.2
Other production charges	267.5	62.6
Total	$672.4	$313.3

a/Does not include funds for support equipment peculiar to specific in-production aircraft, such as the F-18.

b/Funds included in the support equipment category.

c/Funds included in the other production charges category.

The Air Force and Navy fiscal year 1979 budgets also contain the "other procurement" appropriation which includes a wide variety of ground equipment and logistics support programs not funded under "aircraft support equipment and facilities." The Air Force, for example, budgeted $148 million for vehicular equipment, such as maintenance trucks, towing tractors, and forklifts, which could possibly be used to support aircraft. It budgeted an additional $1.4 billion for other base maintenance and support equipment, including test, personal safety and rescue, depot plant and material handling, electrical, and base support equipment. Likewise, the Navy budgeted about $2.7 billion for "other procurement." It appears that most of these funds finance procurement of major weapons and equipment other than aircraft, although some equipment could have aircraft support application.

SCOPE OF REVIEW

We made this review from October 1978 to July 1979 to assess the opportunities available for greater standardization of aircraft support equipment. Specifically, we wanted to see whether the military services emphasized the use of existing Government or industry standards or the development of new ones before selecting items and placing them in the defense logistics system. We also looked at whether earlier planning during the design phase could reduce the number and kinds of items entering military inventories.

We reviewed various documents relating to support equipment acquisition and past and current efforts to achieve more standardization. We discussed these matters with military officials and with officials representing private standard setting and airline trade organizations.

The primary locations visited during our review were:

--DOD and Air Force headquarters, Washington, D.C.

--Defense Materiel Specifications and Standards Office, Alexandria, Virginia.

--Air Force Logistics Command, Wright-Patterson Air Force Base, Ohio.

--Aeronautical Systems Division, Wright-Patterson Air Force Base, Ohio.

--Air Force Cataloging and Standardization Office, Battle Creek, Michigan.

--San Antonio Air Logistics Center, Kelly Air Force Base, Texas.

--Travis Air Force Base, California.

--McClellan Air Force Base, California.

--Naval Air Systems Command, Washington, D.C.

--Naval Air Engineering Center, Lakehurst, New Jersey.

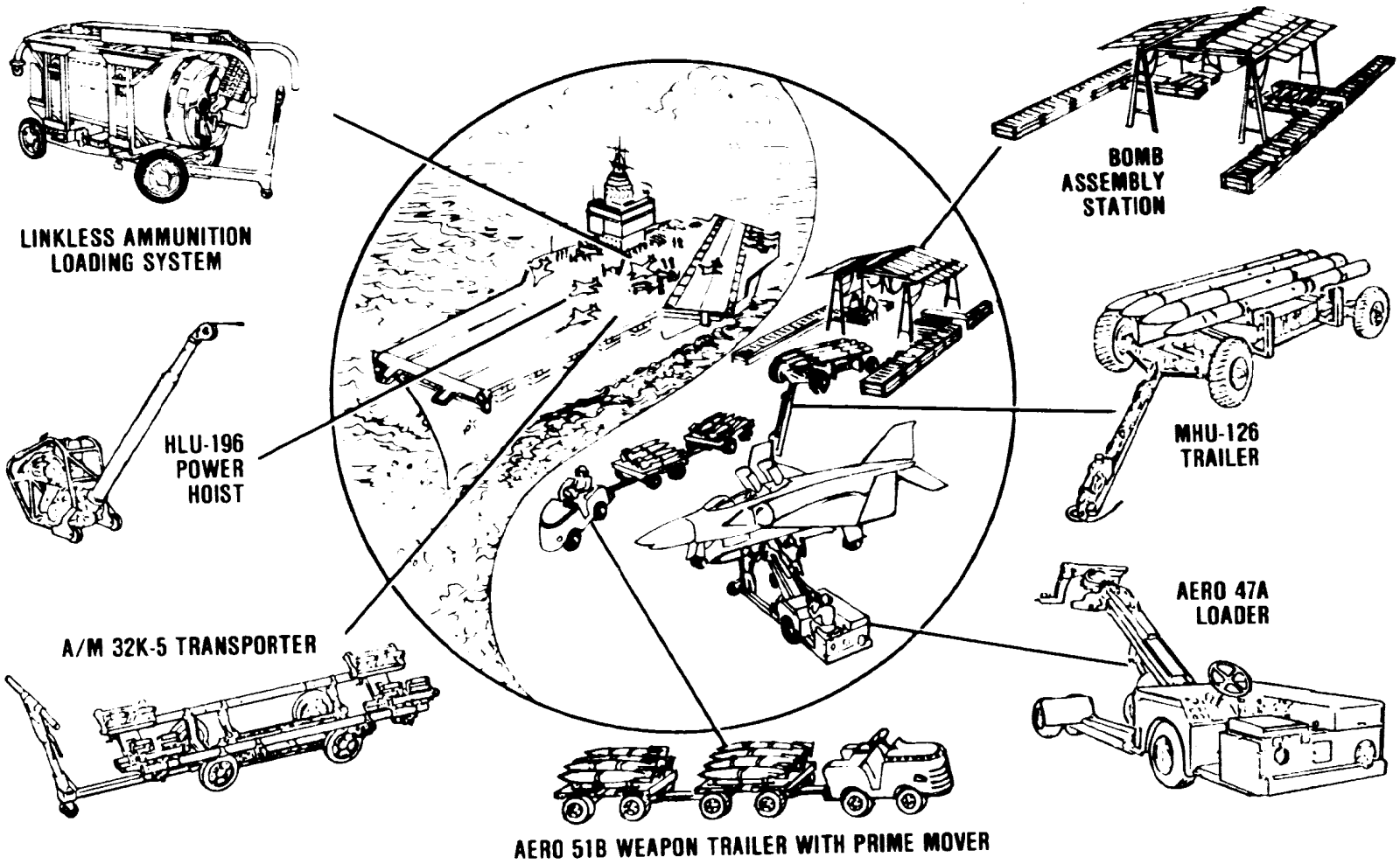
--Aviation Supply Office, Philadelphia, Pennsylvania.

--Naval Air Station, Alameda, California.

--Naval Air Station, Lemoore, California.

--Air Transport Association, Washington, D.C.

ARMAMENT HANDLING



CHAPTER 2

STANDARDIZING AIRCRAFT SUPPORT EQUIPMENT: BENEFITS DERIVED AND OBSTACLES TO OVERCOME

Weapon system developments in recent years have been characterized by marked increases in capabilities, complexities, and costs. The rise in defense costs, particularly for the major weapon systems, has substantially reduced the amount of aircraft support equipment which can be acquired within a given budget. Defense planners and managers are constantly seeking ways to control costs.

One way is to reduce the technical risks in new systems and equipment through the use of proven, or standard, support equipment. The overall goals of standardization are (1) to avoid a proliferation of equipment models designed to perform similar functions and (2) to later reduce the number of such items if a similar one is already available and adequate. It is not easy to design and construct major weapon systems and at the same time increase standardization. Newer aircraft are different from previous models in that they have more power, greater range, and faster operation. Therefore, DOD activities must exercise a high degree of planning and coordination to determine areas where support equipment standardization can provide the greatest benefits and minimum risks.

BENEFITS OF STANDARDIZATION

Various Government and industry studies recognize that standardizing equipment can result in substantial life cycle cost savings, even though developing a standard item may require a greater initial investment in time and money. Aside from the Government's logistics savings, indirect savings accrue when contractors can use standard items because they need not prepare special drawings, test procedures, or conduct special reliability tests.

An official from a leading aerospace corporation commented that:

> "Standardization, on a big program or a small program, on a defense program or a commercial program, provides many interrelated advantages. These include reduced item cost through use of readily available items, reduced assembly and installation costs for items as a result of standard tooling, more predictable reliability through use of items with established service histories,

reduced numbers of total types of items requiring initial procurement and subsequent logistics systems, improved maintenance by elimination of odd or unusual items, and reduction of testing and qualification, all of which adds up to improved potential for meeting schedule and cost goals through elimination of duplicative hours and costs required for development and use of similar items."

The savings from standardization are hard to accurately measure because they depend on such factors as (1) the number of items standardized, (2) the development efforts avoided, (3) the quantities procured, and (4) the methods of procurement. However, some studies have provided general estimates of such savings. For example, a 1974 study estimated that 13 to 26 percent of the life cycle costs could be saved by developing and acquiring one item of equipment rather than two and by reducing the unit cost through competitive, large-quantity buys. Another study estimated in 1971 that savings resulting from standardization could range from $200 million to $300 million.

In addition to savings, other benefits can be achieved, as follows:

--Standard equipment provides incentives to invest in reliable, high-performance equipment.

--Because fewer items need to be provisioned, cataloged, and stocked, the logistics support required is simplified and an agency's workload is reduced.

--Operations and training needs are reduced.

--Aircraft can be deployed faster using standard support equipment already in use at the deployment site.

Although the potential benefits are substantial, they are not automatic. For example, managers must weigh the relative risks involved in meeting the aircraft's mission without standard equipment, even though policy may encourage standardization. They must also be aware that standardizing defective or unreliable and nonmaintainable equipment could cause unnecessary modification and replacement costs. Thorough testing, evaluation, and selection can reduce this possibility.

Decisionmakers must also react to rapid technological changes, particularly in the electronics field, and evaluate the potential consequences of decisions to stay with standard equipment over a long period. They must make sure, for example, that continued adherence to the equipment will not compromise cost benefits or performance improvements. Also, staying with a single source for equipment throughout its procurement life is a major risk of standardization because it could result in higher unit prices and leave the Government vulnerable to a vendor's internal management problems. This risk can be reduced by developing a secondary source for the same equipment.

OBSTACLES TO OVERCOME

Despite the tremendous opportunities and benefits which standardization of aircraft support equipment offers, standardization is not as prevalent as it could be. Several obstacles need to be overcome and certain key issues addressed if greater commonality is desired. Although we did not look at every possible factor, we did examine some major ones.

Lack of integrated support planning systems

Weapon program managers operate independently from other activities and concentrate on each weapon's performance and development costs. The weapon system and most equipment design efforts are geared predominantly to meeting a single aircraft's program schedules and performance requirements, rather than to using highly reliable standard equipment on other aircraft. Program managers are hesitant to accept the risks of using standard equipment on any new development programs if the contractor recommends new equipment.

