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BY THE COMPTROLLER GENERAL

Report To The Chairman, Subcommittee On Defense, Committee On Appropriations, House Of Representatives

OF THE UNITED STATES

Aircraft Thrust/Power Management Can Save Defense Fuel, Reduce Engine Maintenance Costs, And Improve Readiness

The Department of Defense could achieve additional savings in aircraft fuel and reduce engine maintenance costs by making greater use of reduced power takeoffs and climbs by fighter aircraft, where feasible. Commercial airlines and larger military aircraft have used reduced power for several years, with positive results.

Some bases have adopted fuel-efficient procedures, which result in significant differences in fuel consumption in the same type of aircraft. Effective local initiatives should be better identified, reviewed, and implemented servicewide whenever feasible.

UNITED STATES GENERAL ACCOUNTING OFFICE

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JULY 29, 1982

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

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

Dear Mr. Chairman:

This report discusses the Department of Defense's effort to save aircraft fuel and reduce engine maintenance costs through thrust/power management and other effective procedures.

We made this review at your request to determine whether Defense has put basic thrust/power management guidelines into general practice, as recommended by the Defense Audit Service about 3 years ago.

As arranged with your Office, we are sending copies of this report to the Secretaries of Defense, the Air Force, and the Navy. We will make copies available to other interested parties who request them.

Sincerely yours,

Charles A. Bowsher

Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT TO THE CHAIRMAN, SUBCOMMITTEE ON DEFENSE, HOUSE COMMITTEE ON APPROPRIATIONS

AIRCRAFT THRUST/POWER MANAGEMENT CAN SAVE DEFENSE FUEL, REDUCE ENGINE MAINTENANCE COSTS, AND IMPROVE READINESS

D I G E S T

The Chairman, Subcommittee on Defense, House Committee on Appropriations, asked GAO to evaluate the Department of Defense's effort to save fuel and reduce maintenance costs on aircraft engines through thrust/power management.

The Department of Defense spends billions of dollars annually for aircraft fuel and engine maintenance. By controlling how aircraft engines are operated, through a concept called thrust/power management, Defense can improve fuel efficiency and extend the life of engine parts. Improved fuel efficiency can increase flying hours and thus improve aircrew proficiency and readiness. Extended engine life can reduce the frequency of maintenance and thereby increase aircraft availability and readiness.

A 1979 Defense Audit Service report concluded that substantial savings in fuel and engine maintenance costs could be achieved by developing and implementing a Defense policy promoting increased use of reduced engine power in military aircraft. The report projected annual savings of nearly $200 million if the reduced power concept were fully exploited. (See p. 5.)

Despite the potential for improved aircraft readiness and reduced operating costs, Defense does not have an aircraft thrust/power management program. Such a program is needed to establish policy and guidance and to exercise management oversight to ensure that the services are doing as much as possible to conserve aircraft fuel and reduce maintenance costs. (See p. 8.)

The services also lack effective thrust/power management programs. Thrust/power management has been delegated to the local aircraft wings,

GAO/PLRD-82-74
JULY 29, 1982

squadrons, or bases. The service headquarters and major command organizations generally do not get involved with providing guidance, monitoring subordinate units' efforts, or conducting comparative analyses to identify trends, potential problems, and better approaches to improve aircraft fuel efficiency and reduce operating costs. (See p. 9.)

For the past few years, fuel consumption rates per flying hour for most aircraft types either have shown little improvement or have worsened. Also, these rates vary considerably, among and between the services, for the same type of aircraft. For example, in fiscal year 1981, Air Force F-4Ds in the Pacific consumed 1,762 gallons per hour, while in Europe, these aircraft consumed 1,643 gallons per hour. Air Force Reserve and Air National Guard F-4Ds consumed 1,620 gallons per hour. Navy A-7s consumed 613 gallons per hour, while Air Force A-7s consumed 727 gallons per hour. No studies have been undertaken by Defense or the services to identify these variances, to determine the reasons for them, and to develop corrective actions, if warranted. (See p. 9.)

As was the case when the Defense Audit Service performed its analysis in 1978, thrust/power management efforts continue to focus on larger bomber, tanker, and transport aircraft while tactical fighters generally are ignored. Most tactical fighter takeoffs are made at full power and with afterburners. (See p. 17.)

GAO estimates that Air Force, Navy, and Marine Corps F-4 aircraft consumed 21 million more gallons of fuel in fiscal year 1981 just by using afterburners for 30 seconds on most takeoffs in lieu of full throttle without afterburners. While some takeoffs require afterburners for safety and training, based on discussions with the manufacturer and pilots, and on evaluations of flight manual data, GAO found that afterburners do not necessarily have to be used the vast majority of time as is now the case. (See p. 20.)

The Defense Audit Service concluded that only under the most extreme conditions, such as heat, high elevation, heavy loads, or short runways, would some form of reduced power operations not be warranted. The services have not conducted flight tests to determine to what extent thrust/ power management procedures can be implemented for each type of aircraft, as recommended by the Defense Audit Service. (See p. 22.)

The following situations also indicate Defense is missing opportunities to further reduce its aircraft fuel and maintenance costs.

--Fuel-efficient operating procedures followed at some locations are not followed at others. For example, F-4 pilots at the Marine Corps Air Station, Beaufort, South Carolina, alternately run each engine to full power while taxiing before takeoff to check aircraft instruments. Air Force and Navy pilots at the locations GAO visited stopped this practice and now perform this check before or immediately after brake release for takeoff. Air Force and manufacturer officials estimated that the latter procedure saves 50 gallons of fuel per aircraft per sortie. GAO projected that the F-4 aircraft at Beaufort consumed nearly 700,000 extra gallons of fuel in fiscal year 1981. (See p. 23.)

--Other changes designed to save fuel are still being reviewed, but full implementation has not yet occurred. For example, a study estimated the Navy could save 8.5 million gallons of fuel per year in its A-7 fleet by removing wing and fuselage pylons when not needed on missions. Some squadrons have been removing these pylons for several years. The Navy plans to study the operational implications of pylon removal, and may not fully implement changes until fiscal year 1984. (See p. 30.)

GAO believes that, to overcome the problems identified, Defense officials must (1) establish policies and guidelines mandating an active aggressive thrust/power management program and (2) maintain effective oversight of the program to ensure as much as possible is being done to conserve aircraft fuel and reduce maintenance costs. This would provide a mandate or framework around which the services must establish effective programs of their own.

