

BY THE COMPTROLLER GENERAL **RELEASED**

**Report To The Chairman, Subcommittee
On Defense, Committee On Appropriations,
House Of Representatives**
OF THE UNITED STATES

**Requirements And Production Capabilities
Are Uncertain For Some Air Force, Navy,
And Marine Corps Aircraft Spares And
Repair Parts**

Constantly changing requirements and the absence of a management information system to predict production problems make it difficult to determine whether all of the Air Force, Navy, and Marine Corps appropriations requests for aircraft spares and repair parts are needed and whether the industrial base has the capability to produce such items.

Until the underlying systemic shortcomings in the requirements determination processes are corrected, the total annual budgets for aircraft spares and repair parts, which are based in part on the requirements data, will remain questionable.



119118

GAO/PLRD-82-77
JULY 22, 1982

522925

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

B-207226

The Honorable Joseph P. Addabbo
Chairman, Subcommittee on Defense
Committee on Appropriations
House of Representatives

Dear Mr. Chairman:

As you requested, we reviewed the processes the Air Force, Navy, and Marine Corps used to develop their fiscal year 1982 budgets for aircraft spares and repair parts, the subsequent procurement plans for these items, and the adequacy of management information systems to identify availability problems and actions taken to address such problems associated with these items.

As you requested, we did not obtain agency comments on this report. We did, however, discuss the report with program officials and incorporated their views where appropriate.

As arranged with your Office, unless you publicly announce its contents earlier, we plan no further distribution until 10 days from the date of this report. At that time, we will send copies to the Chairmen, House Committee on Government Operations, Senate Committee on Governmental Affairs, and House and Senate Committees on Appropriations and on Armed Services; the Director, Office of Management and Budget; and the Secretaries of Defense, Air Force, and Navy. Copies will also be made available to other interested parties upon request.

Sincerely yours,

A handwritten signature in cursive script that reads "Charles A. Bowsher".

Comptroller General
of the United States



D I G E S T

In fiscal year 1982, the Congress appropriated \$5.4 billion to procure spares and repair parts for Air Force, Navy, and Marine Corps aircraft. This compared to \$1.9 billion provided in fiscal year 1980 and \$3.9 billion provided in fiscal year 1981.

The military services testified that these increases were required to improve the operational readiness of their aircraft. However, GAO has previously reported that many aircraft operational readiness problems were caused by maintenance problems and other reasons--unexpected parts failures, late repair of parts, and modification or updating of parts--rather than a lack of sufficient funds.

While approving these increases, the Congress expressed concern regarding whether the aerospace industry could produce the increased quantity of aircraft parts and whether the increased procurements would result in the increased operational readiness claimed by the services. Because of these concerns, the Subcommittee asked GAO to

- determine the processes used by the Air Force, Navy, and Marine Corps in developing their fiscal year 1982 budgets for aircraft spares and repair parts;
- compare the budgeted requirements for selected sample items to the planned procurements for these items; and
- evaluate the management systems these services have to identify aircraft spares and repair parts problems, such as production problems, and the adequacy of the actions taken to correct identified problems.

In executing this review, GAO also considered the reports it had issued that have a direct bearing on the concerns expressed by the Subcommittee.

FLUCTUATING REQUIREMENTS LED TO CHANGES
IN PROCUREMENT PLANS FOR SOME ITEMS

GAO found that Air Force and Navy procurement plans for aircraft spares and repair parts included in the fiscal year 1982 budget changed because the requirements on which they were based fluctuated with time. Errors and omissions in the budget submissions and an interim change in the computational methodology for at least one aircraft system substantially affected the procurement plans for some items. (See p. 5.)

GAO recently reported that systemic shortcomings in the services' requirements determination processes affect budget submissions. For example, in a November 1981 report, GAO said such shortcomings in the computation of supplies and spare parts requirements for fiscal year 1982 resulted in invalid requirements and procurement actions, and it recommended actions to improve the process. The Department of Defense concurred with GAO's recommendations and has actions underway to address the identified problems. Special attention should be given to solving these systemic problems. (See p. 10.)

The Air Force has a contractor developing a computer model to more realistically determine wartime requirements for aircraft spares and repair parts. Requirements from an interim C-5A aircraft model showed that significant changes could result from using a different methodology.

GAO found that the Air Force revised its procurement plans on the basis of the interim model and that the original requirements for eight C-5A items GAO reviewed were reduced by \$68.8 million. This included increases of \$10.3 million for three items and decreases of \$79.1 million for five items. (See p. 8.)

MANAGEMENT SYSTEMS DO NOT
PREDICT PRODUCTION PROBLEMS

Items can achieve problem status for a number of reasons, some of which are production related and can be predicted. While Air Force and Navy management systems are structured to react to problems, they are not designed to predict their possible occurrence. (See p. 13.)

An Air Force working group has proposed that a system be developed which may enable the military services to predict production lead-time problems for specific items by generically coding items with increasing leadtimes by material content and manufacturing processes. Further study is needed to determine the feasibility, costs, and benefits of such an approach. (See p. 18.)

During this review, GAO noted that a number of deficiencies had recently been identified in Air Force and Navy programs for managing problem items. The programs were using inaccurate data and in some cases did not include all problem items. In reviewing some problem items identified by the Air Force and Navy, GAO found that, frequently, the remedial actions taken were ineffective in addressing production related causes. (See p. 15.)

GAO found that delinquent deliveries of aircraft spares and repair parts have increased and, according to the Air Force, they have become a significant problem affecting operational readiness of Air Force aircraft. Delinquent deliveries may also be a significant problem for the Navy. However, the Navy does not know because it does not track and analyze delinquent contracts and data required to do so has not been obtained or updated. Both the Air Force and Navy have some remedial actions planned or in process to deal with the delinquency problem. (See p. 20.)

RECOMMENDATIONS TO THE SECRETARY OF DEFENSE

GAO recommends that the Secretary of Defense closely monitor the military services' actions to overcome systemic shortcomings with their requirements determination processes to ensure proper resolution of the reported problems. (See p. 12.)

GAO also recommends that the Secretary of Defense require the Secretary of the Air Force to test the feasibility of generically coding aircraft items, based on the material trends identified in the Joint Aeronautical Material Activity reports, to identify the root causes of lengthening leadtimes. (See p. 24.)

Based on the test results, if it is determined that shortages of certain critical materials, components, or manufacturing processes are the causes of lengthening leadtimes, then the Secretary of Defense should pursue alternatives for resolving these problems. (See p. 24.)