It is DOD's policy to include timely and adequate logistics support planning in acquiring defense systems and equipment. The integrated logistics support concept, promulgated in 1964, was intended to motivate design engineers and other management levels to consider early the combined cost of acquiring and owning a weapon system throughout its entire life cycle and to thus avoid excessive, unrealistic, downstream logistics requirements. Support equipment proliferation, therefore, will continue without an effort which formally integrates weapon system development and the equipment which supports it. Program managers should be encouraged to use standard items and to look to these items first before justifying the need for unique items.

Need for management visibility

The services need to increase their visibility and accounting over support equipment to preclude buying equipment which may never be needed and to further opportunities for more equipment commonality both before and after it enters the supply system. The services should be able to tell the contractor what equipment they prefer rather than routinely accept the contractor's recommendations. This could best be achieved by having one primary activity manage support equipment and oversee the equipment's acquisition so that it can make intelligent decisions on introducing new or unique equipment in the military supply system.

Contractor attitudes and practices

The Subcommittee on Legislation and Military Operations, House Committee on Government Operations, reviewed DOD contractors' attitudes and practices concerning weapon system standardization and reported its findings in December 1974. When asked what prevented more effective equipment standardization, contractors replied that:

--Standardization tends to have an unfavorable image; standards engineers admit that it is unexciting and often unrewarding work.

--Explaining the functions and advantages of standardization in design is a difficult task. In the engineering field, where much innovation is sought, standardization is considered a constraint against attempts at improvement.

--Many experts feel that clear proof of savings resulting from standardization is the best way to advance it but that demonstrating savings is impossible, except in a few isolated cases.

The Subcommittee's report concluded that, among other things, more effective standardization in system design could lead to large savings in weapon system costs and logistics costs by preventing duplicate equipment from entering the system in the first place. DOD has not given management support to achieving this goal. Instead, its programs are after the fact.

The report also concluded that the Defense Standardization Program has not operated with the uniformity required for the complex logistics network and engineering systems

which it influences. Some steps have been taken to correct this problem, but much has yet to be done.

A system of incentives which makes standardization desirable to Government and industry might be warranted. Contractors want to develop a good reputation, establish a favorable market position for follow-on business, and increase profits, and therefore, are reluctant to use military inventories or standard items. Favorable consideration could be offered to contractors responding with suitable, standard support equipment for proposed weapon systems. The ultimate contract could be structured with appropriate incentive clauses. On the Government side, program managers could be required to report, during program reviews, how much or how little they use standard equipment. One element in the managers' performance ratings should be a measure of their success in achieving standard support equipment.

EARLIER INTENSIVE PLANNING NEEDED

Optimum use of the same equipment on several aircraft requires early identification and evaluation of opportunities--currently a relatively low priority in DOD. Knowing the present inventory, the future military market, the status and trends of technology, and military requirements is a function of proper planning.

Currently, the Office of the Secretary of Defense does not have a focal point to coordinate the areas of development and acquisition, operational requirements planning, and logistics management of support equipment. The Office should play an active role in emphasizing reduced support equipment costs while recognizing standardization as a primary means to avoid unnecessary development of similar equipment. Because the Defense Materiel Specifications and Standards Office manages the Defense Standardization Program, it would seem the logical agency to provide DOD policy guidance on goals and priorities regarding support equipment standardization.

The services, too, have recognized that little development planning for support equipment has taken place because of the lack of emphasis on it. Problems which the services have experienced could be lessened if support equipment requirements were identified and screened earlier in a weapon system's life cycle. Program managers could then consider whether the support equipment designed has common application on other aircraft or systems or whether opportunities exist to design aircraft systems to match existing equipment.

In addition to increasing standardization opportunities during the early phase of the acquisition process, other rewards of intensive planning include

--better communication between services using similar equipment,

--improved responsiveness by industry to support equipment needs,

--more interaction between support equipment offices and weapon system offices,

--simplified equipment review processes, and

--better feedback from support equipment users.

RECOMMENDATIONS

To effectively restrain the growth of support equipment and increase the likelihood of more standardization, we recommend that the Secretary of Defense:

--Vigorously pursue a policy for support equipment standardization.

--Establish a focal point in the Office of the Secretary of Defense to guide and direct the services in carrying out the policy and detailed plans.

--Require the services to systematically examine what it takes to service an aircraft on the ground and what avionics systems need testing. Once this has been determined, standard equipment could be used or designed to service and test the variety of aircraft currently in the inventory.

--Require that the services implement a system of incentives to make standardization desirable to both contractors and the Government.

CHAPTER 3

SUPPORT EQUIPMENT PLANNING

NEEDS GREATER EMPHASIS

To prevent unnecessary and duplicate support equipment items from entering DOD catalog and supply systems, controls should start at the earliest possible stage--that is, during the design of a new aircraft and its equipment. By operating at the front end during the acquisition of an aircraft's support equipment, the Government can best decide whether (1) the extensive support equipment inventory can satisfy requirements without redesigning the aircraft, (2) the aircraft's design can be altered to accommodate the existing inventory, or (3) a new piece of equipment is required but can be used for other weapon systems.

With the introduction of new, sophisticated aircraft into DOD inventories, the services have increasingly recognized the need for earlier planning to minimize logistics support costs. By more intensively planning and by addressing the problems noted in this and subsequent chapters, the military services could reduce these costs even further while limiting the number and types of support equipment entering the supply system.

PROLIFERATION--A SERIOUS PROBLEM

Unnecessary duplication of aircraft support equipment entering DOD inventories is creating growing operational, maintenance, and logistics problems and must be reduced if maintenance activities hope to effectively support aircraft weapon systems. Developing unique equipment that cannot be used for multiple aircraft systems fosters equipment proliferation and increases life cycle costs. Both services, particularly the Air Force, have recognized that support equipment proliferation is a serious problem and that extensive action is required to reduce it.

Ground support equipment

When ground support equipment is approved without considering its use on other aircraft, proliferation occurs and increases the total cost of logistics support. To illustrate, the A-7 and F-111 aircraft use several hundred types and sizes of electrical connectors. The Air Force spends thousands of dollars yearly to manage, stocklist, and catalog new types of connectors and their repair parts

which enter the inventory. To service the connectors, one Air Force base repair shop had 8 different contact insertion tools and 26 types of contact extraction tools. Nonstandard electrical connectors, according to the Air Force, unnecessarily increase supply support, maintenance hours, technical data, training, and support equipment special tooling expenses.

Failing to consider cost effective ways to maintain aircraft can also result in proliferation. For example, an F-16 project office official told us it was necessary to develop and acquire a peculiar handling tool to remove and replace the F-16's fire control radar antenna. The official said that, had the Air Force considered how the antenna would be maintained, the antenna would have been designed with handles or other means to hold it during removal and replacement, thus avoiding the need to introduce a peculiar handling tool. The cost to develop the tool exceeded $92,000.

Automatic test equipment

The state-of-the-art technologies used in new weapon avionics and other electronic systems drive a comparable level of sophistication and complexity for avionics support equipment. The support role performed by computer concepts, such as automatic testing, has enlarged, as have the development and test programs to support such areas as radar avionics, fuel controls, and engines.

The Air Force has identified 434 types of automatic test equipment in its inventory. It invests considerably in this equipment. For example, in 1975 the Air Force spent about $750 million to purchase automatic test systems. In a recent report, the Air Force noted that it had acquired considerable testing capability but that the equipment's unique applications prevented its use on more than one aircraft weapon system and thus caused serious proliferation problems.

Current efforts

The Air Force has taken action recently to limit support equipment proliferation. In August 1978 it established a working group concerned primarily with limiting proliferation when reprocuring support items it had scheduled to replace. The group concentrated its efforts on flight line "yellow iron" which generally supports aircraft maintenance, launch, and recovery operations. Items planned for procurement in fiscal years 1979 and 1980 were reviewed and strategies developed to reduce proliferation. Although this is a step in

the right direction, the Air Force should also develop methods to standardize the number of new items entering the supply system so that it can minimize proliferation even before it considers replacing items later.

In the automatic test equipment area, the Joint Logistics Commanders, representing all the services, established a panel in March 1978 to reduce proliferation of such equipment and improve its overall management and efficiency. The Commanders developed a 6-year study plan costing more than $250 million through fiscal year 1983. More than 50 percent of this funding is devoted to the Air Force's Modular Automatic Test Equipment Program. The purpose of this program is to develop and demonstrate a cost effective blend of state-of-the-art technologies and management techniques for test equipment to satisfy operational demands. The technical effort of the program is designed to establish criteria for multiapplication equipment.

We cannot as yet assess the impact which this program could have in reducing automatic test equipment proliferation. However, it is a significant logistics effort with potential benefits for all services using this kind of equipment.

NEED FOR EARLIER PLANNING DURING DESIGN PHASE

To enhance support equipment standardization, permit cross-system applications, and reduce weapon system support costs, the services should identify equipment requirements during the design process, before establishing the weapon system's configuration. During the aircraft's conceptual phase of development, when the first decisions are made on how the aircraft will be designed to meet performance requirements, the aircraft's design is flexible enough that the services could consider using support equipment previously developed. If the aircraft could be designed, where practicable, to accommodate existing equipment, the need for many unique items or their modifications could be eliminated. Obviously, tradeoffs must be made to minimize costly redesign later.

The services have recognized that their technical expertise can lead to greater use of existing equipment when they participate in the aircraft equipment development and selection process. However, such interaction does not take place until the aircraft design has been fully developed and a prototype aircraft has already been built for testing. At

this late point, the aircraft design is so inflexible that few cost-beneficial changes can be made to permit more standardized support equipment.

After the design stabilizes, the services lack the necessary plans to integrate one aircraft's support equipment with other aircraft. Also, the services lack the capability to effectively use their extensive inventories to satisfy new equipment requirements.

In its recent cataloging and standardization report on stock class 4920, "Aircraft Maintenance and Repair Shop Equipment," the Air Force reported:

> "Continued reliance on contractor developed systems and use of specially designed commercial equipment has resulted in a large influx of non-standard material. The military services need a more active role in the design and development stages with greater emphasis on the use of standard components."

The following typical examples illustrate the need for early planning during the design phase.