RECOMMENDATIONS

GAO recommends that the Secretary of Defense issue policy and guidelines identifying the importance of thrust/power management and the positive effects on fuel use and improved engine life which have been achieved by bomber, tanker, and transport aircraft. The Secretary should:

--Direct the services to give greater attention to the possible benefits of thrust/power management as a means of saving tactical aircraft fuel and reducing engine maintenance costs.

--Require that the services conduct engineering analyses and flight tests, where necessary, to determine which fighter aircraft can use reduced power safely and economically.

--Require that the services report how they plan to analyze and evaluate the use of reduced power by tactical fighter aircraft.

--Require that all appropriate aircraft, including tactical fighters, use reduced power when cost effective and consistent with safety and mission considerations.

The Secretary should maintain oversight of the services' programs to implement aircraft thrust/power management, where feasible, ensure effective coordination of information, and implement efficient operating and maintenance procedures where possible.

In addition, other recommendations are included on pages 15 and 32.

AGENCY COMMENTS

Defense agrees in principle with the recommendations in the report. Defense recognized that the use of reduced engine power in military aircraft can save fuel and reduce engine maintenance costs. Defense stated this concept has been a part of the services' aircraft fuel conservation programs for several years, especially in transport and bomber operations. Defense was primarily concerned with what it perceived as GAO's opinion that reduced power is always beneficial, particularly with regard to tactical aircraft operations. Defense maintained that, in some cases, reduced power on takeoff can increase fuel consumption while reducing operational and safety margins to unacceptable levels. Defense was concerned with the generalization that thrust/power management is beneficial in every case when, in fact, engineering analyses may prove otherwise.

GAO recognizes that many variables affect the conditions under which reduced power usage is warranted on the basis of safety and efficiency. GAO points out, however, that even in those cases where operating at reduced power on take-off can increase fuel consumption, the savings from extended engine life could outweigh the added fuel cost. GAO believes the services should identify, through analyses and flight tests, those conditions which do warrant reduced power operations for each type of fighter aircraft, and implement revised procedures where feasible and cost effective.

Defense also stated that there is sufficient oversight, monitoring, and reporting of aircraft fuel conservation actions by the services and that no additional action was required. GAO believes, based on examples in this report, that there is still room for improvement in how the services monitor, coordinate, and implement efficient procedures. Defense should also maintain better oversight of the services' programs to ensure coordination and implementation of efficient operating and maintenance procedures.

C o n t e n t s

ABBREVIATIONS

AFB	Air Force Base
AGETS	Automated Ground Engine Test Set
AIRLANT	Naval Air Force Atlantic Fleet
AIRPAC	Naval Air Force Pacific Fleet
ASD	Aeronautical Systems Division
ATC	Air Training Command
DAS	Defense Audit Service
GAO	General Accounting Office
PATTS	Programmable Automated Trim Test System
SAC	Strategic Air Command
TAC	Tactical Air Command

CHAPTER 1

INTRODUCTION

The Department of Defense spends billions of dollars annually on aircraft fuel and engine maintenance. Thrust/power management offers Defense the potential to save fuel and reduce engine maintenance by improving fuel efficiency and extending engine parts life. Improved fuel efficiency can increase flying hours and thus improve aircrew proficiency and readiness. Extended engine life can reduce frequency of maintenance and thereby increase aircraft availability and readiness.

WHAT IS THRUST/POWER MANAGEMENT?

Aircraft engine thrust/power management involves operating an engine in such a manner as to achieve minimum fuel consumption and reduce maintenance. It also includes maintenance actions which can affect aircraft or engine efficiency. Day-to-day management includes but is not limited to

--reducing power on takeoff and climb,

--limiting use of afterburner takeoffs to operational necessity,

--accurately adjusting (trimming) engines to specifications,

--removing unnecessary equipment, and

--obtaining automated flight management systems.

WHY IS AN EFFECTIVE THRUST/POWER MANAGEMENT PROGRAM IMPORTANT?

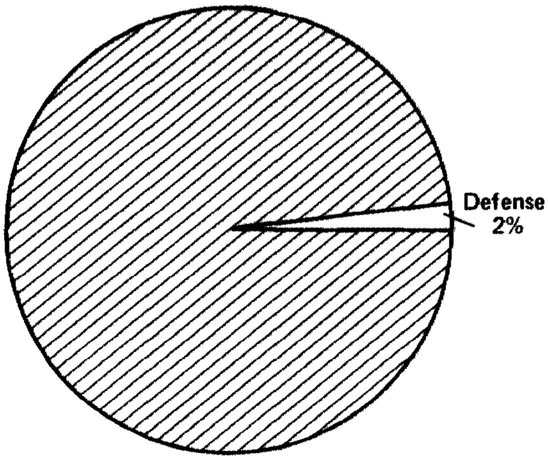
An effective thrust/power management program is vital to the Defense mission from a readiness, energy, and maintenance standpoint. The implications on readiness are quickly apparent when considering that flying hours were reduced in face of rapidly rising fuel costs. When considering the billions of dollars spent on aircraft fuel and maintenance, thrust/power management offers great potential for reducing these costs.

In fiscal year 1981, Defense used approximately 179 million barrels of petroleum, the equivalent of over 7.5 billion gallons. Defense accounted for approximately 2 percent of the total U.S. petroleum demand and used about 80 percent of the total petroleum used by the Federal Government. As shown on the following page, aircraft operations use over 66 percent of the petroleum in Defense. The value of aviation fuel consumed is estimated in excess of $5.7 billion.