RECOMMENDATION TO THE SECRETARY OF THE AIR FORCE

GAO recommends that the Secretary of the Air Force speed up the testing and validation of the wartime assessment and requirements simulation model as well as mission essentiality coding and use these tools in procuring spares and repair parts to fill war reserve materiel requirements. (See p. 12.)

AGENCY COMMENTS

As directed by the Subcommittee, GAO did not obtain agency comments on the matters discussed in this report. However, the report was discussed with agency officials and their views were incorporated where appropriate.

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ABBREVIATIONS

AFLC Air Force Logistics Command
GAO General Accounting Office
OWRM other war reserve materiel
WARS wartime assessment and requirements
 simulation

CHAPTER 1

INTRODUCTION

Over the past several years, the military services, particularly the Air Force, have testified that aircraft readiness was severely affected by spares and repair parts shortages. The services have repeatedly requested increased funding to buy more spares and repair parts to improve this readiness situation. However, in our earlier report, ^{1/} we stated that many aircraft operational readiness problems were caused by unexpected parts failures, late repair of parts, and modification or updating of parts, rather than a lack of sufficient funds.

In providing funds for aircraft spares and repair parts, the Congress has expressed concern regarding the capability of the aerospace industry to absorb increased defense spending. Conditions prompting this concern included the recent shortages and supply disruptions experienced in strategic and critical materials vital to aircraft manufacture, lengthening lead-times for aircraft production, and "bottlenecks" at the subcontractor level.

Because of these concerns, the Chairman, Subcommittee on Defense, House Committee on Appropriations, asked us to

- determine the processes used by the Air Force, Navy, and Marine Corps in developing their fiscal year 1982 budget requests for aircraft spares and repair parts;
- compare the budgeted requirements for selected sample items to the planned procurements for these items; and
- evaluate the management systems these services have to identify aircraft spares and repair parts problems and the adequacy of the actions taken to correct identified problems.

DESCRIPTION OF AIR FORCE AND NAVY BUDGETS FOR AIRCRAFT SPARES AND REPAIR PARTS

The budget formulation process is an 18-month cycle, beginning with the development of the Program Objective Memorandum in support of the Department of Defense's Five-Year-Defense-Plan and resulting in a final budget request provided to the Congress. This process requires, in varying degrees of

^{1/}"An Analysis of Air Force Rates of Aircraft Not Operationally Ready Due to Supply" (B-179264, Mar. 29, 1974).

participation, the efforts of many service command levels, installations, and activities, who prepare, review, and approve the budget request. Air Force and Navy (including Marine Corps) budgets for aircraft spares and repair parts are comprised of two basic categories--initial and replenishment spares.

Initial provisioning spares are those reparable spare parts required to support a new weapon system or subsystem through an initial period of service. Since actual usage data does not exist for computing these requirements, they are determined manually, based on such factors as

- engineering failure rates,
- data derived from historical experience with like aircraft, and
- proposed flying hours.

Replenishment spares are those items required to replenish or replace parts consumed or lost to a support or logistic system or to increase the quantity of spare parts in a system necessitated by changes in weapon system reliability, support system policies, or programmed activities, such as flying hour programs. Both the Air Force and the Navy formulate their budget requests for aircraft replenishment spares and repair parts using a computerized "stratification" process. The stratification process involves computing an item's total requirement ^{1/} and applying available assets to the requirement. When there are insufficient assets to satisfy the total requirement, the difference is the asset deficiency. The dollar value of all asset deficiencies represents the basis for the budget request.

President Reagan's amended fiscal year 1982 budget included about \$4.3 billion and \$1.5 billion for Air Force and Navy aircraft spares and repair parts, respectively. This represents about a 48-percent increase from the Air Force's previous year's spare parts budget of \$2.9 billion and a 36-percent increase from the Navy's fiscal year 1981 spare parts budget of \$1.1 billion. The fiscal year 1982 amounts included a Department of Defense approved inflation rate of 6.7 percent.

A breakout of the Air Force's and the Navy's appropriation requests for fiscal year 1982 and amounts actually appropriated are shown in the table on the following page.

^{1/}The total requirement for an item consists of the sum of its various requirements levels, such as for administrative lead-time, production leadtime, safety level, repair cycle, etc.

	<u>Air Force</u>	<u>Navy and Marine Corps</u>	<u>Total</u>
	----- (millions) -----		
Initial spares	\$ 898.7	\$ 739.8	\$1,638.5
Replenishment spares:			
Peacetime	2,055.4	807.1	2,862.5
War reserves	<u>1,312.0</u>	<u>0</u>	<u>1,312.0</u>
Total request	<u>\$4,266.1</u>	<u>\$1,546.9</u>	<u>\$5,813.0</u>
Total appropriated	\$3,889.8	\$1,545.4	\$5,435.2

OBJECTIVES, SCOPE, AND METHODOLOGY

Our objectives were to (1) determine how the Air Force, Navy, and Marine Corps developed their fiscal year 1982 budget requests for aircraft spares and repair parts, (2) compare the budgeted requirements for selected sample items to the planned procurements for these items, and (3) evaluate the management systems these services have to identify aircraft spares and repair parts problems and the adequacy of the actions taken to correct identified problems.

During our review, we

- interviewed Air Force and Navy program officials and personnel at headquarters, intermediate headquarters, and field installations about the processes used to develop fiscal year 1982 budgets for aircraft spares and repair parts (see app. I);
- examined the information/documentation available in support of specific aircraft spares and repair parts items contained in the fiscal year 1982 budget requests and compared this information to subsequent procurement plans for these items;
- reviewed management systems used by the Air Force and Navy to identify aircraft spares and repair parts production problems and the steps taken to alleviate them;
- discussed with officials in the Office of the Undersecretary of Defense for Research and Engineering and officials in headquarters and intermediate headquarters of the Air Force and Navy the ability of industry to produce aircraft spares and repair parts requested for the fiscal year 1982 budgets;

- analyzed various reports and studies dealing with the ability of the public and private sectors to produce aircraft spares and repair parts, and
- obtained public and private industry officials views regarding aerospace industry capabilities during conferences conducted by the American Defense Preparedness Association.