Drain valve adapter--fuel sample

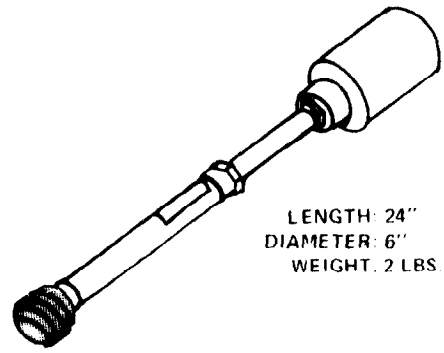
The adapter, which costs about $19,500 to develop and about $280 for each unit, is used to extract fuel samples from the F-18's drain valve to see if the fuel supply is contaminated. Its use prevents spillage and reduces the risk of fire and slippery decks on aircraft carriers. The contractor stated that it had evaluated fuel sampling devices for the F-15 and S-3A aircraft but had concluded that they were not compatible with the F-18's drain valve.

The Navy previously spent about $24,000 to develop two similar items for the F-14--one called a tip fitting water drain and the other called a water drain adapter assembly. The Navy prefers the former item for the F-14. The Air Force developed a similar item for the F-15, called a siphon tool, wing root fuel drain. Although these items are not physically the same, they perform the same function. In addition, we identified 10 other types of drain valve devices in the supply system which were not reviewed to see if any of them could be used. If early consideration had been given to developing a standard drain valve before the F-18's design became frozen, the F-18 could have used an existing item at a lower cost.

DRAIN VALVE ADAPTER, FUEL SAMPLE
PART NO. 74D 460101 1001

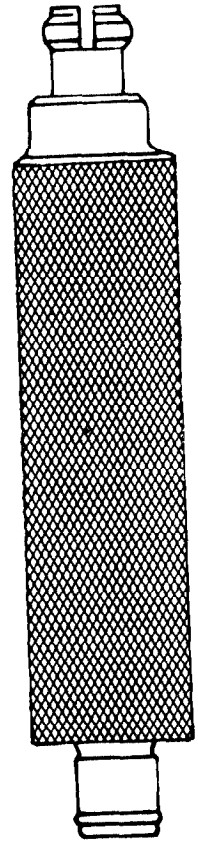
LENGTH: 8"
DIAMETER: 1.5"

SIPHON TOOL, WING ROOT FUEL DRAIN
PART NO. 68D290023-1001



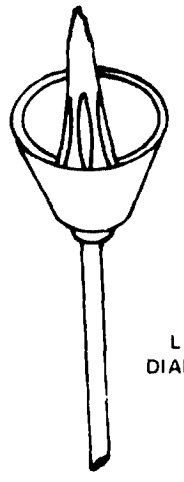
LENGTH: 24"
DIAMETER: 6"
WEIGHT: 2 LBS.

TIP FITTING WATER DRAIN
PART NO. A51S31910-1



LENGTH: 5"
DIAMETER: 1"

ADAPTER ASSEMBLY, WATER DRAIN
PART NO. A51S31040-1

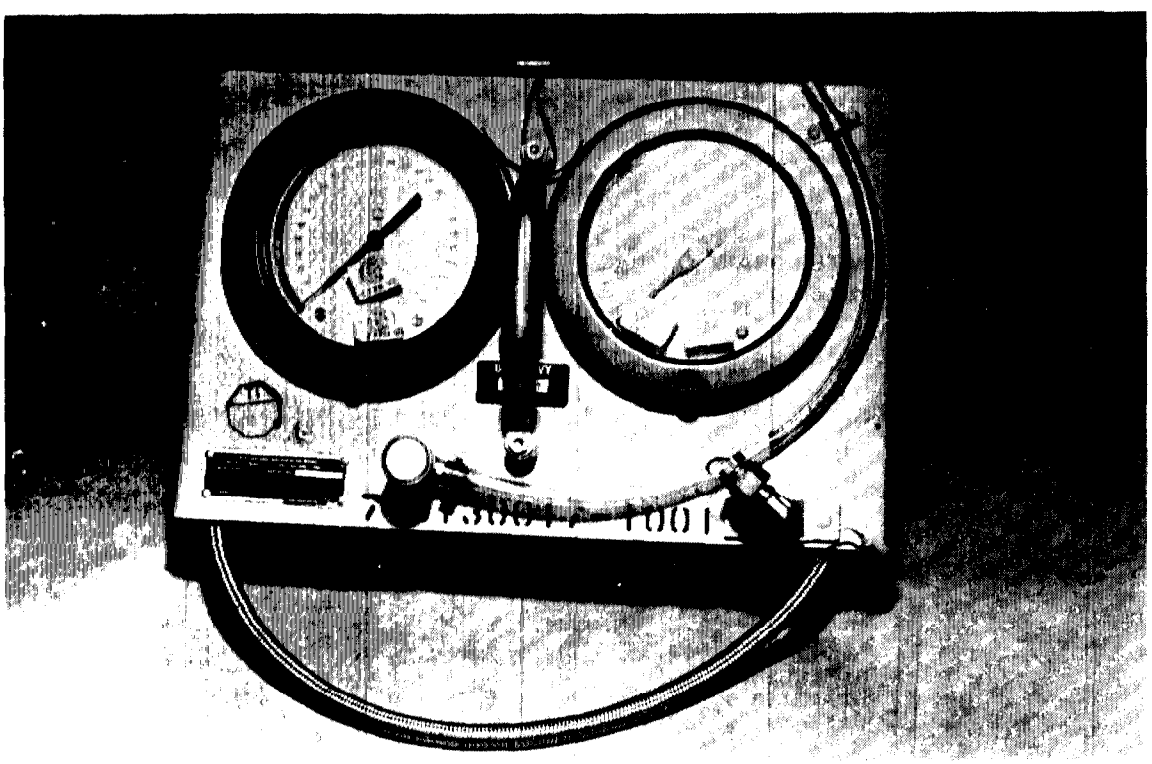


LENGTH: 34"
DIAMETER: 3"

Bleeder assembly and pressure indicator--brake

The assembly, which costs about $16,000 to develop and about $3,100 for each unit, is needed to overhaul, rig, or troubleshoot the F-18's brake system. It checks the hydraulic brake pressure and "bleeds" the system of any air pockets. The contractor reviewed about seven sources to identify an existing, suitable assembly and identified one item on the F-15 which could have been appropriate.

The F-15 item is called a brake bleed port pressure hydraulic indicator and is identical to the F-18 item except that an adapter had to be added to the F-15 unit's high pressure hose so that it could "interface" with the F-18 wheel brake fittings. Navy engineers told us that the F-15 item does not possess the ability to test the hydraulic pressure ranges required by the F-18. We believe, however, that a tradeoff analysis, if it had been made early enough in the F-18's design stage, could have suggested ways to use the F-15's pressure hydraulic indicator for the F-18.



Courtesy of the U.S. Navy

BLEEDER ASSEMBLY AND PRESSURE INDICATOR-- BRAKE
PART NO. 74D 130017 - 1001

Pin, ground safety, canopy jettison

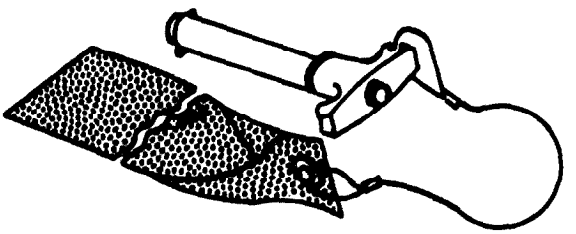
This peculiar item was specifically designed to secure the F-18's canopy jettison system. It cost $13,600 to develop and $15 for each unit. Every aircraft with a canopy jettison has a ground safety lock system held together with ground safety pins to prohibit inadvertent movement of the canopy. Every aircraft model has a uniquely designed cockpit, canopy, and canopy jettison system.

The F-18 pin measures one-quarter inch in diameter and 3 inches long and is made from corrosion resistant steel. The Navy and the contractor agreed that no known Government item could satisfy all specified design requirements for the pin. Although 486 ground safety pins are identified in the Federal Catalog and 71 pins are listed in the Navy's Data Retrieval System, we found no evidence that any of these items were checked for possible F-18 use. Navy officials believe too many item characteristics are omitted from data sources to properly evaluate whether an existing item can be used. (See ch. 4.)

The Navy approved the contractor's request to change the diameter of the F-18 pin from one-quarter inch to three-sixteenth inches to avoid confusion with a rear seat safety pin having the same one-quarter inch diameter. However, two F-15 pins are identical to the one recommended for the F-18 except that the diameters are one-half and nine-sixteenth of an inch, respectively. If the Navy had done the necessary front-end planning and had been involved earlier in the F-18's design phase, the only change needed in the F-18's design would have been to drill a slightly larger hole in the canopy to accommodate the F-15 ground safety pin. Illustrations of the F-15 pins and a photograph of the F-18 pin are shown on pages 20 and 21.

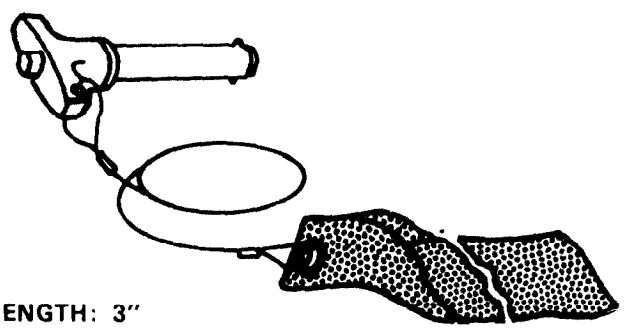
A unique design, particularly on such devices as the ejection system, reduces the chances for using existing equipment or developing standard items to fit all canopy and ejection systems. This example demonstrates, in our opinion, that considering aircraft design adjustments could reduce proliferation of ground safety pins without compromising safety.