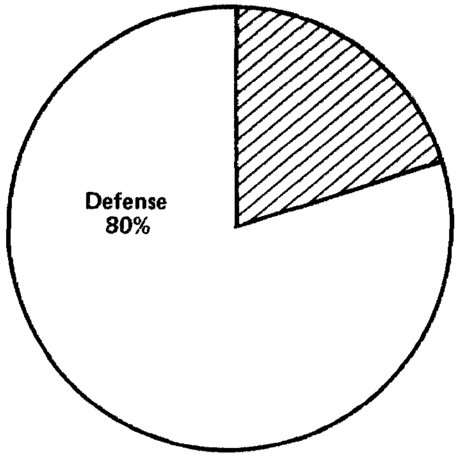
DEFENSE PETROLEUM CONSUMPTION

FISCAL YEAR 1981

U.S. Total Petroleum Consumption

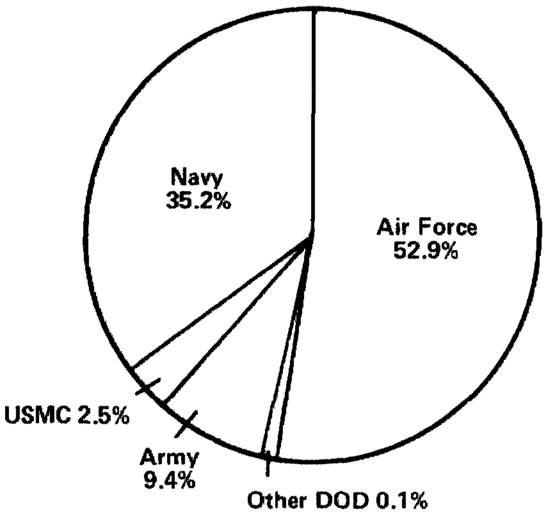


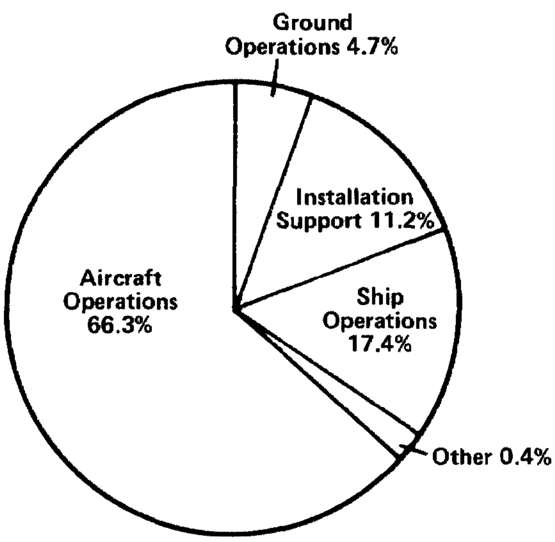
Federal Government Petroleum Consumption



Breakdowns of FY 1981 Defense Petroleum Consumption

179 Million Barrels (7.5 Billion Gallons)





The United States' dependence on foreign oil and the highly unstable international situation make fuel resources a critical and potentially finite resource. Since energy is central and vital to the operational readiness of U.S. Forces, effective energy management is essential to successful accomplishment of the defense mission.

Improving the durability and serviceable life of aircraft engines is also extremely important to Defense. Frequent and repeated engine deterioration and failure not only adversely affect readiness, but also increase costs associated with overhaul and repair. The Air Force alone spends approximately $2 billion annually for spare parts and personnel to support a fleet of 44,000 engines. The potential cost avoidance in parts purchases and reductions in maintenance labor through thrust/power management is large.

OBJECTIVE, SCOPE, AND METHODOLOGY

Our objective was to evaluate the Department of Defense's effort to save aircraft fuel and reduce engine maintenance costs through thrust/power management. This subject was reported on and addressed by the Defense Audit Service (DAS) in 1979. 1/ The Chairman, Subcommittee on Defense, House Committee on Appropriations, asked us to follow up on that report to determine whether Defense has put basic guidelines into general practice as recommended by DAS.

Because the Army has only recently begun to investigate ways to improve aircraft efficiency, we conducted our audit primarily at Air Force, Navy, and Marine Corps locations. Appendix I lists the activities contacted during this assignment. We selected these activities to provide a broad perspective of thrust/power management from field units through the chain of command to Defense headquarters.

Our work focused on what Defense has and has not done in the past 3 years to implement thrust/power management programs and concepts, and how it fulfills this management responsibility. Although thrust/power management applies to all types of aircraft, the services have directed their actions toward bomber, tanker, and transport aircraft.

1/Defense Audit Service report 79-086, "Report on The Audit of Reduced Power Usage on Department of Defense Aircraft," May 10, 1979.

While addressing the major initiatives for these aircraft, we placed additional emphasis on tactical aircraft. Our evaluation of Defense program management covered all Air Force and Navy aircraft types.

We interviewed Defense officials involved with aircraft operations, maintenance, and energy. We also reviewed documents on thrust/power management organization and philosophy, studies, and initiatives.

We performed our review in accordance with GAO's current "Standards for Audit of Governmental Organizations, Programs, Activities, and Functions."

CHAPTER 2

DEFENSE SHOULD ESTABLISH AN AIRCRAFT THRUST/POWER MANAGEMENT PROGRAM

Defense does not have a thrust/power management program to reduce aircraft fuel consumption and engine maintenance costs. The situation today remains nearly the same as reported by DAS in 1979. Defense has not assigned responsibility for thrust/power management to any of its organizations. Further, it has not issued policies or guidance addressing the use of reduced power and other aircraft thrust/power management concepts to the services. Only broad energy conservation guidelines have been issued to the services.

Defense's position is that the services are aggressively pursuing thrust/power management, and therefore, there is no need for formalized policies and guidance. We found, however, that the services do not have an effective thrust/power management program. Such management is generally weak or nonexistent, and what thrust/power management does exist is primarily at the base, wing, or squadron level. As a result, effective practices and procedures followed by one service, command, unit, or base are not always being implemented or considered by other activities. Moreover, servicewide variances in aircraft fuel consumption per flying hour are not being investigated to see whether opportunities exist for saving fuel and reducing maintenance costs.

SPECIFIC DEFENSE POLICIES, GOALS, AND OVERSIGHT ARE LACKING FOR AIRCRAFT THRUST/POWER MANAGEMENT

The 1979 DAS report concluded that the services could substantially reduce fuel use and engine maintenance costs by developing and implementing a Defense policy promoting increased use of reduced engine power in military aircraft. Using fiscal year 1977 cost data, DAS projected annual savings of nearly $200 million if the reduced power concept were fully exploited. We estimate this figure to now be $400 million based on modest escalation and current fuel costs. DAS reported that although the services had taken some initiatives to use reduced power by bomber, tanker, and transport aircraft, they were reluctant to use reduced power in tactical and training environments. Although this reluctance was based on perceptions of degraded performance capability and safety, DAS concluded that only under the most extreme conditions, such as heat, high elevation, heavy loads, or short runways, would some form of reduced power operations not be warranted. DAS stated that:

"We believe enough compelling information is available to DOD [Department of Defense] to warrant the adoption of a policy on reduced engine power. In our opinion, the policy should be applicable to all categories of aircraft, including tactical aircraft. As a matter of policy, specific aircraft would be exempted from the reduced power management policy only after engineering analyses and flight test studies warrant. We do not foresee that all types of tactical aircraft will be excluded from the policy; therefore, selective, if not across-the-board, indoctrination and training of pilots in the reduced power concept will be required."