We limited the scope of our review to replenishment items, which accounted for the majority of the dollars requested for aircraft spares and repair parts in fiscal year 1982. We selected these items based on high dollar value, long leadtime, planned procurements in fiscal year 1982, and/or presence on listings indicating the items' critical problem status. Because items were not randomly selected, the incidence of each specific deficiency found within our sample items cannot be projected to the total universe of Air Force and Navy aircraft spares and repair parts or to the total budget requests for these items.

Nevertheless, we believe that our sample data, reflecting deficiencies of a systemic or generic nature, coupled with information from interviews and industry publications and past studies, provides relevant information regarding potential bottlenecks in the production of aircraft spares and repair parts.

Our review was performed in accordance with our "Standards for Audit of Governmental Organizations, Programs, Activities, and Functions."

CHAPTER 2
IMPACT OF FLUCTUATING
REQUIREMENTS ON PROCUREMENT
PLANS FOR SOME AIRCRAFT SPARES
AND REPAIR PARTS

The determination of the services' annual budget submissions for aircraft spares and repair parts is a comprehensive and time-consuming process. Also, the requirements upon which these requests are based are dynamic and fluctuate constantly with the passage of time. It is therefore not unusual for planned procurements to be revised after budget submission because of changes in missions, flying hours, repair cycles, failure rates, and other such factors.

We recently reported ^{1/} that a number of systemic problems were impairing the services' requirements determination processes for supplies and spare parts. Our current review disclosed many of these same problems affected the budget requirements developed for specific aircraft spares and repair parts. For example, we found that changes in computational models, omissions, and systemic shortcomings in the requirements determination processes contributed significantly to inaccuracies in the fiscal year 1982 requests for aircraft spares and repair parts and the subsequent need to modify procurement plans.

Because the same processes were used for the fiscal year 1983 budget, the validity of the total requirements used to formulate the fiscal year 1983 budget is also questionable.

CONSTANTLY CHANGING REQUIREMENTS
AFFECT PROCUREMENT PLANS

To permit military service, Department of Defense, Office of Management and Budget, and White House review prior to submission to the Congress, the services' initial budget submissions are developed based on requirements generated about 18 months before the date the services expect to receive the funds. For example, the Department of Defense's amended fiscal year 1982 budget was primarily based on requirements computed as of March 31, 1980, about 18 months before the start of fiscal year 1982.

^{1/}"The Services Should Improve Their Processes for Determining Requirements for Supplies and Spare Parts" (PLRD-82-12, Nov. 30, 1981) and "More Credibility Needed in Air Force Requirements Determination Process" (PLRD-82-22, Jan. 7, 1982).

After they are verified, the individual item requirements for aircraft spares and repair parts are combined. Throughout the remainder of the budget review and approval process, the funding proposal is reviewed in terms of "lump sums." However, the factors involved in the budget process are dynamic. Consequently, subsequent events can and do significantly change item requirements and procurement plans.

Because item requirements are a continually "moving target," the Air Force and Navy cannot be certain of which aircraft spares and repair parts to buy until months after their initial budget submissions are made. Recognizing this, the services continually update their requirements, and actual item procurements are based on the latest requirements information available. This process fosters substantial differences between specific items and quantities used in the budget formulation and subsequent procurement plans. These differences include both increases and decreases in originally budgeted amounts. The following examples illustrate this point.

F-100 engine

Backup data for the Air Force's fiscal year 1982 budget submission showed that about \$325.7 million of the \$4.3 billion for aircraft spares and repair parts request was for F-100 engine parts. The F-100 engine is relatively new to the Air Force's system and actual usage experience has not been sufficient to stabilize item requirements.

From a list provided by Air Force officials, we selected three F-100 engine items from the items and quantities included in the budget and still planned for procurement in fiscal year 1982. We then compared the initial requirements for these items with their revised requirements and, as summarized below, we found substantial differences because budget backup data showed that:

- \$13.3 million was included for the procurement of 14,221 first-stage turbine vanes for the F-100 engine. However, subsequent to the budget submission, a repair program was established for this item, and a purchase request was processed for 6,459 vanes, using fiscal year 1981 supplemental funds. According to Air Force officials, the Air Force only needs to procure two additional vanes in fiscal year 1982 at a total cost of about \$2,328.
- About \$11.3 million was included for the procurement of 10,109 external nozzle segments for the F-100 engine. However, because of subsequent aircraft modifications, there is no longer a need to procure these items during fiscal year 1982.

--About \$2.4 million was included to purchase 22 fuel controls for the F-100 engine. However, procurement of this new item was uncertain at the time we did our review because its requirements had not yet stabilized.

F-15 aircraft

The amount requested for F-15 aircraft replenishment spares and repair parts was reduced by \$163 million after budget submission. According to budget backup data, the Air Force had originally requested \$287.5 million for these parts; however, because of subsequent reductions in the need for peacetime operating stocks and war readiness spares kits/base level self-sufficiency spares, the amount was reduced to \$124.5 million. The following table shows the originally requested and revised amounts for each category.

<u>Category</u>	<u>Budget request March 1980</u>	<u>Revised estimate March 1981</u>	<u>Net change</u>
------(millions)-----			
Peacetime operating stocks	\$ 160.5	\$ 66.8	\$ -93.7
War readiness spares kits/base level self-sufficiency spares	<u>127.0</u>	<u>57.7</u>	<u>-69.3</u>
Total	<u>\$287.5</u>	<u>\$124.5</u>	<u>\$-163.0</u>

F-14 aircraft

Budget backup data for the Navy's fiscal year 1982 aircraft spares and repair parts request showed that approximately \$126.3 million was for F-14 parts. Our review of the following F-14 items showed that the funding requirements for:

--Gimbal assemblies were increased about \$2.7 million after budget submission. Budget backup data showed that 12 assemblies were included at a cost of \$53,820 each. However, the Navy understated the unit cost and total requirements for this item. As of October 1981, the Navy planned to buy 45 of these items, at an estimated cost of \$75,000 each or \$3,375,000.

--Arresting gear stinger assemblies were increased \$10 million as of October 1981. Budget backup data included a \$2 million requirement for 100 items, based on a 36-percent wear-out rate. However,

after budget submission, a cracking problem surfaced with these items, increasing the wear-out rate. As a result, the Navy now plans to buy 628 stinger assemblies at an estimated total cost of \$12 million.

--Arresting gear trunnion assemblies increased by about \$1.6 million after the budget submission. Budget backup data showed that about \$430,000 was originally requested to buy 100 of these items. This was based on a 34-percent wear-out rate. However, unanticipated problems developed with this item, increasing the wear-out rate to 50 percent. As of October 1981, the Navy planned to buy 446 units at a total cost of more than \$2 million.