PIN, AIRCRAFT GROUND SAFETY, LANDING GEAR
PART NO. 68D320002-1001

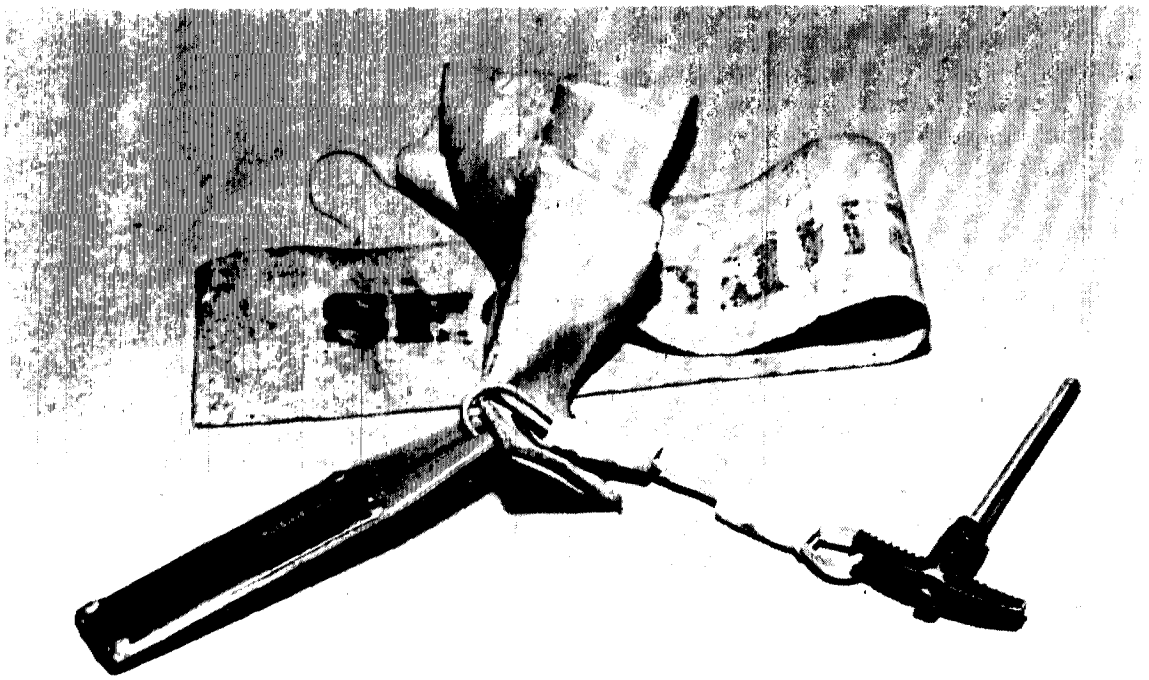


LENGTH: 3"
DIAMETER: ½"
WEIGHT: 8 oz

PIN, AIRCRAFT GROUND SAFETY, MLG DOOR
PART NO. 68D320006-1003



LENGTH: 3"
DIAMETER: 9/16"
WEIGHT: 8 oz.



Courtesy of the U.S. Navy

PIN, AIRCRAFT GROUND SAFETY -- CANOPY JETTISON
PART NO. 74D 110004 - 1001

NEED TO EXPAND SUPPORT EQUIPMENT PLANNING

Planning for support equipment has been limited. Although the services have developed overall plans to increase an aircraft's operational effectiveness through better support equipment acquisition practices, they have not expanded planning to the point where opportunities for greater application of support equipment to many aircraft can be identified. To promote standard support equipment, all organizational elements involved in the acquisition must participate in equipment planning.

The Air Force Systems Command, for example, has four divisions involved in support equipment acquisition; namely, aeronautical systems, space and missile systems, electronic systems, and armament. Air Force officials told us that the Systems Command had not developed an overall plan to coordinate the divisions' support equipment planning. Only two of the four divisions have developed plans of any kind for acquiring support equipment.

Plans developed for aeronautical systems recommended that the Systems Command expand its planning to include the other divisions involved in acquiring support equipment. Planning had not been expanded because adequate personnel were lacking and because the concept of standardizing support equipment was given relatively low priority. The program manager of a proposed new enhanced tactical fighter explained the need for expanded planning. He said this new weapon will require coordination with the armament and electronic systems divisions and, in the event that managers revise the fighter's operations concept, with the missile systems division.

Assistance in coordinating these divisions with the required support equipment should come from the Support Equipment Systems Project Office for aeronautical systems. Presently, the office is not participating with the weapon program managers early enough during a system's acquisition to help plan support equipment strategies and requirements. Although the office's charter requires it to work closely with weapon planners during a new system's conceptual phase, it has not done so. This lessens the chances that standard equipment will be recommended and developed.

We believe the services should develop and monitor an overall support equipment acquisition management plan. The plan should include information applicable to all organizations involved in support equipment planning and should specifically address ways to increase the use of common equipment.

CONCLUSIONS

The services need to formally coordinate efforts of weapon system program managers and support equipment managers to ensure not only that schedules and aircraft performance requirements are met but also that support equipment is designed and intended for application among many aircraft systems where practicable. Controls to prevent unnecessary item proliferation should start at the earliest possible stage; that is, during the design of new aircraft and its equipment.

Although the services recognize the need for earlier planning, it has not been as early, intensive, and complete as it should be. Proper planning offers many other incentives and rewards in addition to increasing standardization opportunities. The services need to strongly emphasize

early planning during the design phase to take advantage of these benefits.

RECOMMENDATIONS

We recommend that the Secretary of Defense:

--Develop a general planning strategy for support equipment that not only identifies acquisition problems and areas for increased management attention but also takes advantage of opportunities to promote standardization and reduce the number of different support equipment items.

--Require the services to assess, during aircraft design, whether support equipment needs can be satisfied (1) by using the existing supply system without redesigning the aircraft, (2) by altering the design to accommodate an existing piece of equipment, or (3) if new equipment is justified, by evaluating whether it could be used for other aircraft.

--Monitor the services' planned use of standard support equipment items to ensure that they have participated in the equipment's design and development stages.

CHAPTER 4

THE SYSTEMS PROVIDING INFORMATION ON AVAILABLE SUPPORT EQUIPMENT NEED UPGRADING

To limit the introduction of unnecessary support equipment through effective planning, the services need access to accurate and timely data on equipment already in DOD inventories or under development. Such data can help the services assess whether the Government has equipment which can meet new requirements or whether the equipment being considered is unique to the weapon system.

Data systems currently in use are inadequate to promote use of existing equipment and to avoid development and support costs of items not actually needed. The systems contain information which is inaccurate, incomplete, outdated, and not readily available. The services should evaluate the capabilities of their existing systems, identify shortfalls, and ensure that all equipment in military inventories, under development, or available from commercial sources is included.

INADEQUATE DATA ON NUMBER OF ITEMS AND TECHNICAL CHARACTERISTICS

For a data system to work, it should (1) list all support equipment in the Government inventory, including the equipment's technical capabilities and physical characteristics, and (2) designate preferred items that the services want contractors to use when they design new equipment. This information helps contractors determine what equipment the Government has already developed and enables the services to assess contractors' efforts in using existing items. The Air Force and Navy policy, for example, identifies existing inventory items as the first priority for selecting support equipment during the acquisition process.

Existing support equipment data systems are not accomplishing the objective of providing adequate information to control support equipment proliferation and promote increased equipment commonality. Recognizing the problems associated with the existing systems, the Air Force initiated a project in fiscal year 1978 to evaluate current systems and those being developed. A report on the first phase of this project found that:

> "Present data retrieval systems on support equipment are not used extensively due to information being incorrect, incomplete, outdated, costly, and difficult to use. Decisions, based on these

data systems, are difficult to make if not impossible. An effective data retrieval system would reduce proliferation of support equipment and provide cost avoidances in R&D [research and development], inventory (items and spare parts), and training."

The remaining phases of the project will develop capabilities where existing retrieval systems were inadequate, develop the initial data base, and update the system continuously.

The Navy's Engineering Data Retrieval System illustrates the need to upgrade existing systems and their capabilities. It includes data on about 22,300 items. The Navy, however, has estimated that it carries about 167,000 aircraft support equipment items in its inventory. Standardization tools which the Navy uses to keep items entering the inventory at a minimum include the technical information file of ground support equipment and the avionics and nonavionics preferred support equipment lists. These sources list about 5,000 to 6,000 items. Thus, the Engineering Data Retrieval System, considered to be the primary system in the Navy for locating existing support equipment, includes only 13 percent of all existing Navy support equipment items listed. Progress in updating the system has been slow.

Before the Navy established the system, Navy officials told us that they had screened all support equipment items for potential future applications. Those items not determined to have future application were placed on a nonapplications item list. This list provided only part numbers and limited space for item names and has not been maintained for 3 years. Therefore, the Navy has no vehicle for considering the tens of thousands of items not listed on its data systems or otherwise not maintained in readily available form.

The Navy's data system also contains incomplete descriptions of items' technical capabilities because it (1) uses unapproved item names, as discussed later, and (2) does not list critical performance requirements of items having approved names. The system has the capacity to screen acceptable items possessing performance capabilities which a user may be looking for. If a contractor is interested in an item having several different characteristics, the system will provide data on only those items which meet these requirements. Any items in the system without a critical capability listed will not be included for the contractor's consideration.

For example, the Navy currently uses 19 types of tow bars to provide towing services for its various aircraft. It has, however, adopted five types as standard items. One of these, the NT-4 model, is the standard item for aircraft under 90,000 pounds gross weight. As long as this particular tow bar meets a contractor's need, it will be the only type purchased. However, the amount of weight which the NT-4 can tow is not included in the Engineering Data Retrieval System. If a contractor using the system were interested in finding a tow bar capable of pulling up to 90,000 pounds, such as the NT-4 model, it would not identify this standard item.

NOMENCLATURE PROBLEMS

In our previous report, 1/ we noted that using unapproved item names substantially weakens the item identification process because most items cannot be described from their physical and performance characteristics and because proper classification into one of the 603 Federal stock classes is uncertain. Duplication can result from this shortcoming, since more than one national stock number can be assigned to the same or similar items and since identical and similar items can remain in the supply system undetected. The three major stock classes comprising most aircraft support equipment contain about 222,450 items, yet 118,400 of them, or 53 percent, are cataloged without approved item names.

This problem exists in the Navy, as well as in the Air Force. If approved item names for new support equipment items cannot be determined, the services generally adopt the ones suggested by the contractor which originally developed the items. The services lose visibility over items when contractors, which later develop similar items to satisfy future requirements, choose different names for the items and when no action is taken to change the names. The problem becomes even more serious when the Air Force uses other unapproved names for items similar to those the Navy uses. This situation can lead to the development of unnecessary new items if adequate controls are not imposed.

1/"Fragmented Management Delays Centralized Federal Cataloging and Standardization of 5 Million Supply Items" (LCD-79-403, Mar. 15, 1979).

We provided the Air Force Logistics Command a random list of F-18 support equipment items having unapproved item names to see if the Air Force could identify the items and if it used the same names as the Navy. Of the 13 items listed, the Air Force could not identify 2 and used substantially different names for 5 others. After we gave the Air Force a copy of the Navy's recommendations for the two unrecognized items, the Air Force identified a substantially different name for each item. As typical examples, the Air Force identified the F-18's brake assembly and pressure indicator as a hydraulic system filler and bleeder. In another case, the F-18's liquid coolant servicing unit was identified as a liquid oxygen servicing cart. These examples illustrate that items performing the same function can and do enter the supply system, which creates proliferation problems and limits opportunities to identify standard items.