DAS recommended that the Office of the Assistant Secretary of Defense for Manpower, Reserve Affairs and Logistics establish a policy promoting the increased use of reduced engine power during takeoff and climb. This policy should:

--Encourage the voluntary use of operational (pilot-applied) procedures to achieve reduced engine power.

--Instruct the services to investigate reducing engine power through maintenance procedures if an operational procedure is not feasible and when flight safety, pilot proficiency, and mission performance requirements will not be jeopardized.

--Require each service to assign a single office or staff element the primary responsibility for working with the operating commands in assessing the applicability of reduced power techniques, methods of implementation, and tradeoffs between reduced power benefits and mission requirements.

--Require the services to establish baseline data necessary to measure and document the benefits of reduced power application for all aircraft in, and entering, the active inventory.

Defense replied that it did not believe such formal policies and procedures were necessary because "* * * the concept of power management is being pursued aggressively within the DOD."

We found the situation nearly the same as DAS did 3 years ago. For example, larger, multiengine, strategic aircraft continue to use reduced power for takeoffs and climbs. Full implementation of voluntarily reduced thrust operations for fighter aircraft has not occurred, although the Air Force did mechanically reduce the power of some engines to reduce high engine failure rates. The Air Force has not studied voluntarily reduced power operations for its tactical aircraft. The Navy looked only at fuel consumption for F-4 reduced power operations, but it did not consider extended engine life benefits. Even the mention of reduced power, whether voluntary or involuntary, in the tactical aircraft community raises extensive opposition and dismissal. We believe the lack of Defense policy, guidance, and emphasis has contributed to the services' limited action to evaluate the use of reduced power by their tactical aircraft.

Defense Energy Program Policy Memoranda establish broad energy management goals and objectives of limiting fuel consumption and improving the aggregate efficiency of operational equipment, which includes vehicles, ships, and aircraft. The efficiency of existing equipment need not necessarily be improved if newly developed and replacement systems are efficient enough to meet the overall goals. The memoranda do not identify goals and objectives specifically for aircraft, nor do they establish a basis for measuring progress, such as reduced consumption per flying hour.

The Air Force has not established an aircraft energy efficiency goal, but it has continued to stress holding energy consumption to the fiscal year 1975 level. Its fiscal year 1981 energy goal was to be controlled by the flying hour program. The Air Force is now identifying some energy efficiency goals and giving its major commands various options on how to evaluate improved efficiency. These options include gallons per flying hour, training accomplishments per flying hour or fuel consumed, and mission accomplishment per fuel consumed. As a result, each command could measure efficiency differently, which would pose problems in measuring results when the same aircraft is used by different commands.

The Navy has established a specific goal of improving aircraft fuel efficiency by 5 percent per flight hour over the 1975 level by fiscal year 1985. Not only has the Navy identified a specific parameter to measure efficiency, but it has also set its target date 5 years before the fiscal year 1990 target established by Defense. We noted some problems, however. Navy headquarters has not issued guidelines on how fuel efficiency can be improved. The Atlantic fleet air force has established guidelines identifying how to improve fuel efficiency, but the Pacific fleet has not. Also, as the following table shows, the fiscal year 1975 baseline consumption rates against which progress will be measured vary by fleet for the same type of aircraft.

Aircraft	Atlantic	Pacific
	(gallons per hour)	
A-3	1,226	1,252
A-6	1,004	1,029
A-7	575	609
E-2	403	416
F-4	1,478	1,491
F-14	1,201	1,281
P-3	739	727
S-3	399	416

A Navy official stated that the baseline rates may not be realistic since no information was kept on how the aircraft were used and the types of operations and training conducted. Further, accomplishment of the goals will be measured at the activity level rather than at the overall Navy level.

NO EFFECTIVE THRUST/POWER MANAGEMENT EXISTS IN DEFENSE

No Defense organization is specifically dedicated to aircraft thrust/power management. Thrust/power management is a broad concept encompassing aircraft engine operations, maintenance, and fuel consumption. Defense and service involvement with thrust/power management is, at best, fragmented along these lines, with no activity exercising overall management responsibility. The thrust/power management responsibility that exists rests primarily with individual bases, wings, or squadrons, while major commands are involved in varying degrees, and headquarters activities to a lesser extent.

Defense has not directed the services to establish, maintain, and coordinate comprehensive thrust/power management programs (which integrate aircraft operations, maintenance, and energy) to save fuel and reduce maintenance costs. Defense said that the services are aggressively pursuing thrust/power management, but officials told us that they do not routinely coordinate, compare, or monitor what the services are doing concerning this management. Thus, if Defense wants to know what the services are doing, it must task the services for responses. Not surprisingly, the services have reported that they are pursuing aggressive programs.

Fuel consumption rates per flight hour vary considerably between the Air Force and Navy for similar types of aircraft and, as shown below, generally have worsened since 1978 (the year DAS completed its evaluation).

Aircraft	Fiscal year 1978 Navy	Fiscal year 1978 Air Force	Fiscal year 1981 Navy	Fiscal year 1981 Air Force
	--------(gallons per hour)------------			
A-7	599	685	613	727
C-9	838	1,005	911	1,009
C-130	730	759	741	799
F-4	1,414	1,569	1,421	1,692
RF-4	1,327	1,325	1,304	1,391
UH-1N	78	90	84	90
CT/T-39	332	315	348	308
OV-10	92	90	91	97

Neither Defense nor the services have formally evaluated these trends, determined the reasons for the variances, and developed corrective actions, if warranted.

The services are concerned about rising fuel costs and reduced readiness. However, thrust/power management is viewed by most Defense personnel as relevant only to the larger, multi-engine bombers, tankers and transports as is evidenced by the direction of thrust/power management-related initiatives being pursued. Many of these initiatives, such as reduced power take-offs and flight management systems, were developed by commercial airlines and have been in use for several years. Tactical fighter aircraft are quickly discounted because of differences in missions and the aircraft themselves. Yet all aircraft must take off and climb, carry enough fuel to perform their mission, and land safely. In addition, fighter aircraft engines are more susceptible to heat, stress, and failure due to their high performance characteristics. Yet there is not an aggressive program to evaluate what more can be done to reduce fighter fuel and engine maintenance costs.