The Congress does not allocate aircraft spares and repair parts funding to the Air Force or Navy by weapon system. Therefore, the proposed funding used in the budget submission for a particular aircraft system or component is not necessarily a firm commitment to actually buy any particular aircraft item. Except where specific allocations are made by headquarters, the buying installations have considerable flexibility in applying spares and repair parts funds.

WARTIME REQUIREMENTS CHANGED BY INTERIM MODEL

To more realistically determine other war reserve materiel (OWRM) requirements for aircraft spares and repair parts, the Air Force Logistics Command (AFLC) has a contractor developing a computer model ^{1/} to quantify such spares requirements and to assess the impact of these spares on wartime sortie generations. In the interim, AFLC has developed another model for the C-5A aircraft which it believes more closely simulates expected wartime logistics requirements than the requirements determination process currently used. On May 1, 1981, this interim model produced the OWRM spares and repair parts requirements for the C-5A aircraft. After validity testing and adjustment, item managers were instructed to use the requirements to prepare advance purchase requests for the fiscal year 1982 procurements.

C-5A aircraft

For fiscal year 1982, Air Force budget backup data showed that \$463 million in aircraft spares and repair parts funding was required to fill OWRM requirements for the C-5A. However, these requirements were subsequently and substantially reduced based upon what Air Force officials believed to be a more realistic computational model.

^{1/}Wartime assessment and requirements simulation (WARS) model.

According to Air Force officials, the Air Force's present requirements systems have a basic flaw when forecasting wartime requirements because the systems assume that wartime conditions are a simple extension of peacetime operations. These officials stated that this assumption is invalid because, in wartime, most of the peacetime standards would be greatly compressed. For example, during peacetime, most industrial activities, including repair and overhaul activities, operate one or two 8-hour shifts a day, 5 days a week. During wartime, production activities could, and most likely would, expand to full production and work three 8-hour shifts or two 10-hour shifts a day, 6 or even 7 days a week. Air Force officials said that repair cycles could consequently be compressed by as much as 25 percent or more and that this in turn would increase the availability of items from repair, thereby reducing procurement requirements for reparable items.

Our comparison of the originally budgeted requirements and the requirements subsequently developed by the model for eight C-5A items showed an overall reduction of \$68.8 million, as shown in the chart below.

National stock number	Fiscal year 1982 budget amounts		Revised procure- ment plan		Difference	
	Quantity	Dollars	Quantity	Dollars	Quantity	Dollars
	(millions)		(millions)		(millions)	
2840-00-502-2563PS	68	\$77.0	44	\$49.9	-24	\$-27.1
2840-01-033-3307PS	161	70.5	136	59.5	-25	-11.1
2840-01-036-5687PS	2,694	55.5	2,919	60.1	225	4.6
2840-01-041-8616PS	139	39.4	28	7.9	-111	-31.5
2840-01-044-6141PS	20,136	20.7	14,908	15.4	-5,228	-5.3
2840-01-072-3526PS	43	19.9	44	20.4	1	.5
2840-01-072-3527PS	61	22.9	50	18.8	-11	-4.1
2840-00-097-9248PS	29	14.9	39	20.1	10	5.2
Total		<u>\$320.8</u>		<u>\$252.1</u>		<u>\$-68.8</u>

AFLC officials stated that the interim model for the C-5A aircraft will be replaced by WARS, a more sophisticated model. These officials also said that the command eventually intends to use the WARS model for other aircraft, such as the A-10, C-130, C-135, C-141, F-15, and F-16, as well as the F-100 engine.

Although Air Force officials said that the interim C-5A model has shown a general trend of reducing OWRM requirements for the C-5A aircraft, they did not know what effect the new model would have on requirements for other aircraft systems. They also said that the results of a new update of the interim C-5A aircraft model will be used to decide fiscal years 1982 and 1983 procurements of C-5A OWRM airframe items. However,

the procurement decisions for other aircraft OWRM items will continue to be based on the Air Force's present requirements system until it is replaced by the new model.

RECENT CRITICISM OF
REQUIREMENTS COMPUTATION PROCESSES

In our past reports, we stated that numerous inconsistencies existed in the requirements processes which were used to formulate the fiscal year 1982 budget requests for supplies and spare parts. We reported that data used frequently required extensive adjustments before they could be used and that inconsistencies and inaccurate data could result in invalid requirements and procurement actions.

Computerized requirements for replenishment spares and repair parts accounted for over 70 percent of the Air Force's and Navy's budget requests for aircraft spares and repair parts in fiscal year 1982. Manual adjustments are made to these computerized requirements computations. In November 1981, we reported that

- about 65 percent of the computerized item requirements involved manual adjustments and
- manual adjustments were often incorrect, resulting in both overstated and understated requirements and unnecessary procurements.

Many of the problems identified in the November 1981 report had also been identified in our 1972 report. 1/ In that report, which dealt with the Air Force's requirements system, we said that inaccurate data and adjustments were caused by

- data not being checked for accuracy before being used due to manager's heavy workload,
- good information sources not being readily available for some of the needed data,
- policies and procedures being ambiguous and unclear, and
- personnel not being thoroughly trained in the system's operations.

1/"Need To Improve Accuracy Of Air Force Requirements System For Repairable Parts" (Sept. 12, 1972).

Our major recommendations in the November 1981 report were that the Secretary of Defense direct the service Secretaries to

- improve training of personnel operating the requirements system,
- develop a more uniform Defense-wide definition of production leadtime, and
- develop improved leadtime and demand forecasting techniques.

On February 25, 1982, the Department of Defense commented on the report, indicating agreement with our major recommendations. Regarding the training requirement, Defense said that each service maintains specific training courses in all phases of requirement management and continually strives to improve the quality of these efforts and that increased emphasis will be placed on this important area.

To meet the need for more effective policies in the areas of production leadtime and demand forecasting, the Department said it had initiated a major analysis effort on demand forecasting with the objective of developing improved, uniform Defense-wide forecasting techniques. It also said that as resources permit, a specific definition of production leadtime will be developed and included in the appropriate Defense policy issuance.

In view of the recency of the report and the Department of Defense's positive response to our recommendations, we are not making further recommendations regarding the requirements determination processes. However, we believe the Secretary of Defense should closely monitor the military services' actions to correct identified systemic shortcomings to ensure proper resolution of the problems.