CONCLUSIONS

Inadequate data systems lead to the introduction of new, unnecessary support equipment items. This results in additional acquisition costs and additional logistics support costs for spare parts, training, and technical manuals.

Because data systems are crucial to improving support equipment planning and enhancing equipment commonality, the systems must provide complete, accurate, and up-to-date information on the number of items and their technical capabilities. For data systems to be relied on, the data also must be readily accessible to potential users.

RECOMMENDATIONS

We recommend that the Secretary of Defense:

--Evaluate the capabilities of the various support equipment data systems to determine which system(s) can most promptly provide the most complete, up-to-date, accurate, and readily accessible information.

--Direct the services to include all necessary support equipment items in their data systems. The systems should include data on item descriptions, sizes, shapes, reliabilities, capabilities, and applications. The systems should also designate preferred items that the Government wants contractors to use when they design new equipment.

--Impose tight controls when new items enter the supply system so that their assigned names are recognized by all potential users when screening available data systems and manuals.

CHAPTER 5

ANALYSES OF SUPPORT EQUIPMENT PROPOSED FOR NEW AIRCRAFT NEED TO BE STRENGTHENED

Timely and thorough reviews of contractor-recommended support equipment are necessary for proper equipment identification and selection. The services, however, have limited their reviews and analyses of equipment items because of time and staffing constraints and complexities in the process itself. The services need to simplify and streamline the current review process so that they adequately consider all items, particularly the more complex ones, and eliminate nonessential items. In other words, the reviewer's role and responsibilities must be adequately defined, and a methodology must be devised to systematically review the items. Otherwise, the services should evaluate the propriety of the process in its entirety and recommend alternatives to accomplish the task.

PROCESS FOR ACQUIRING SUPPORT EQUIPMENT

Determining support equipment requirements for new aircraft is a very complex process. After a decision is made to design and produce an aircraft and a contract is awarded, the Navy, as well as the Air Force, provide the contractor with maintenance standards, regulations, and concepts to enable the contractor to prepare and support its equipment recommendations. Using this information, the contractor determines whether a need exists for specific support equipment and what quantity is required.

The contractor then submits its recommendations to the respective service for approval. The recommendations describe the requirement for an item, suggest equipment to satisfy the requirement, and identify the quantity needed at each of the three maintenance levels--organizational, intermediate, and depot. To promote maximum standardization of support equipment within the Government, the contractor should consider, in order of priority, (1) equipment defined by current Government specifications or modification of such equipment, (2) off-the-shelf commercial equipment currently in inventory, (3) other off-the-shelf commercial equipment or modified commercial equipment, and (4) equipment to be developed by the contractor or subcontractor. In preparing its recommendations, the contractor should use Government data sources to determine whether a functional requirement can be fulfilled by an equipment item which is already in the Government's inventory.

The recommendations should contain a summary of the contractor's efforts to select an existing item in the event it is proposing to develop a new one. Generally, the Air Force and the Navy must review the contractor's recommendations within 60 days and either accept or reject them. Once approved, the item becomes part of the Navy's Application Data for Materiel Readiness List or the Air Force's Table of Allowances. From this general list, individual lists are developed for aircraft maintenance activities by extracting portions which relate to maintenance and logistics needs. These needs, when approved by proper authority, become requirements.

The Naval Air Engineering Center is the Navy's principal field center for ensuring that new items which duplicate the functions and capabilities of existing inventory items do not enter the supply system. In the Air Force, a technical review of each new item submitted to the weapon system project office is usually made by the air logistics center assigned primary inventory management for that type of equipment. Air logistics centers also must screen existing assets to avoid unnecessary duplication of new equipment.

LIMITED REVIEW COVERAGE

The services' reviews and analyses of the support equipment items recommended by contractors should be strengthened to keep unnecessary items from entering the supply system. Currently, service engineers base their decisions on accepting contractor-recommended items largely on their knowledge of and experience with the general functions the items are intended to perform, as well as some degree of subjective judgment. No concrete methodology exists to logically guide the reviewers through the review process so that they can decide realistically whether the items are needed. As a result, the Air Force and Navy cannot assess whether like items are recommended and approved needlessly or whether a standard item can be substituted.

Once each service receives the contractor's recommendation for a support equipment item, it needs to consider many important factors before deciding to accept or reject the item. For example, it should determine whether:

--The item is necessary to perform an important maintenance function.

--The contractor fully describes the item's physical and functional properties in justifying its need.

--The item has an adequate and descriptive name.

--Existing inventories contain a like item or one which could be modified to preclude the new item from entering the supply system. If not, the reviewer should justify why existing assets are unacceptable.

Because of the time constraints imposed in the review process, the large number of items which must be reviewed, and the difficulty of evaluating technically complex equipment, the services are normally under pressure to review the items' suitability quickly, yet satisfy themselves that the recommended items are desirable for the aircraft to be supported. Very little documentation was available to justify reviewers' decisions to accept the items.

In our review of 16 items approved for the F-18 (see app. II), we could not determine what procedures the Navy reviewers used in their analyses, how extensive the analyses were, or what alternatives to the items under review were considered and rejected. Navy analysts told us they could sometimes recall what they did but had not documented their work before accepting the contractors' recommended items. This shortcoming not only makes quality control over the analysts' work impossible but also could allow unnecessary items to enter the system.

In the Air Force, we looked at 17 items (see app. II) for the F-16 aircraft, for which the San Antonio Air Logistics Center is the inventory manager. Equipment specialists there make technical reviews of the items, provide a basic check of the contractors' screening of existing Air Force inventories, and recommend to the weapon system project office whether the items are necessary. We identified serious weaknesses in the Air Force's reviews. For example:

--The air logistics center does not provide written instructions to assist equipment specialists in item reviews.

--Supervisors do not routinely check the thoroughness or accuracy of the specialists' reviews and therefore fail to ensure that the center's recommendations to the project office are accurate.

--The equipment specialists' knowledge and experience provide the only basis for reviewing 13 items. One principal reference source, "Military Handbook 300," was not routinely used for inventory screening because specialists felt the handbook was not up-to-date or were unaware that it even existed.

--Equipment specialists are not required to screen an item's requirements against other services' inventories, and no adequate data system is available to assist the specialists in such screening.

--Contractors' descriptions of the need for items and the proposed solutions do not provide the necessary detail to accurately screen existing inventories.

These problems are compounded by the fact that the Support Equipment System Project Office does not routinely review contractor-recommended items or the air logistics center's views on whether the items are necessary. The office also does not coordinate with the respective weapon system program offices during the review process to ensure that sound logistical support decisions are made on behalf of support equipment.

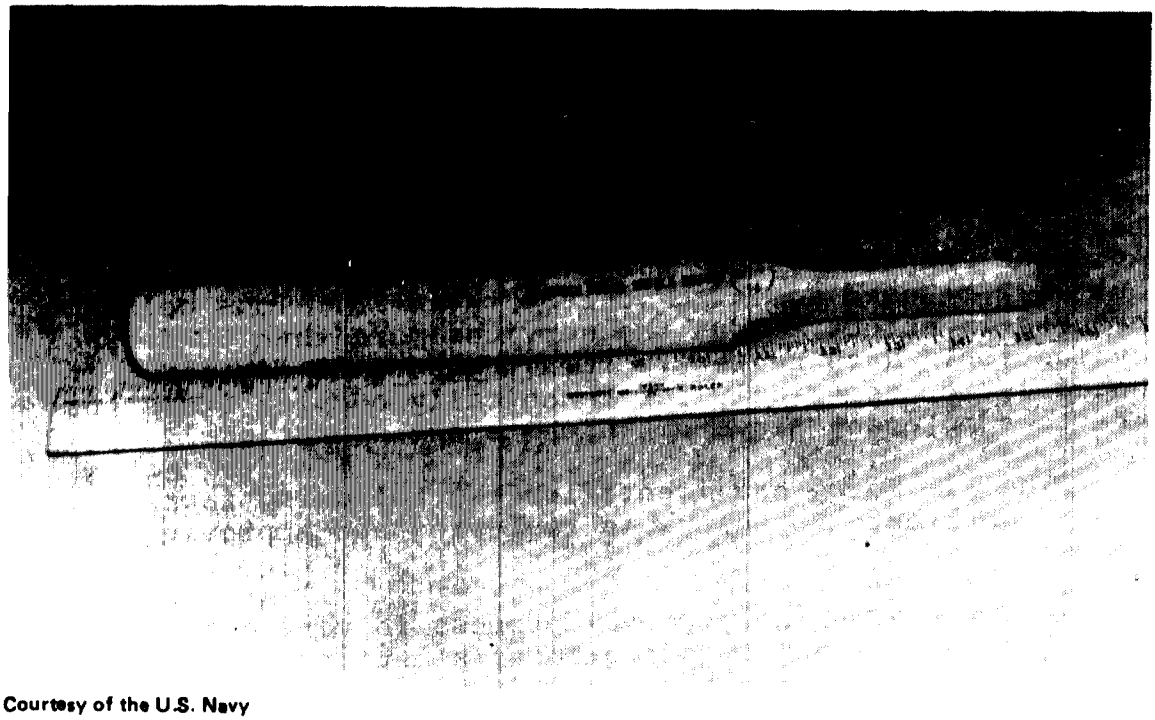
APPROVAL OF NONESSENTIAL EQUIPMENT

Inadequacies in the system for reviewing support equipment items have led to the development and selection of items which are of little value to supporting an aircraft's mission, particularly when other locally manufactured equipment is available to accomplish the task. These inadequacies severely limit standardization opportunities and, coupled with the problems previously mentioned, raise serious questions about the adequacy of the entire review and approval process.

For example, Naval Air Engineering Center officials approved two items which support the F-18's parachute packing container. One item was a drogue unit packing stick, costing $22 each and $4,500 to develop, which pushed overlapping portions of the parachute into its packing container (see page 33). The other item was a transfer tool rigging line, costing $7 each and $4,600 to develop, which prevented rigging lines from becoming entangled in the packing container. Although the contractor explained that no known item in the Government's inventory could satisfy all the design requirements to accomplish these functions, officials at the Parachute Riggers School, Lakehurst Naval Air Station, said they routinely used either a wooden stick or a ruler to push the parachute completely in its container and used a common screwdriver to prevent entangled rigging lines.