Air Force

Air Force headquarters does not actively monitor its commands to identify aircraft fuel consumption differences, trends, or potential problems and improvements. We identified fuel consumption trends which should be analyzed by the Air Force but were not. For example, fuel consumption rates for most aircraft types have gotten worse or remained nearly the same since fiscal year 1978, yet we could not identify any Air Force activity that formally evaluated this trend and documented the causes of this apparent regression or lack of improvement. The following table illustrates the trend for major types of aircraft:

Comparison of Air Force Fuel Consumption Rates (Fiscal Years 1978 and 1981)

Aircraft	FY 1978	FY 1981	Difference	Percent
	--------(gallons per hour)--------			
A-7D	685	727	+42	6.1
A-10	515	580	+65	12.6
B-52D	3,875	4,100	+225	5.8
B-52G	3,955	4,071	+116	2.9
B-52H	3,300	3,376	+76	2.3
FB-111	1,410	1,370	-40	2.8
C-5A	3,330	3,387	+57	1.7
C-130A	770	791	+21	2.7
C-130B	770	791	+21	2.7
C-130D	770	791	+21	2.7
C-130E	770	791	+21	2.7
C-130H	770	832	+62	8.1
C-141A	2,000	2,001	+1	0.1
F-4C	1,570	1,742	+172	11.0
RF-4C	1,325	1,391	+66	5.0
F-4D	1,450	1,620	+170	11.7
F-4E	1,555	1,700	+145	9.3
F-4F	1,715	1,700	-15	0.9
F-4G	1,555	1,700	+145	9.3
F-15A	1,440	1,476	+36	2.5
F-111A	1,470	1,570	+100	6.8
F-111D	1,470	1,570	+100	6.8
F-111E	1,470	1,570	+100	6.8
F-111F	1,470	1,570	+100	6.8
KC-135A	2,415	2,177	-238	9.9
T-38A	400	395	-5	1.3
T-39	315	308	-7	2.2
T-43A	865	886	+21	2.4

We projected that the Air Force used about 40.5 million more gallons of fuel in fiscal year 1981 than it would have had the 1978 consumption rate been sustained.

Similarly, consumption rates for the same model aircraft indicated wide variance from one major command to another. Again, we could not identify any activity that had formally evaluated the situation and documented the causes of the variances so that corrective actions could be taken where necessary. Examples of these variances follow:

Comparison of Major Command Fuel Consumption Rates in FY 1981

Aircraft	Tactical Air Command	U.S. Air Force, Europe	Pacific Air Force	Strategic Air Command	Military Airlift Command	Air Force Reserve	Air National Guard
	-----------------(gallons per hour)-----------------						
A-7D	765	-	-	-	-	-	718
A-10	577	566	-	-	-	580	572
C-130H	-	-	-	-	851	-	743
F-4C	1,742	-	-	-	-	1,658	1,520
RF-4C	1,392	1,370	1,520	-	-	-	1,374
F-4D	1,693	1,643	1,762	-	-	1,620	1,620
F-4E/G	1,680	1,664	1,926	-	-	-	-
F-15	1,486	1,466	1,476	-	-	-	-
KC-135A	-	-	-	2,193	-	1,884	2,027

The Air Force is considering awarding a contract to evaluate aircraft ground operations and to identify actions that can be taken to decrease fuel consumption. It claims the project cannot be accomplished in house because of the lack of expertise and personnel.

Although Air Force headquarters gathered a list of major command energy conservation initiatives, in an effort to provide a greater coordination of information among its commands, it has not been effective in coordinating this information. In February 1981, the Air Force Inspector General reported that

--there was no standard major command, numbered Air Force, or wing office with primary responsibility for energy conservation programs;

--receipt of energy conservation program information, policies, and procedures at the proper field level action office could not be assured; and

--information coordination was hindered.

None of the Air Force major commands we visited have an organization with overall responsibility for thrust/power management. Air Force Regulation 60-16 delegated the responsibility for establishing an energy awareness and conservation program to the major commands. The commands, in turn, delegated this responsibility to unit commanders, and therefore, the commands do not have a comprehensive, effective program of their own. Officials at the Tactical Air Command (TAC) told us that whatever efforts were being taken in this area were piecemeal and fragmented in the absence of Defense and Air Force headquarters direction.

Although data is available to track fuel consumption by individual aircraft as the commercial airlines do, this information remains at the local level and is not used by the major commands. The Air Force Audit Agency, commenting on a late 1980 survey of fuel saving devices, stated that:

> "* * * all of the airlines we visited stressed the importance of crew/personnel training in all phases of fuel conservation and the monitoring of fuel conservation measures and fuel usage by specific aircraft * * * . However, we found no well defined training program or plans to monitor fuel usage by flight or sortie. We believe the Air Force should investigate the military applicability of all these measures particularly the training and monitoring aspects."

We believe the commands should review this information to identify trends and compare data between and within operating units.

Major command inspection and evaluation teams appear to be the main activities which review operations and maintenance energy conservation practices at the base level. Their emphasis on energy conservation varies, however, from a special interest area, where evaluation teams use specific energy-efficiency checklists, to a broad overview, where evaluation teams addressed only a few general questions. These teams inspect only on an intermittent basis, usually once every 1 to 2 years.

Navy

The Navy does not have a comprehensive aircraft thrust/power management program to establish policies and guidance and perform oversight functions to insure as much as possible is being done to save fuel and reduce engine maintenance costs.

Implementation of Navy thrust/power management is essentially the responsibility of local squadron commanders. Higher level organizations do little to monitor and analyze trends, identify potential problems, and insure the widest application of efficient practices. Commanders can determine the manner in which aircraft are operated as long as the squadrons do not violate standard flight procedures. Squadron practices directly affect fuel consumption. For instance, routinely using afterburners, carrying external fuel tanks, or using full fuel loads versus mission-tailored fuel loads all increase fuel consumption. Squadrons have established their own standard operating procedures, yet higher commands generally do not review their procedures for inconsistencies or wasteful practices.

The Navy reported to the Chairman of the House Appropriations Committee in 1981 that:

> "As a result of conservation efforts, the Department of the Navy's Fiscal Year 1980 aircraft fuel consumption was nearly 6% less than it would have been at Fiscal Year 1975 consumption rates."

We made a similar analysis comparing fiscal year 1978 to 1981 and concluded that the projected fiscal year 1981 consumption rate was over 1 percent higher--10.3 million gallons more--than the fiscal year 1978 consumption rate. The following table compares the fuel consumption rates for various aircraft models.