In another report, 1/ we pointed out that the Air Force has developed a conceptual system for determining mission essential items. Among other things, the system would aid in identifying war reserve needs. However, system implementation has been plagued with problems, such as most of the items are subjectively coded mission essential and certain non-essential items have a higher essentiality ranking than other more essential items. In commenting on the report, the Department of Defense agreed that the essentiality coding criteria should be more responsive in order to meet user needs.

1/"Mission Item Essentiality: An Important Management Tool for Making More Informed Logistics Decisions" (PLRD-82-25, Jan. 13, 1982).

CONCLUSIONS

Many of our past reports have addressed problems with the military services' processes for determining requirements, including those for aircraft spares and repair parts. Our current study disclosed that many of the previously reported problems still exist. The military services recognize the problems, and they have recently initiated actions to correct them. However, until the underlying systemic shortcomings in the requirements determination processes are corrected, the total annual budgets for aircraft spares and repair parts, which are based partly on the requirements data, will remain questionable. Because these systemic shortcomings may be resulting in the budgeting for more or less aircraft spares and repair parts than are needed, the Department of Defense needs to devote more attention to assuring that the services improve their requirements determination processes.

RECOMMENDATIONS

We recommend that the Secretary of Defense closely monitor the military services' actions to overcome systemic shortcomings with their requirements determination processes to ensure proper resolution of the reported problems.

We also recommend that the Secretary of the Air Force speed up the testing and validation of the WARS model as well as mission essentiality coding and use these tools in procuring spares and repair parts to fill war reserve materiel requirements.

CHAPTER 3

MANAGEMENT SYSTEMS DO NOT PREDICT PRODUCTION PROBLEMS

The Air Force and Navy have management systems which are structured to react to problem items, once they arise, rather than predict their occurrence. Consequently, service actions are generally more reactive than preventive.

Many items end up in a problem status because of a lack of an effective system to predict potential problem areas. As a result, receipt of items is often delayed by lengthening production leadtimes and industry's inability to rapidly increase production capability because many items are procured from a sole source.

Recent Air Force and Navy actions taken to remedy some problem item situations are commendable. For example, an Air Force working group recommended establishing a coding system to categorize items with increasing production leadtimes generically by material content, manufacturing processes, and/or critical components. Such an approach could aid in identifying basic causes of problems and actions could be directed at solving the basic causes. Once these basic causes are resolved, the incidence of problem items due to that particular cause would be reduced. However, the proposal has not been tested sufficiently at this time to ensure its feasibility.

AIR FORCE AND NAVY MANAGEMENT SYSTEMS

Under their critical item management programs, the Air Force and Navy compile daily and monthly listings that identify items affecting the operational capability of their aircraft and related equipment. Many items appear on these listings because of temporary supply shortages and/or repair disruptions. However, some items develop more long-lived problems and become "critical" items. An item is generally considered to be critical when

- unavailability impairs aircraft operational capability for a significant number of hours,
- withdrawals from war reserve materiel are necessary to satisfy operational needs for the item, and/or
- cannibalizations 1/ are required to satisfy operational needs for the item.

1/Cannibalizing is the act of taking serviceable parts from one aircraft in order to satisfy operational needs for another.

Item managers are required to identify the cause or causes for the critical item and to take appropriate remedial action. The following table shows the six broad categories the Air Force uses to report critical item causes and the number of times each was cited as contributing to criticality of the 430 items included in its program as of September 1981.

	<u>Number of times cited</u>
Base interest	98
Transportation	-
Quality of material	66
Repair problems	108
Supply problems	154
Procurement problems	<u>122</u>
Total	<u>a/548</u>

a/Adds to more than 430 because some items were included in more than one category.

Although the table indicates that the "supply problems" category is the one most frequently cited, this can be misleading. For example, the supply problems category includes the cause "parts shortage for repair." This cause, which was cited 25 times, could also be considered a repair problem. Similarly, the "base interest" category 1/ includes a cause "untimely return of reparable" which was cited 33 times. Clearly, this too could be considered a repair problem. If these two causes were included as repair problems, then the "repair problems" category would have accounted for 166 of the 548 criticality cause citations in the Air Force's Critical Item Management Program as of September 1981.

Procurement problems were cited 122 times. Production related causes were among those most frequently cited. For example, Air Force managers cited lengthening leadtimes as a criticality cause for 76 of the 122 times that procurement related problems were cited, as summarized in the table on the following page.

1/The base interest category includes causes such as demands exceed authorized stock levels, untimely return of reparable, and inaccurate stock balance and consumption reporting.

<u>Procurement related problems</u>	<u>Number of times cited</u>	<u>Percent of total</u>
Contractor delivery slippage	26	21.3
Late award of repair contract	8	6.6
Long leadtime	76	62.3
Contracting-bidding problems	<u>12</u>	<u>9.8</u>
Total	<u>122</u>	<u>100.0</u>

Remedial actions frequently selected by the Air Force and Navy during reviews of critical items include (1) using repair facilities to manufacture the needed item in-house, which affects normally scheduled maintenance, (2) cannibalizing equipment, (3) limiting flying hour programs and/or performing increased inspections, (4) increasing depot maintenance support or initiating contract maintenance, (5) initiating emergency procurement where a new contract is awarded usually on a sole-source basis at premium prices, and (6) arranging for accelerated delivery of future production or making production trade-offs where scheduled delivery dates on some contracts are extended to obtain accelerated delivery on critically needed items.

Problems with the Air Force's critical item program

Major operating commands have voiced dissatisfaction with the results obtained from the Air Force's critical item program. For instance, in its September 1981 message to its subordinate air logistics centers, AFLC stated:

"Operating Commands have expressed on numerous occasions * * * that AFLC does not appear to be working on the items that are causing them problems. They have lost faith in our critical item program and feel that we hide behind cannibalizations and WRM (War Reserve Material) withdrawals."

Also, several deficiencies have been noted regarding the program. During the February 11, 1981, audit of the San Antonio Air Logistics Center's program, the Air Force Audit Agency found that:

--Maintenance personnel had to rely on inaccurate data provided by AFLC in monthly critical item master lists.

- Stronger distribution controls were needed over the inventory process because accountable asset records contained a number of erroneous critical item inventory balances.
- Inventory managers did not effectively manage some critical items and one local critical item report contained inaccurate data.
- Air Force bases did not include all critical items in their programs.