The above two items were approved by the engineering center, and some already have been purchased. However, the Naval Air Test Center has not yet tested them. The engineering center official who reviewed the items said

he had no expertise in parachute packing and rigging devices and had not consulted anyone who did. He felt, though, that the test center could delete the items later if it found the items unnecessary after testing. We believe this condition could have been avoided if the Navy's review and approval process had a systematic way of identifying items which are available to satisfy new requirements.



Courtesy of the U.S. Navy

STICK, PACKING -- DROGUE PARACHUTE
PART NO. MBEU 68048

UNTIMELY REVIEWS

A critical element in the support equipment review process is the timeliness of the services' evaluations of contractor-recommended items. If the evaluations are delayed, the equipment may not be available when needed and the costs for relying on contractor support can increase.

The time allowed for approving or disapproving a contractor-recommended item is generally 60 days. If more than 60 days elapse, the contractor understands that the item is automatically approved and may begin to order or develop it. Air Force and Navy officials told us that review times are often exceeded because of the complexity of the items under review and the large number of items submitted. The Air Force's Aeronautical Systems Division, for example, processed about 8,000 contractor recommendations for various aircraft in 1978.

We reviewed the extent to which processing times were met. Of 128 contractor-recommended F-18 items received at the Naval Air Engineering Center from January to December 1978, 41, or 32 percent, were not processed within the specified time. In the Air Force, the average time to complete review of 29 F-16 items we analyzed was 98 days.

These figures actually understate the time it takes to evaluate items. For technically complex items, some contractor recommendations are deleted "pending evaluation" if the reviewing authority feels that the 60-day limit will be exceeded. Of 469 F-18 items received as of June 1979, 191 had to be changed and resubmitted later. In one case, the Naval Air Engineering Center deleted about 40 test sets because they were to be used on the Navy's Intermediate Level Avionics Support System--a system that has been disapproved but will be used sometime to test the F-18. This deletion process in effect allows the services more than 60 days of evaluation. Navy reviewers feel that the 60-day limit is unrealistic, especially for technically complex items that are to complement a system which is not operational.

The Air Force has identified the following factors which contribute to delays in reviewing and approving items:

--The review and approval process is very complex, and many internal organizations (sometimes up to 28 activities) are involved.

--Recommended items are not generally submitted in a systematic, organized manner to permit timely evaluation.

--Contractors tend to specify parameters of support equipment they have available or would like to develop rather than to identify the minimum requirements. This practice confuses reviewers about the adequacy of the items being recommended.

--No documented review procedures exist to assist reviewers in deciding whether items are needed.

--The design of an aircraft weapon system is not "frozen" by the time a service receives the contractor's item submissions, which causes continual changes in many items originally recommended.

According to a recent Air Force report on improving the support equipment acquisition process, late delivery of equipment decreases the availability of the weapon system when needed. Increased costs and reduced operational readiness result.

CONCLUSIONS

The process for reviewing support equipment items submitted by contractors for Government approval is extremely complex. In many cases, the complexities of the process and time and staffing constraints have limited the adequacy of the reviews. The process should be simplified and streamlined so that all items, particularly those which are technically complex, are properly and promptly considered and nonessential items are eliminated.

To accomplish this, roles and responsibilities of those reviewing the items must be adequately defined and guidelines must be provided to evaluate the items systematically.

RECOMMENDATIONS

We recommend that the Secretary of Defense:

--Develop specific methodology to guide reviewers through the review process so that they can decide realistically whether items are necessary. The methodology should include the requirement to screen existing inventories and justify why existing assets are unacceptable.

--Require that Air Force and Navy top management oversee the adequacy of the review process and take an active part in the approval or denial of contractor-recommended items.

--Clearly define the review roles and responsibilities of essential organizations and eliminate those activities which provide little or no substantive assistance in deciding the adequacy of recommended items.

--Decide whether the time constraint imposed for unusually complex items, such as avionics testing equipment, is appropriate. If not, devise different strategies to ensure that complex equipment can be carefully reviewed and delivered when needed.

CHAPTER 6

BETTER MANAGEMENT VISIBILITY OVER SUPPORT EQUIPMENT PLANNED AND IN USE IS NECESSARY

To further opportunities for greater equipment standardization both before and after equipment items enter the supply system, the services need better visibility over the entire support equipment spectrum. Although the services have separately taken some steps to address support equipment and the problems it presents, they should focus on establishing an activity to actually manage support equipment and to oversee its acquisition. Organizationally, the services are too fragmented to play a larger role in initially determining what support equipment items they need for new aircraft.

With greater management visibility, top officials will be better able to understand and quickly act on problems identified at the operating levels. At the same time, the necessary visibility will help management assess whether more standard support equipment should be developed.

EFFORTS TO STANDARDIZE EQUIPMENT

The services have made some progress in reducing the number and kinds of support equipment which will enter their inventories in the future. One area which the Navy looked into dealt with engine test stands which test various engine parameters to help maintenance personnel determine if engines are working properly. Until 1978, the Navy was purchasing 28 different engine test stand systems. Twenty-two stands tested engines in the turbojet family, but each stand could test only a limited number of engine types within that family. In addition, the Navy had one stand to test turboprop engines and five to test turboshaft engines.

Although all these test stands still exist, the Navy recognized that it could develop a single engine test system, with wide capabilities, to test each family of turbojet, turboprop, and turboshaft engines. Thus, the Navy is now buying only three standard engine test systems. And because it designed the three stands with the objective of using common component items, the stands have over 90 percent common items among them. This effort enabled the Navy to reduce the need for unique items and other equipment to support and maintain the stands, to eliminate unnecessary stock from its supply system, and to simplify training requirements because fewer standard equipment items will be onhand.

Another example of the Navy's success involved hydraulic aircraft jacks. Recognizing that these items proliferated in the supply system, the Naval Air Engineering Center completed a study in March 1971 which substantially reduced the number of jack types needed, as follows.

Category	Types onhand before study	Number remaining after standardization	Number deleted
Aircraft jacks	127	25	102
Jack repair kits	58	19	39
Extension kits	26	22	4
Jack handbooks	58	29	29

In 1972 the Navy further reduced the number of jacks to 18, jack repair kits to 12, extension kits to 9, and jack handbooks to 23.

The Navy is currently testing a new jack to be used on the F-14 and F-18 aircraft. It may have further application on other aircraft and replace three jacks now in use.

STANDARDIZATION IMPEDIMENT ADDRESSED BY NAVY AND AIR FORCE

According to Navy and Air Force officials, the single greatest drawback to greater standardization has been the implementation of the Defense Acquisition Regulations. The regulations encourage competitive procurement whenever possible, but when performance type specifications are developed to meet the competition requirements, a different contractor may be awarded the contract each time the item is procured.

The new contractor must now provide the Government new technical manuals, different spare parts, a new training package, and so on. This results in functionally identical equipment produced by several different manufacturers, all in operation at the same site. The Navy identified five types of hydraulic test stands, three types of nitrogen servicing carts, and five liquid oxygen trailers as examples of the problem. While each meets the performance requirements, each is configured differently.

We believe, however, that several ways exist to reduce proliferation and still meet the procurement regulations' requirements for maximizing competition. One way to control proliferation and increase standardization is through

multiyear contract requirements. Multiyear procurement is a method of competitively contracting for DOD planned requirements up to a 5-year period if authorized by law. Multiyear requirements contracting enhances standardization because the same item can be delivered to the services each year for the duration of the contract. Other advantages of this method include lower costs and reduction in the administrative burden in placing and administering contracts.

Another method involves the use of detailed design specifications for follow-on procurements. Section 3-108 of the regulations encourages analyses of the advantages to be gained through obtaining detailed manufacturing, process, and assembly drawings, with rights to use for competitive procurement purposes at the earliest possible date, from the developer of the item.

If the services find any of the above methods undesirable or not practicable, they should consider section 3-213 which authorizes the Secretary of each service to negotiate contracts for equipment whose standardization and interchangeability of parts are necessary in the public interest and whose procurement through negotiation ensures this. This authority applies, in part, when it is necessary to limit the variety and quantity of items which must be carried in stock. Before buying a specific make or model under this authority, the services must consider whether the current design of the item to be standardized has been changed from the design of an existing item.

Since this option tends to limit competition, it should be used only when use of design specifications, multiyear contracts, or other means to increase standardization through competitive procurement cannot be applied. DOD, however, should establish criteria which identifies the circumstances when use of this authority is warranted.

COORDINATION REQUIRED BETWEEN NAVY AND AIR FORCE

The Navy and Air Force do not routinely coordinate their support equipment programs when they introduce new aircraft or equipment into their inventories, nor do they have a systematic method for evaluating equipment planned

or in use by the other service. By coordinating their support equipment programs, both services could identify common equipment requirements and develop a single item for use by both services.

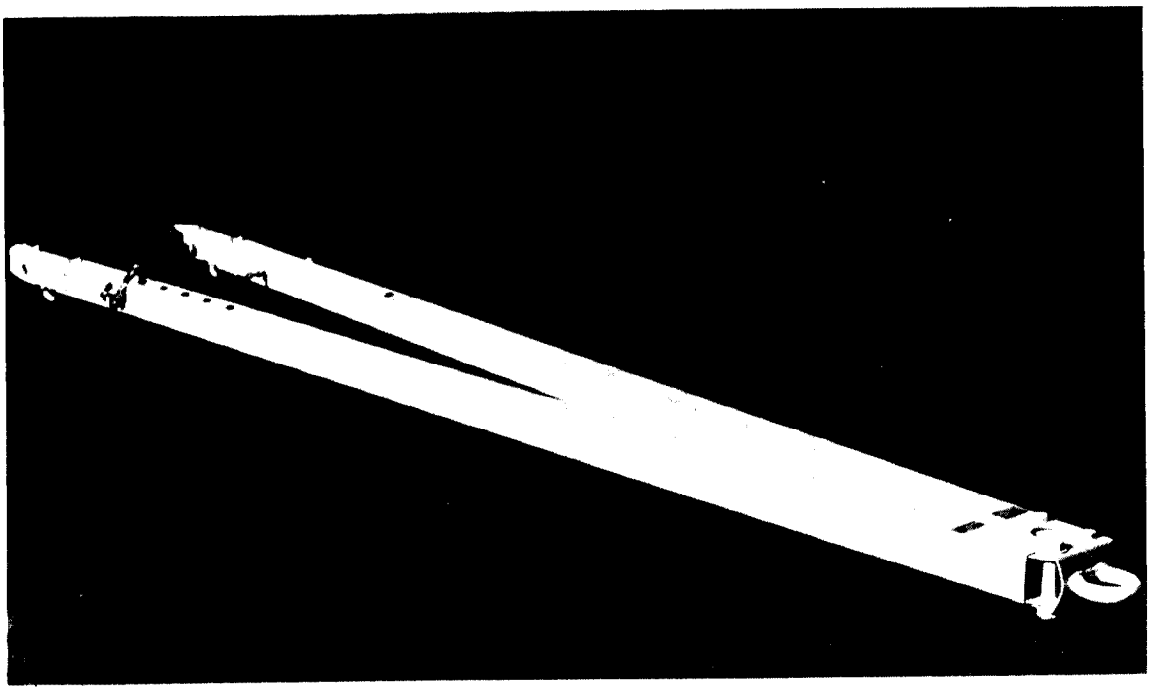
However, the services believe that any joint effort to identify equipment common to both services would be hampered by the fact that their aircraft are rarely in the same stage of development, and therefore, they do not see a need to solicit participation from the other service. Navy officials feel that the differing operational environments and missions of Navy and Air Force aircraft seriously restrict any benefits which could be gained through greater coordination. The Navy justifies this position because of its operations aboard aircraft carriers. Support equipment, it believes, must withstand the conditions posed by sea duty, including the need for being compact and corrosion resistant.