Comparison of Fuel Consumption Rates For Selected Navy Aircraft In Fiscal Years 1978 and 1981

Aircraft	FY 1978	FY 1981	Difference	Percent
	-------(gallons per hour)--------			
A-4	482	509	+27	5.6
A-6	940	967	+27	2.9
A-7	599	613	+14	2.3
F-4	1,414	1,421	+7	0.5
F-14	1,272	1,249	-23	1.8
P-3	715	701	-14	2.0
S-3	366	385	+19	5.2

We could not identify any Navy activity which formally evaluated these trends or documented the causes of this apparent regression or lack of improvement.

The Naval Air Force Atlantic and Pacific Fleets (AIRLANT and AIRPAC) have been slow to implement the Navy's May 1978 instruction on energy resource management. This instruction requires establishing energy resource management plans to achieve the stated goals. For aircraft, the goal is a 5-percent reduction in fuel consumption per flight hour. AIRLANT did not issue its implementing instructions until February 1981, and its energy management office has been staffed by a succession of short-term officers awaiting reassignment. The individual who now performs the energy officer role as a secondary duty said that the fleet aircraft energy program is not working effectively. AIRPAC had not issued its implementing guidelines as of September 1981. The officer in charge of AIRPAC's energy program was a civil engineer with limited knowledge concerning aircraft.

Monthly reports identifying squadron costs per flight hour, including fuel and maintenance costs, are prepared by the fleet air forces and sent to Navy headquarters. Fleet headquarters activities do not routinely analyze this report for comparisons since operating costs vary depending on whether the unit is deployed at sea or training ashore. Also, while ashore, squadrons are undergoing different phases of training, depending on the time remaining until their next carrier deployment. We believe, however, that fleet headquarters could compare squadron costs for the same phases of training and operations, even if the phases are not occurring simultaneously.

According to officials, the fleet air wings responsible for the P-3 do compare squadron data and attempt to determine why variances occur. They also stated that the P-3 community has strongly emphasized the need to improve fuel conservation and engine life. As shown in the table on page 13, P-3 fuel consumption per flying hour has decreased by 14 gallons (2 percent) between fiscal years 1978 and 1981.

We also identified examples of variances in fiscal year 1981 fuel consumption rates per flight hour for Navy fleet and Reserve aircraft.

Aircraft	Atlantic	Pacific	Reserve
	---------(gallons per hour)-------		
A-4M	522	558	-
A-6E	1,006	875	-
A-7E	652	619	-
F-4S	1,509	1,392	1,417
F-4N	1,582	1,437	1,357
CH-53D	254	212	-

Navy headquarters officials said they sometimes review and compare fleet performance data and attempt to identify reasons for differences, but they could not document examples where this had actually occurred. In the interest of good management, Navy headquarters should analyze these variances to determine the causes and take corrective action if warranted.

The Navy established a research and development activity at the Naval Air Development Center to identify ways to improve the efficiency of existing aircraft. To date, several potentially efficient low-cost concepts, procedures, and modifications have been identified, but the Navy has been slow to implement them.

The Navy is reluctant to direct changes, which have been proven to work, without additional testing. For example, for several years, some A-7 squadrons have removed external wing and fuselage pylons when not needed for a mission. A study estimated that the Navy could save over 8.4 million gallons a year if it removed these unneeded pylons. The Navy plans to further study the operational implications of pylon removal and may not fully implement changes for all units until fiscal year 1984. Also, officials stated that while funding is available to conduct research, implementation of the most costly ideas must compete with other priorities for limited funds.

CONCLUSIONS

The Department of Defense does not have a comprehensive, effective aircraft thrust/power management program to save fuel consumption and reduce engine maintenance costs. Further, it has not issued specific policies or guidelines for the services to follow. Likewise, the services do not have effective thrust/power management programs. As a result, effective practices and procedures followed by one service, command, or base may not necessarily be implemented or considered by other activities, Defense or servicewide variances are not being investigated, and the potential exists for incurring greater fuel and maintenance costs.

RECOMMENDATIONS

We recommend that the Secretary of Defense issue policy and guidelines identifying the importance of thrust/power management and the positive effects on fuel use and improved engine life which have been achieved by bomber, tanker, and transport aircraft. The Secretary should direct the services to give greater attention to the possible benefits of thrust/power management as a means of saving tactical aircraft fuel and reducing engine maintenance costs.

The Secretary should also require the Secretaries of the Air Force and Navy to more effectively:

--Monitor existing fuel consumption data to identify trends, variances, and potential problems. When adverse trends, significant variances, or problems are identified, a formal evaluation should be made to determine why the situation exists and the corrective action needed.

--Establish specific criteria, such as gallons or training accomplishments per flight hour, against which to evaluate progress in improving aircraft fuel efficiency. These criteria should be standardized by aircraft type and command, wherever possible, so that effective and meaningful evaluations can be made.

The Secretary should maintain oversight of the services' programs to implement aircraft thrust/power management, where feasible, ensure effective coordination of information, and implement operating and maintenance procedures where possible.

AGENCY COMMENTS AND OUR EVALUATION

Defense agrees in principle with the recommendations in this report. Defense's primary concern focused on a proposal in our draft report calling for the Secretary of Defense to issue policy and guidelines requiring the services to establish and maintain an aggressive thrust/power management program and emphasize the importance and positive effects of thrust/power management on fuel use, maintenance costs, and readiness. Defense believed specific actions should not be directed before savings are validated, and that these actions should be directed by the services on the basis of validation results. Defense proposed rewording the recommendations to require that the Secretary of Defense direct the services to give greater attention to the benefits of thrust/power management as a possible means of reducing fuel and engine maintenance costs.

Commercial and large military aircraft have been using thrust/power management techniques for several years and have achieved savings from extended engine life and fuel savings from engines which operate more effectively for longer periods of time. These results should serve as the basis or precedent for determining the extent to which thrust/power management can be extended to tactical fighter aircraft. We did not mean that tactical fighters perform reduced power operations before the services analyze and evaluate the extent such operations can be safely and cost effectively accomplished, consistent with mission requirements. We have revised our proposal to clarify this position.

Defense stated that there is sufficient oversight, monitoring, and reporting of aircraft fuel conservation actions by the services and that no additional action was required. We recognize that the services do gather information and monitor energy conservation efforts by subordinate organizations. We believe however, based on examples in this report, that there is still room at the Defense and service levels to improve how efficient operating and maintenance procedures are monitored, coordinated, and implemented.