Problems with the Navy's critical item program

The Navy's Aviation Supply Control Center has the responsibility of maintaining a worldwide requisition data base for items that have affected aircraft operational readiness. The control center provides status reports and statistics that are used to monitor and expedite problem items.

Control center representatives stated that statistics covering the fleet and naval air stations are reviewed and evaluated daily. In addition, each month these representatives brief the Commander of the Naval Supply Systems Command on problem items. The Naval Supply Systems Command, in turn, uses the control center's information to identify trends and major problem areas in naval aviation support. Also, based on the control center's information, the Aviation Supply Office takes action to alleviate problem item situations.

However, we found that the Navy does not analyze the underlying causes of problem items. In addition, during our attempt to use the Navy's data to select items with production related problems for review, we found the Navy's cause codes were frequently incorrect. We also found that the control center does not maintain overall statistics regarding the significance of various causes or their effects on overall operations. Therefore, the Navy does not know how significant the production problems are and how they relate to known readiness problems.

LENGTHENING PRODUCTION LEADTIMES

Production leadtime is a key element in determining requirements for aircraft spares and repair parts. As reported in our earlier report, 1/ each day of leadtime can equate to several hundred thousand dollars of system requirements.

1/"The Services Should Improve Their Processes for Determining Requirements for Supplies and Spare Parts" (PLRD-82-12, Nov. 30, 1981).

The consequences of either overstating or understating leadtimes are important ones. Overstated leadtimes can result in the unnecessary expenditure of funds to procure items that are not needed. On the other hand, failure to adequately compensate for lengthening leadtimes can cause budgeted requirements to be understated.

To minimize the impact of increasing leadtimes and to discern leadtime trends, the Air Force and Navy compare leadtime estimates from contractors with available leadtime history. This could aid the services in identifying potential problems. Nevertheless, increases in production leadtimes continue to be cited as a primary cause for many items being categorized as critical items.

We selectively reviewed 12 Air Force and 10 Navy aircraft items which the services had identified as having procurement leadtime-related problems. Our review disclosed that these items usually attained a problem status as the result of a number of combined causes, only some of which were production related. For example, nozzle segments for one Air Force aircraft system have been in a critical item status since about March 1980 because of unexpected increases in item demand, attributable to improper handling and removal procedures, and a 27-month increase in production leadtime, caused by the contractor's inability to obtain vendor supplied parts manufactured with the material "Iconel." In another case, the arresting gear "stinger" assembly for the Navy's F-14 aircraft became a critical item because of significant increases in item demand, caused by unexpectedly high wear-out rates, and long production leadtimes, caused by the need to obtain and machine forgings used in manufacturing the item.

Twelve of the 22 items reviewed had production leadtimes that were specifically linked to industry problems, such as the availability of castings, forgings, and/or raw and semi-processed materials shortages. The remaining items had sole-source contractor delinquency problems and/or capacity problems.

Air Force production leadtime surveys do not result in credible information

Each of the air logistics centers conducts an annual survey to obtain updated production leadtime information from contractors, many of which are the only production source for the item. Participation in the survey is voluntary, and contractors are not paid for or bound by the information they provide. Many contractors do not respond to these surveys. For example, in its fiscal year 1981 survey, the Sacramento Air Logistics Center requested production leadtime estimates for 6,309 items. However, it only received 3,346 responses--a response rate of only 53 percent.

Perhaps more importantly, item managers do not trust contractors' responses since the contractors are not bound to the information they provide. One item manager stated that:

"Everyone recognizes that contractor responses from the PLT [Production Lead Time] Survey are suspect for use in item computations. We know that contractors are not paid to provide estimates; are not obligated by estimates and estimates do not relate to actual experience history data, etc. * * * Normally, if the response shows increased PLT, the decision is made to use the increased time. When a decrease is indicated, the decision is usually to not use it."

Possible "early warning" system
for leadtime increases

The Joint Aeronautical Material Activity, located at Wright-Patterson Air Force Base, Dayton, Ohio, monitors potential material shortages and possible increases in production leadtimes for aircraft and associated spare parts. Using information from aerospace contractors, this activity issues to the services a two-part quarterly report which shows average leadtimes incurred for materials by 6 major airframe producers and by 15 to 17 additional airframe, engine, and electronics manufacturers.

Theoretically, this advance warning should enable the services to avoid, or at least minimize, an adverse impact from unexpected increases in production leadtime. For instance, if the quarterly report showed that industry leadtimes for obtaining titanium forgings increased significantly, then the production leadtimes for aircraft items requiring titanium forgings would also be expected to increase. To compensate for these potential delays, production leadtime information could be updated with contractors, and procurement actions taken sooner.

We found that Air Force buying activities receive the Joint Aeronautical Material Activity reports, but the Navy's buying activity--the Aviation Supply Office--does not. Several Air Force and Navy item managers stated that there is no mechanism with which to identify items requiring castings, forgings, special materials, or manufacturing processes and that this activity's information is therefore too general to be of practical use.

Our review disclosed that in February 1981 an AFLC working group issued a report that recommended several actions for improving the Air Force's ability to compensate for increasing production leadtimes. One recommendation involved establishing a generic coding system which would identify those items requiring critical materials, components, or manufacturing processes. This coding would be applied to the national stock

numbers for these items and would be used, in conjunction with the Joint Aeronautical Material Activity's information, to identify specific items likely to be affected by increasing leadtime problems.

Conceptually, this proposal would provide item managers with advance warning regarding increasing leadtimes affecting the production of specific aircraft spares and repair parts. Based on this information, advance procurements and other compensating actions could be taken before adverse impact was incurred. However, Air Force officials believe that the time and effort required to establish such a system would be prohibitive and the concept has not been implemented.

We believe that the generic coding proposal has merit and warrants limited testing to determine its practicality and utility.

THE ABILITY TO INCREASE PRODUCTION OF SOME ITEMS IS QUESTIONABLE

Two major indicators of the ability to increase production for aircraft spares and repair parts are the number of producers and past delivery performances under contracts to the Air Force and Navy. Our review disclosed that limited sources are available for some items and the number of contractor delinquencies have increased.

Limited sources available for some items

In general, the services procure many of their items from sole-source contractors primarily because of the

- time, trouble, and expense required to identify, develop, and/or qualify additional sources;
- small quantities being procured;
- inability of other sources to economically compete with the past or present producer; and
- tendency to deal with prime contractors rather than individual subcontractors in procuring follow-on item support.