Although these factors have merit, they should not impose constraints so large as to make more coordination between the services impractical. We identified a number of cases in which more coordination could have prevented similar items from entering the supply system.

For example, the Navy developed the NT-4 model tow bar in 1964 as the universal item for all aircraft weighing less than 90,000 pounds. Although deployed on aircraft carriers, it was designed for use on shore-based activities as well. The Navy uses the NT-4 model on 20 weapon systems--mostly fighter and attack aircraft. It also uses four other types of tow bars to service four additional aircraft. The Air Force, conversely, was buying 18 types of tow bars to service its fleet as of June 1979 but actively uses 86 types.

The Air Force is just now recommending development of universal tow bars for aircraft weighing 80,000 pounds or less (class I) and for aircraft weighing between 80,000 and 325,000 pounds (class II). The Air Force estimates each class I tow bar will cost $775 and each class II $1,775. If the Air Force had coordinated tow bar acquisition with the Navy, it could have evaluated whether the NT-4 or other models were more appropriate and could have reduced unnecessary buys of actively reprocured equipment accordingly.

Before the Air Force proceeds with its development of universal tow bars, it should thoroughly evaluate the processes which the Navy used.



Courtesy of the U.S. Navy

NT - 4 AIRCRAFT TOWBAR
NSN 1730 - 00 - 954 - 8751

More coordination between the Air Force and Navy also could have limited certain types of avionics testing equipment. In many cases, test equipment for common avionics is functionally similar in both services. Following are examples of avionics systems common to the Navy and Air Force and the different testing equipment supporting them.

Common avionics systems	Navy avionics test equipment	Air Force avionics test equipment
Radio set, TACAN (AN/ARN-21) (note a)	TACAN test sets (AN/ARM-155 and 156)	Manual beacon simulator (ARM-135)
Navigation set, TACAN (AN/ARN-84)	TACAN test sets (AN/ARM-155 and 156)	TACAN test set (AN/ARN-172)
Navigation set, TACAN (AN/ARN-118)	(ARM-156 only)	Manual beacon simulator (ARM-135) and a 255 H1 junction box

a/TACAN--Tactical Air Control and Navigation.

The item manager in charge of Air Force TACAN avionics systems told us that, when both the Air Force and the Navy have the same or similar avionics systems, the same testing equipment could probably be developed. He pointed out that the differences in Air Force and Navy testing equipment come about from the services' differences in operating philosophies, willingness to buy greater reliability in a given test system, and differences in maintenance concepts.

In demonstrating the above differences in testing equipment, we do not intend to suggest that one piece of support equipment used by one service is better than that used by another. Our thrust is that, with better coordination between the services, the number and types of test equipment used to test common avionics systems could be reduced.

MANAGEMENT FEEDBACK NEEDED TO CORRECT PROBLEMS

To maintain an overview of the support equipment spectrum and to correct problems which arise, management needs feedback from the various component levels involved

in all equipment areas; that is, from its acquisition to its use at site locations. Adequate feedback is critical for

--determining whether an item is actually needed,

--determining which item should be bought (Government or contractor furnished),

--isolating and correcting problems in the evaluation process,

--responding to needs with the appropriate equipment, and

--seeing if the best use is made of equipment at field activities.

The various organizations involved with support equipment become isolated from each other's roles and responsibilities through either breakdowns in communications or philosophical differences. Weapon managers, for example, tend to operate independently from support equipment managers because they are primarily interested in making sure the aircraft performs as intended. They are not particularly interested in whether support equipment has application on aircraft other than their own. The services are trying to coordinate the functions of weapon and support equipment managers, but much more feedback between both is necessary to increase standardization.

A lack of feedback could contribute to the development of unnecessary duplicate equipment. To illustrate, in September 1975 the Naval Air Engineering Center approved the development of a unique, 4-gallon-capacity, hydraulic servicing unit for exclusive use on the A-7 aircraft. The center justified the unit's development because fleet activities complained that they could not adequately service hydraulics on "arresting" gears. Over 3 years later, the Naval Air Testing Center concluded that the recommended servicing unit would not meet performance needs. It also pointed out that four other hydraulic units would have fulfilled the requirements.

By the time the test center made its decision, 38 units of the originally recommended item had been bought at a total cost of about $56,000. At the time of our review, Navy officials told us that the item was still authorized for procurement despite the test center's evaluation. If

better communication and feedback existed between the engineering and test centers, another satisfactory unit could have been identified and an unnecessary one avoided.

To confirm the types of problems discussed previously, we visited selected military installations and observed how support equipment was being used and whether adequate substitutable equipment was available. The results showed, in many cases, that equipment was used infrequently and could have been deleted because maintenance personnel used another item to accomplish the task.

At Travis Air Force Base, for example, we looked at 46 stock numbered items, having unit costs of $10,000 or more, which were used for the C-5, C-141, and KC-135 aircraft. The inventory value of these items was about $2 million. Our tests showed that four of the KC-135 items were not used and that quantities for two others could be reduced.

After we brought these problems to the attention of the using maintenance unit, maintenance personnel either reduced requirements or deleted authorizations for the items. Furthermore, we noted that other available items could perform the same functions for three of the four deleted items.

We made no tests of the need for equipment at Lemoore Naval Air Station because (1) the Naval Audit Service reported in 1978 that several authorized allowances should be reduced and (2) equipment reductions and authorization changes were in progress as a result of an October 1978 command and user equipment review conference.

We did, however, gather information on the common ground support equipment pool concept implemented in 1978. Essentially, the concept involved establishment of a common pool to support various services for tenant and transient aircraft at Lemoore. Included in the equipment pool were such items as tow tractors, starters, tow bars, maintenance stands, and jacks.

The pool concept was intended to (1) bring about higher equipment use and thereby reduce the amount of equipment required, (2) improve equipment availability, (3) reduce misuse, abuse, and equipment downtime, and (4) reduce the number of support parts needed. A July 6, 1978, memorandum identified a reduced inventory of 149 ground support equipment items and a savings of about $200,000 in maintenance costs as a result of the pool concept.

The Navy should assess the results of its 1978 audit and see whether its pooling concept could result in further reductions. It should also make sure that managers having jurisdiction over support equipment decisions routinely receive feedback on problems at the user level. Naval Air Systems Command support equipment officials, for example, were unaware of the 1978 Navy audit at Lemoore and therefore could do little to prevent the kinds of problems found from recurring.

IN-HOUSE STANDARDIZATION CAPABILITY NOT USED AS MUCH AS POSSIBLE

The Air Force has an in-house capability which could provide the required visibility over support equipment standardization activities. Its Cataloging and Standardization Office is responsible for updating over 1,100 military specifications and standards and for making standardization program analyses for 63 stock classes. However, the lack of trained personnel and absence of command emphasis in this area have substantially reduced the office's role in standardization. The office has not updated engineering standards and specifications and has made only limited program analyses. Therefore, the potential to avoid unnecessary items from entering the supply system and to increase use of more common equipment has been seriously restricted.

Outdated engineering specifications and standards

The Air Force controls the quality and state of the art of equipment it buys through the criteria in its Military Engineering Specification and Standards. These documents tell how to fabricate an item and what level of technology it should meet. Although the documents should be updated at least once every 5 years, many are outdated and have not been reviewed. For example, 475 of the 1,116 standards for which the Air Force is responsible have not been reviewed for over 5 years. Two of them have not been looked at in more than 24 years.

The Cataloging and Standardization Office is required to update the specifications and standards but has no in-house engineering resources. The air logistics centers which manage the support and maintenance of all Air Force weapon systems do this work when resources are available. However, updating standards and specifications has low priority, and this shortcoming has created backlogs. Engineers are in short supply and are used on projects judged to be more important.

Equipment that does not have the usefulness of more modern equipment is not generally used for its full service life before being replaced by more modern items. By keeping the specification or standard at the current state-of-the-art technology level, the Air Force can ensure it buys those items that will be outdated last and that will provide a practical basis for greater common use. Up-to-date and detailed specifications and standards permit items to be designed with the potential for multisystem use. Therefore, the engineering documents should be updated periodically to save money, to cut down proliferation, and to ensure that equipment meets the latest state-of-the-art technology.

Limited program analyses

DOD requires each service to annually prepare program analyses of stock classes having standardization potential. The analyses, part of an overall DOD 5-year standardization plan, cover item procurement, engineering design and development, and supply management activities. They describe

--a stock class' condition from a standardization viewpoint,

--the work required to achieve a practical degree of standardization,

--the conditions which preclude the above action and ways to overcome the conditions, and

--the tasks being done to improve the situation.

Air Force standardization program analyses of current Federal stock classes have received little attention. Most of the analyses we saw gave little or no indication of the plans being made to carry out standardization but merely stated what actions had or had not been accomplished over the past year. According to Air Force standardization officials, the quality of their analyses depends heavily on input from contributing agencies, which has been minimal. As a result, the Air Force is overlooking a key element necessary to gain good visibility over equipment having standardization potential.

CONCLUSIONS

The services should increase their visibility over the entire support equipment spectrum to further standardization opportunities and to preclude purchasing equipment

which may never be needed. Better visibility also enables top management to understand and quickly act on support equipment problems at the operating levels.