CHAPTER 3

MORE CAN BE DONE TO IMPROVE THRUST/POWER MANAGEMENT

The services can do more to reduce fuel consumption and engine maintenance costs. This is especially true for the tactical fighter community. Reducing power on takeoff and climb, limiting the use of afterburners, taxiing on less than all engines, ground refueling with engines shut off, and removing unneeded external equipment all result in less fuel consumption. Using reduced power can significantly extend the life of engine components. While the savings on a single sortie may be relatively small, annual savings for an entire fleet of aircraft are significant. Although the tactical fighter community contends the greatest potential to save fuel exists while the aircraft is on the ground, it does not consistently use efficient techniques. As a result, the services are losing opportunities to save millions of gallons of fuel annually and to improve engine component life.

Commercial airlines have been at the forefront of actions to reduce fuel consumption and maintenance costs through good thrust/power management. They have implemented many operating procedures which also apply to military aircraft. For example, reduced power takeoffs and climbs used by the commercial airlines during the past decade have reduced fuel costs by 2 to 5 percent and engine maintenance costs by 10 percent. According to an Air Force study, the cost effectiveness of reduced thrust takeoffs by airlines was a twofold to tenfold improvement in engine life. This, in turn, positively affects engine durability, reliability, and reduced maintenance costs. The following table presents some of the major actions taken by the airlines to save fuel.

Action	Potential fuel savings (percent)
Improved engine maintenance	4.0
Computer flight planning	4.5
Avoiding carrying extra fuel	5.7-10
Improved crew education	1.5
Taxiing with less than all engines running	0.4
Optimized altitude selection and cruise speed	2.0
Optimized descent procedures	2.5-3
Using lesser angles of wing flaps or delaying flap use during landing approaches	1.0-2

These procedures can also extend engine life and reduce maintenance costs by allowing the engines to operate at less than full power. Within Defense, more fuel, longer engine life, extended mission, increased loiter time over station, and preservation of needed training hours are all benefits that can be achieved through the effective application of thrust/power management concepts.

Aircrews of larger Air Force and Navy aircraft are using techniques followed by the airlines, such as reduced power takeoffs and taxiing with less than all engines running. The tactical fighter community, however, continues to strongly oppose some of these techniques, especially reduced power takeoffs, citing the differences between fighters and other aircraft, as well as safety factors and the need to "fly as we fight." The tactical fighter community contends the greatest potential to save fuel exists while the aircraft is on the ground, yet it does not consistently use efficient techniques.

ACTIONS HAVE BEEN TAKEN BUT MORE NEEDS TO BE DONE

We identified differences in the way the Air Force, Navy, and Marine Corps operated their aircraft, which could adversely affect fuel consumption and maintenance costs. Although bomber, tanker, and transport aircraft generally use efficient procedures, such as reducing power during takeoffs and climbs and taxiing on fewer engines, fighter aircraft generally do not. We recognize the obvious differences in these aircraft, but we also believe that some of the procedures used by the larger planes have application to fighters as well.

The feasibility of reduced power takeoffs by tactical fighters needs to be evaluated

The 1979 DAS report concluded that military pilots were not adequately exposed to the reduced power concept in training and that the use of reduced power techniques was impeded by the lack of policy and flight performance charts for determining when reduced power could be used. The report recommended that Defense

- --establish a policy of reduced engine power;
- --exempt specific aircraft from the reduced power management policy only when warranted on the basis of flight tests and engineering analyses;
- --require pilots be indoctrinated and trained in the reduced power concept; and

--encourage the voluntary use of reduced power; if this was not feasible, the services should consider reducing engine power through maintenance procedures.

Defense has not effectively implemented these recommendations regarding tactical fighter aircraft. Neither the Air Force nor the Navy has implemented a reduced power policy for tactical fighter aircraft. Moreover, they have not conducted flight tests and comprehensive engineering analyses to determine to what extent thrust/power management procedures can be implemented for each type of aircraft. Two Navy analyses concluded that using reduced power versus full military power on takeoff would increase fuel consumption. These analyses, however, did not identify the effects of reduced power on engine life. Apparently, the only time fighter aircraft use anything less than full power on takeoff is when the engines have been mechanically adjusted to reduce their performance and unacceptable component failure rates. Fighter aircraft flight manuals we examined do not have charts showing how the aircraft would perform on takeoff at less than full power under various conditions.

A 1981 Air Force report stated that thrust reductions of 5 to 10 percent would reduce engine temperatures enough to increase the life of critical engine combustion section parts 20 to 100 percent. The report recommended that the following actions be taken to increase engine durability and reliability and also to reduce fuel consumption and maintenance costs:

--Reduced thrust takeoff procedures now available to pilots should be expanded.

--Reduced power takeoffs should be mandatory, if conditions are suitable to perform it safely.

--Reduced thrust operations training should be made a part of the curriculum for all pilot training.

--Commands not using reduced thrust should identify techniques which enable reduced thrust operations.

--Afterburner use for takeoffs should be reexamined and eliminated where not necessary for a safe takeoff.

--All new aircraft systems should implement thrust management concepts from the outset of the program.

The study noted, and we confirmed, that even though Air Force multiengine aircraft are authorized to perform reduced thrust takeoffs at the pilot's option, the implementation of reduced thrust operations for fighter aircraft has not occurred. Significant disagreement exists as to the overall effect of reduced thrust on tactical aircraft, centering around the need for realistic training versus the logistics benefit. The tactical fighter community cites the need to "fly as we fight" as a reason for not using reduced power on takeoff. While we recognize that pilots must use some full power takeoffs to maintain combat proficiency, we do not believe this procedure is warranted to the degree it is now practiced by tactical fighter aircrews. Reduced power takeoffs are possible as evidenced by continued tactical fighter operations after their engines were mechanically adjusted to lower power and reduce unacceptable component failure rates. Therefore, the services should evaluate the reduced power concept to determine when it is cost effective and does not affect training, mission requirements, or safety, so that guidelines could be provided identifying when the concept should be applied.