Sole-source procurements can lead to capacity problems which severely limit the services' ability to procure additional quantities of items if needed. The following two examples illustrate this point.

Example 1

In September 1980, the Air Force's T-39 aircraft "eyebrow" window became a critical item when the sole-source contractor was unable to meet unexpected increases in demand. The annual demand rate for this item increased from 12 in November 1979, to 26 in May 1980, to 43 in September 1981. The increased demand was attributable to damage resulting from the use of improper maintenance procedures. The contractor indicated that he was working at his maximum production capacity of one item a week and could not expedite deliveries to meet increased demand.

The Sacramento Air Logistics Center has taken several steps to minimize the impact of shortages of this item on operational readiness. For example, the center tried to develop a second source for the item. However, the contractor refused to give the center permission, which was needed, to use his technical data, stating that the data had been developed at private expense for use on both military and commercial aircraft. In addition, the center emphasized adherence to proper maintenance procedures and placed an advanced purchase order for the item.

The "get well" date for this item is now August 1983. However, this date assumes that the contractor can increase production from 1 item a week to 14 items a week, which as indicated above, the contractor says cannot be done.

Example 2

The "leading edge" is a critical pacing item for a portion of the T-38A aircraft wing. The leading edge became a critical item in March 1981 after increases in production leadtime delayed the contract delivery schedule.

We found that the contractor could not accelerate delivery because (1) the autoclave used in the bonding process for this item was scheduled at capacity and other orders were awaiting processing and (2) priority was given to production on F-18 contracts. Thus, F-18 items went to the bond shop before T-38A orders even though the spares were in a critical item status.

Increase in contractor delinquencies

We found that production contract delinquencies for Air Force aircraft spares and repair parts have increased. For example, the number of contracts delinquent over 90 days was 487 in September 1978 in comparison to 4,464 in September 1981. Although we did not determine the correlation of the delinquencies to nonmission capable hours or to essentiality of the parts, we noted that the recorded nonmission capable hours

increased over this same period of time. In addition, Air Force officials said that contractor delinquencies have adversely affected the Air Force's operational readiness during the past few years.

Delinquent contractors may also be a significant problem for the Navy. However, the Navy does not have a working system to track or analyze delinquent contracts and the data required to do so has not been obtained or updated. Also, it was not feasible for us to attempt to construct this information during our audit. Navy officials told us they rely on the Defense Contract Administration Service and day-to-day contact with industry to keep informed regarding the status of their contracts.

Air Force Contractor Responsibility Review Program

The Air Force's Contractor Responsibility Review Program requires each air logistics center to maintain data on the ability of contractors to successfully perform on Government contracts. This information is to be used in the placement of new procurements.

The program also requires that the air logistics centers identify problem contractors and urge them to take corrective action. This is usually done either by letter or through meetings between logistics center officials and contractor management.

Although continued unsatisfactory performance can result in contractor suspension or debarment, Air Force officials stated that such formal actions are seldom taken unless there is a clear case of fraud or the contractor is going bankrupt because:

- The Government shares responsibility for many of the delinquent deliveries when it expedites the delivery of some parts at the expense of other parts.
- Many delinquent deliveries are provided by a sole-source contractor. In this case, the Government can either continue with the delinquent contractor or not obtain the needed part.
- Even if a delinquent contractor is not the sole source for the item, starting the procurement process over and going to another contractor would probably take longer than waiting for the delinquent contractor to deliver.
- The administrative burden of proving and processing formal actions is excessive, and, in the end, the action can be overturned by an appeal.

--There is insufficient staff to process the number of formal actions that would be needed.

Air Force representatives stated that, to initiate effective compensating actions, item managers need to know in advance, that there is going to be a contractor delinquency. They also said that they recently initiated actions to identify potential contractor delinquencies. For example, they are working with the Defense Contract Administration Service to improve contractor surveillance on production contracts for high-priority items.

Navy system of contractor surveillance

The Aviation Supply Office's automated data system includes the compilation of a contract status file, the purpose of which is to reflect the status of open and completed procurements. This file and its complementary due-in, due-out file are to identify such procurement information as

- contract number,
- quantities,
- unit price,
- destination, and
- expected or actual delivery dates.

However, Navy representatives told us that the automated maintenance of these files has not taken place because of problems in obtaining and processing required data. Therefore, the information in these files is inaccurate and cannot be used to determine the current status of active contracts, the percentage of delinquencies, or the length of time that contracts are delinquent.

Although no attempt is made to track or analyze contractor delinquencies, Aviation Supply Office representatives in the procurement division said that they are in constant touch with industry and they believe they are aware of current trends and problems. Also, they said they recognize that there is a serious deficiency in the contract data base and a project is currently underway to study the cause of the problem and to determine how the files can be improved.

OBSERVATIONS ON AIR FORCE PRODUCTION CAPABILITY STUDY

On August 1, 1980, AFLC and the Air Force Systems Command issued a combined study entitled "Production Capability, A

Look Into the Industrial Capacity FY 82 Through FY 86." The purpose of this study was to determine industry's capability to produce the increased numbers of aircraft replenishment spares in the Air Force's fiscal year 1982 program.

This evaluation encompassed 80 percent of the total dollar quantity and 30 percent of the total replenishment line items to be procured. Information was obtained from 58 manufacturers and 15 vendors. Raw material availability and leadtime projections by some of the larger forging industries were also investigated.

The Air Force study concluded that industrial capacity would not be a limiting factor on the production of Air Force replenishment spares in the fiscal year 1982-86 time frame. The study and its findings were verified and agreed to by the Air Force Audit Agency.

While we did not make a detailed analysis of this study or its assumptions, we did note a couple of major limitations on its overall scope. First, the study did not take the total Defense-wide increases in demand for like-production capacity into account when the determination for production capability was attempted. Only projected increases in fiscal year 1982 requirements and funding levels for the Air Force's replenishment spares and repair parts account were considered. Second, the study did not consider that the introduction of new aircraft types into the procurement cycle would increase the demand on existing production capability, key components, and the availability of strategic and critical materials needed in aircraft manufacture.

In our opinion, these areas should have been expanded. In reference to the first limitation, the study should have considered that many of the contractors producing replenishment spares for the Air Force also produce initial and replenishment spares and repair parts, as well as finished aircraft, for all three services. Also, it should have considered that concurrent increases projected for these additional item categories would place an additional demand on existing production capabilities. Regarding the second limitation, the introduction of the B-1 bomber into the procurement cycle should have been considered because it will increase demand for production capability, components, and scarce materials, such as titanium, which are also required in the production of other aircraft and spare parts currently being manufactured.