The services also need to coordinate their support equipment programs when they introduce new aircraft or equipment into the inventory. Currently, they work independently and have no systematic way to evaluate support equipment planned or in use by the other service. By coordinating their programs, the services could identify equipment common to both and prevent different items performing the same or similar functions from entering the supply system unnecessarily.

To acquire more visibility over equipment, each service needs information fed back from top management to users at field activities and vice versa, so that management can maintain an overview of problems which could limit standardization. Without this feedback, unnecessary equipment could be developed. In some cases, managers are not aware of support equipment problems identified by the services' internal auditors.

Finally, the services should use their in-house expertise to a much greater extent to maintain visibility. One activity, the Air Force's Cataloging and Standardization Office, has the capability to control support equipment standardization functions but has not kept its engineering specifications and standards up-to-date and has not devoted sufficient attention to analyzing standardization potential in assigned stock classes. These shortcomings seriously restrict the increased use of common support equipment.

RECOMMENDATIONS

We recommend that the Secretary of Defense:

--Establish an activity to coordinate the efforts of item and system managers, equipment specialists, design engineers, users, and any other group participating in support equipment acquisition. The activity should maintain management visibility over support equipment and assess whether more standard equipment should be developed.

--Require the services to coordinate their research and development efforts so that they do not duplicate support equipment items performing similar functions, particularly for aircraft common to both services.

--Require the services to use design specifications and multiyear procurements, if authorized by law. The Secretary should provide instructions for the services to use negotiated procurements when competitive means to increase standardization cannot be applied.

--Direct support equipment managers to coordinate with weapon program managers and field activities to provide and get feedback to enhance standardization.

--Reinforce the services' cataloging and standardization organizations' role in approving new equipment by requiring their input before such equipment enters the system.

CHAPTER 7

COMMERCIAL AIRLINE PRACTICES COULD BENEFIT THE MILITARY SERVICES

Commercial airlines strongly emphasize reduced costs in outfitting their fleet with support equipment. To simplify support requirements, airlines prefer to standardize on one equipment model for their whole fleet. If standardization for the entire fleet is not practical, they attempt to minimize the number of different models.

Although the operating environments of the military and commercial sectors are quite different, some of the airlines' practices could benefit DOD. We believe DOD should study the support equipment acquisition practices used in the commercial airline industry and evaluate whether the advantages which the airlines have gained in reducing costs could accrue to the military services.

DIFFERENCES IN OPERATING ENVIRONMENTS

The different missions and operating environments of the commercial airline industry and the military services present different types of problems, solutions, and strategies when acquiring support equipment. Some of the the major differences are shown below.

Commercial airlines	Air Force and Navy
1. Mission	1. Mission
A. The single mission is transportation of people and freight.	A. Multiple missions are required, such as airlift, air-to-air combat, bombing, and electronic warfare.
B. One major aircraft family comprises 15 to 16 aircraft types, such as, DC-9, B-727, and L-1011. About 2,500 aircraft are in operation.	B. Ten major aircraft families comprise 70 to 75 different mission/design types. Over 14,000 aircraft are in operation.
C. Operating bases are in prime populated cities, and flight schedules are fixed.	C. Aircraft must be ready to deploy at any time to various locations to meet contingencies.

2. Environment	2. Environment
A. The technological environment is relatively stable.	A. Technology is constantly changing as weapon systems and avionics advance.
B. Aircraft and related equipment are defined as a total investment package with emphasis on minimizing the overall cost.	B. Aircraft design and development of support equipment are looked at separately with primary emphasis on aircraft operational effectiveness.
C. The management and maintenance personnel situation is generally stable.	C. Management personnel at all levels frequently rotate and uniformed maintenance personnel at the organizational and intermediate levels rotate or leave.

The less complex environment in the airlines undoubtedly makes it easier for them to have good visibility over their support equipment acquisition process. However, the airlines have also instituted sound management policies and practices for their support equipment.

EFFORTS TO REDUCE SUPPORT EQUIPMENT COSTS

Our contacts with the airline industry indicated that airlines have achieved much common use of their equipment through effective management, interservicing arrangements among the various air carriers, and emphasis on minimizing overall costs. For example:

--Organizationally, airlines have their own internal programs which promote standardization. Their internal management structures strongly emphasize nonproliferation and an inventory containing only the minimum essential equipment.

--Airlines insist that aircraft be designed to accept the equipment in their supply systems. They thereby limit the amount of new equipment they need to manage and minimize the number of design specifications required.

--Airlines use form, fit, and function standards for avionics equipment to facilitate the use of the same item on many different aircraft. The standards establish criteria for physical and electrical characteristics without changing equipment design. Such factors as case sizes, connectors, interwiring, power circuitry, and weight are specified to ensure equipment interchangeability. The engineering design and equipment configuration are left to the manufacturer's discretion. The motivating factor in using this alternative is support requirements simplification.

--Airlines often use interservicing arrangements. They are willing to contract for services or share their equipment with other airlines when they believe their own in-house capability is not cost effective. This is particularly true at locations where air traffic is sporadic or a full maintenance capability is not necessary.

We asked one airline for data on the extent to which it uses support equipment common to all aircraft in its fleet. In response, the airline estimated that, of 1,982 motorized ground support items used on Boeing 707, 727, and 747 passenger aircraft, about 90 percent was common to these aircraft. When it operated Boeing 707, 727, and DC-8 aircraft, about 99 percent of the equipment had common use.

We also asked the airline to show us typical examples of using the same type of support equipment for the Boeing 747 and the newer Lockheed L-1011 aircraft--built by different manufacturers. The airline provided the following list.

Equipment item	Number required	Unit cost
Towing tractor	1	$250,000
Passenger boarding	2	40,000
Cargo--baggage, container/ pallet loader	2	80,000
Belt conveyor	1	20,000
Container dolly	20	3,000
Cargo pallet dolly	4	3,000
Baggage/cargo tug	4	12,000
Deicing truck	1	100,000
High access unit	1	75,000
Medium access unit	1	40,000
Low access unit	1	20,000
Engine work stand (wing)	1	5,000
Lavatory service truck	1	30,000
Potable water truck	1	30,000
Axle jack	1	10,000
Airstart turbine	3	50,000
Electric power unit 400Hz	1	25,000
Air-conditioner	1	100,000
Hi-lift truck	2	45,000

Note: All this equipment rarely, if ever, would be allocated to a single location due to such factors as climate, local airport operation, and servicing policy.

The only items not common to the two aircraft are the unique tow bar and tail engine work stand required for the L-1011. The airline noted that interchangeability is high because it purchases an item designed to fulfill a maximum requirement rather than an item which might be maximum for the 747 and another which might be 25 percent smaller for the L-1011.

CONCLUSIONS

Although missions and operating environments of the commercial airline industry and the military services differ substantially, the airlines have implemented sound management policies and practices for support equipment and have obtained many standardization benefits. These types of benefits merit the military services' consideration.

RECOMMENDATION

We recommend that the Secretary of Defense evaluate the support equipment acquisition practices used in the airline industry and determine the extent to which the practices instituted to limit support equipment items and costs and to increase standardization could be used by DOD.

APPENDIX I

EXAMPLES OF VARIETIES OF AIRCRAFT GROUND SUPPORT EQUIPMENT CURRENTLY IN MILITARY INVENTORIES

Federal stock class	Item name	Number of varieties
1730	Maintenance platform	163
	Tow bar, aircraft	129
	Sling, aircraft maintenance	1,040
	Ladder, aircraft boarding	71
	Pin, aircraft ground safety	486
	Cover, aircraft ground servicing	517
	Shield, aircraft ground servicing	464
	Jack hydraulic tripod	63
	Adapter, hoisting	610
	Lock, aircraft ground safety, landing gear	108
4920	Power supply	623
	Cable assembly, power electrical	337
	Test set, fire control system	235
	Test set, flight control system	348
	Test set, radar	174
	Test set, indicator	144
	Test set, amplifier	122
	Maintenance stand, aircraft engine	111
	Electronic components assembly	1,552
	Wiring harness, branched	309
6625	Shunt, instrument	790
	Oscilloscope	784
	Voltmeter, electronic	490
	Cable assembly, radio frequency	2,161
	Lead, test	1,927
	Ammeter	8,512
	Dolly, test equipment	51
	Transducer, motional pickup	228
	Indicator, digital display	394
	Galvanometer	273

APPENDIX II

LISTING OF AIR FORCE F-16 AND NAVY F-18 SUPPORT EQUIPMENT ITEMS SELECTED FOR REVIEW

Air Force

Item number	National stock or part number	Item name
1	1730-01-011-2332	Pad, tiedown
2	-01-011-2334	Adapter assembly, engine
3	-01-017-2823	Tow bar, aircraft
4	-01-020-1232	Adapter assembly, jack
5	-01-042-9847	Ladder, aircraft
6	-01-172-967P	Pin, safety
7	4920-01-020-0363	Alinement fixture, angle of attack
8	-01-020-0364	Fixture kit, boresight
9	-01-036-4939	Test set, fuel capacity
10	-01-040-5070	Test set, environmental control system
11	-01-041-5833	Tester, pressure assembly
12	-01-046-2480	Test fixture, lending edge flap
13	-01-053-7789	Test set, emergency power unit
14	-01-054-4816	Fixture, holding, antenna
15	-01-061-7605	Test body, solenoid valve
16	-01-062-5779	Adapter, pitot static
17	6625-01-041-5999	Test set, battery

APPENDIX II

Navy

Item number	National stock or part number	Item name
1	A513S31460-1	Fluid makeup unit, liquid coolant
2	A51531170-41	Service unit, liquid coolant
3	74D110029-1001	Alinement set bore-sight
4	74D110020-1001	Frame assembly, boresight reference
5	1128AS100	Jack, hand, hydraulic, 20-ton
6	74D750013-1001	Adapter, gun handling
7	74D130017-1001	Bleeder assembly and pressure indicator-brake
8	74D110004-1001	Pin, aircraft ground safety--canopy jettison
9	MBEU66494	Strap, webbing-lifting, seat
10	132D1727	Fixture, checking, transfer unit
11	74D460101-1001	Adapter, drain valve, fuel sample
12	AN/ASM-184B(V)-1	Test set, aircraft weapon control
13	MBEU68042	Box packing, parachute
14	74D470001-1001	Tester, pressure, oxygen system
15	MBEU68048	Stick packing-drogue parachute
16	MBEU68052	Transfer tool, rigging line

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