Also, the study assumed a \$2.4 billion replenishment spares procurement level for the Air Force in fiscal year 1982. However, about \$3.4 billion was subsequently approved.

CONCLUSIONS

Items can achieve problem status as a result of a combination of interrelated causes, only some of which are production related. While the services have a number of systems in place to identify and deal with problem items in general, they do not have systems in place which can predict the problems. Consequently, their actions tend to be more reactive than preventive.

There is no mechanism to tie overall industry supply trends to potential effects on the production of specific aircraft items. However, a system was recommended by an AFLC working group which could potentially predict production leadtime problems for military items.

Because increases in production leadtimes are only symptoms of production problems, more emphasis is required to determine the specific reasons why production leadtimes are increasing and to solve the underlying causes.

RECOMMENDATIONS

We recommend that the Secretary of Defense require the Secretary of the Air Force to make limited tests of the feasibility of generically coding aircraft items, based on the material trends identified in the Joint Aeronautical Material Activity reports, to identify the causes of lengthening leadtimes.

Based on the test results, if it is determined that shortages of certain critical materials, components, or manufacturing processes are the causes of lengthening leadtimes, then the Secretary of Defense should pursue alternatives for resolving these problems.

LISTING OF COMMANDS, INSTALLATIONS, AND ORGANIZATIONS
VISITED OR OTHERWISE INCLUDED IN THIS REVIEW

Office of the Undersecretary of Defense
for Research and Engineering,
Pentagon, Washington, D.C.

Defense Contract Administration Service,
Cameron Station,
Alexandria, Virginia

Air Force Office of Comptroller,
Pentagon, Washington, D.C.

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

Air Force Office of the Deputy Chief of Staff
for Logistics and Engineering,
Pentagon, Washington, D.C.

Air Force Systems Command,
Andrews Air Force Base,
Camp Springs, Maryland

Ogden Air Logistics Center,
Hill Air Force Base,
Ogden, Utah

Sacramento Air Logistics Center,
McClellan Air Force Base,
Sacramento, California

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

Warner Robins Air Logistics Center,
Warner Robins Air Force Base,
Macon, Georgia

Naval Air Systems Command,
Washington Navy Yard, Washington, D.C.

Naval Aviation Supply Office,
Philadelphia, Pennsylvania

Chief of Naval Operations,
Pentagon, Washington, D.C.

Naval Office of the Comptroller,
Pentagon, Washington, D.C.

Naval Material Command Headquarters,
Crystal City, Virginia

LISTING OF SELECTED PAST REPORTS ON RELATED ISSUESGAO REPORTS

System for Buying Spare Parts for Initial Support of New Military Aircraft Needs Substantial Improvements (B-133396, Jan. 31, 1972).

Need To Improve Accuracy of Air Force Requirements System for Reparable Parts (B-146874, Sept. 13, 1972).

Reduced Requirements for Modular Electronic Equipment for Aircraft (B-133396, July 3, 1973).

An Analysis of Air Force Rates of Aircraft Not Operationally Ready Due to Supply (B-179264, Mar. 29, 1974).

Information on the Requirement for Strategic Airlift (PSAD-76-148, June 8, 1976).

Air Force Could Reduce War Reserve Requirements of Combat-Ready Units for Spares and Repair Parts (LCD-75-444, Aug. 27, 1976).

Determining Requirements for Aircraft Maintenance Personnel Could be Improved--Peacetime and Wartime (LCD-77-421, May 20, 1977).

The Air Force Can Reduce Inventories by Eliminating Unneeded Stock Levels (LCD-76-425, June 17, 1977).

Alternatives Available for Reducing Requirements for Spare Aircraft Engines (LCD-77-418, Oct. 12, 1977).

Need to Strengthen Justification and Approval Process for Military Aircraft Used for Training, Replacement, and Overhaul (LCD-77-423, Oct. 28, 1977).

Air Force Maintenance Depots--The Need for More Responsiveness to Mobilization as well as Peacetime Efficiency (LCD-78-403, Nov. 23, 1977).

Operational and Support Costs of the Navy's F/A-18 Can be Substantially Reduced (LCD-80-65, June 6, 1980).

F-16 Integrated Logistics Support: Still Time to Consider Economical Alternatives (LCD-80-89, Aug. 20, 1980).

DOD's Industrial Preparedness Program Needs National Policy to Effectively Meet Emergency Needs (PLRD-81-22, May 27, 1981).

Less Costly Ways to Budget and Provision Spares for New Weapon Systems Should be Used (PLRD-81-60, Sept. 9, 1981).

Potential Impediment of Foundry Capacity Relative to National Defense Needs (EMD-81-134, Sept. 15, 1981).

Need for Better Monitoring and Analysis of Foundry Data by the Department of Commerce (EMD-82-15, Nov. 10, 1981).

The Services Should Improve Their Processes for Determining Requirements for Supplies and Spare Parts (PLRD-82-12, Nov. 30, 1981).

More Credibility Needed in Air Force Requirements Determination Process (PLRD-82-22, Jan. 7, 1982).

Mission Item Essentiality: An Important Management Tool for Making More Informed Logistics Decisions (PLRD-82-25, Jan. 13, 1982).

REPORTS BY OTHERS

Congressional Budget Office report, "Defense Spending Increases and Inflation," Mar. 24, 1980.

Air Force Systems and Logistics Commands report, "Production Capability, a Look into the Industrial Capacity, FY 1982 through FY 1986," Aug. 1, 1980.

Department of Commerce, "Aerospace Industry Response to Accelerated AF Parts Procurement," Aug. 14, 1980.

Air Force Audit Agency, "Review of Selected Productivity Issues," Sept. 16, 1980.

The Analytic Sciences Corporation, "Analysis of Critical Parts and Materials" (TR-3370, Dec. 1980).

The American Defense Preparedness Association white paper, "Defense Readiness-Force Sustainability and Industrial Preparedness, 'Why We Are Concerned'," Aug. 1980.

The Defense Industrial Base Panel report of the House Committee on Armed Services, "The Ailing Defense Industrial Base: Unready for Crisis," Dec. 31, 1980.

Defense Science Board report, "Defense Science Board 1980 Summer Study on Industrial Responsiveness," Jan. 1981.

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