Afterburner use continues to be widespread

Air Force, Navy, and Marine Corps pilots use afterburners on takeoff in many instances even though appropriate flight manuals do not require afterburners for safe takeoffs. This is especially true for the services' F-4 aircraft and for the Navy's F-14 aircraft (notable exceptions to this are the Air Force's F-15 and F-16 aircraft which normally use full throttle without afterburners). Afterburners provide additional thrust to fighter aircraft by injecting fuel into hot exhaust gases for a second ignition. Significant amounts of fuel are used to achieve the added thrust. A May 1980 Navy study concluded that the F-4 aircraft consumes 82 percent more fuel using afterburner takeoffs than with full power nonafterburner takeoffs. We estimated that Air Force, Marine Corps, and Navy F-4s consumed 21 million more gallons in fiscal year 1981 just by using afterburners for 30 seconds on most takeoffs in lieu of full throttle without afterburners. While we recognize that some takeoffs require afterburners for safety and training, we do not believe they must be used the vast majority of time as is now the case.

The Principal Deputy Assistant Secretary of the Navy for Logistics reported that afterburner takeoff is limited to operational necessity. Based on our work at Navy and Marine Corps locations, however, we found that this was not the case. In reality, the nonuse of afterburners is limited to operational necessity. For example, on the F-14 aircraft,

--the Navy has reduced the amount of afterburner allowed on takeoff because afterburner power has caused aircraft spinouts when one of the engines stalls;

--trainees are not allowed to use afterburners during the takeoff of their first flights because they are unfamiliar with the aircraft's excessive power; and

--afterburners are not used during takeoffs when standing water is on the runway because the engines could ingest the water and stall out.

Further, Navy F-4 and F-14 pilots stated they did not use afterburners when they considered it essential to save fuel, such as

--when traveling cross-country to assure an extra margin of fuel is available and

--during practice carrier landings ashore when light fuel loads are used to reduce the landing weight.

Air Force F-4 pilots we contacted told us they always use afterburners as a standard procedure. They have been conditioned to using afterburners from their early training days because afterburners are routinely used for takeoff on the T-38 trainer aircraft. Navy basic training aircraft do not have afterburners.

At Seymour-Johnson Air Force Base (AFB), North Carolina, F-4s share a runway, over 11,000 feet long, with B-52 and KC-135 aircraft. These bomber and tanker aircraft use reduced power takeoffs, but the F-4s take off with full power and afterburners, while using only about 3,000 feet of runway. Officials stated that, because the aircraft is out of controlled airspace sooner, using afterburners is better for reducing noise.

Fighter pilots most frequently mention safety and the need for realistic training as the main reasons for nearly always using their afterburners on takeoff. Takeoff distances, however, are affected by variable factors, such as runway length, air temperature, aircraft weight, airfield altitude, and winds. A change in even one of these elements affects the distance down the runway where the pilot can either take off or stop safely if the takeoff is aborted.

For example, the critical takeoff point for an F-4N at 50,000 pounds gross weight, 104 degrees Fahrenheit air temperature at a sea level field, without afterburner and no headwind is about 7,400 feet. If the air temperature changes to 32 degrees Fahrenheit and all other factors remain constant, the critical point drops to 4,800 feet. Flight manuals consider these factors and contain performance charts for both afterburner and nonafterburner takeoffs. Thus, pilots can compute takeoff distances with and without afterburners, given the existing variables mentioned earlier, to determine whether safe stopping distance remains if the takeoff is aborted.

In 1979 DAS concluded that only under the most extreme conditions, such as high temperature, short and high elevation runways, and heavy loads, would the critical takeoff point be approached during normal operations. Therefore, tactical and training aircraft could use reduced power techniques for nearly all peacetime operations. Based on flight manual data and discussions with the manufacturer and pilots, we found that the F-4 can take off safely without afterburners under many conditions, such as cooler temperatures, lower aircraft weight, low altitude airfields, long runways, and headwinds.

The concept of reduced power is unpopular with the tactical aircraft community. The services, however, have not conducted flight tests and engineering analyses, as recommended by DAS, to determine to what extent voluntary thrust/power management procedures can be safely implemented for each type of aircraft. We believe the services should evaluate each type of tactical fighter aircraft to determine the cost effectiveness of reduced power use and the maximum extent that reduced power and nonafterburner takeoffs and climbs can be made without adversely affecting training, mission requirements, or safety.

<u>Taxi on fewer engines not consistently done</u>

There is no overall policy on using less than all engines during aircraft taxi. Bomber, tanker, and transport units we contacted all turned off several engines when taxiing after landing; some B-52 units shut down as many as five of the eight engines. Twin-engine fighter type aircraft, however, do not consistently practice taxiing with one engine shut off. An F-4 consumes about 3 gallons per minute per engine at taxi speed and an F-14 about 2.5 gallons. No aircraft taxied for takeoff on less than all engines at the locations we visited, even though such a practice is feasible.

--According to a 1981 evaluation by the Strategic Air Command's (SAC's) 8th Air Force, all eight B-52 engines are not needed for taxi, except where gross weights and taxi gradients dictate. If two engines which do not affect system operation and capability are not started until just before takeoff, approximately 100 gallons per mission can be saved. The evaluation projected an annual savings of nearly 900,000 gallons for just B-52G aircraft. This practice was not in effect at the locations we visited.

--Air Force F-4 pilots at McConnell AFB, Kansas, and Seymour-Johnson AFB shut off one engine to taxi after landing. Navy F-4 pilots at the Naval Air Station, Oceana, Virginia, and Marine pilots at the Marine Corps Air Station, Beaufort, South Carolina, taxi with both engines running. Two engines, taxiing for 5 minutes, consume an extra 15 gallons of fuel per aircraft per mission.

--Marine Corps F-4 pilots at Beaufort alternately run each engine to full power during taxi before takeoff, for a full power instrument check. The procedure lasts about 1 minute for both engines. Air Force F-4 pilots at McConnell AFB and Seymour-Johnson AFB and Navy pilots at Oceana taxi at idle speed and perform the instrument check just before or immediately after brake release for takeoff. Both services discontinued the full power check on the ramp because it contributes to wear of engine hot section components. Air Force and manufacturer officials estimated a fuel savings of 50 gallons per mission by this change. We project that this Marine procedure at Beaufort consumed nearly 700,000 extra gallons of fuel in fiscal year 1981.

--At the Naval Air Station, Miramar, California, one F-14 squadron is allowed to taxi to the ramp or fuel pit on one engine, while another squadron's F-14s must taxi with both engines running.

<u>Navy's use of "hot" refueling can be reduced to save fuel</u>

The Navy makes considerable use of aircraft "hot" refueling procedures. This means that aircraft is refueled with at least one of its engines running. Several years ago, the refueling procedure was to taxi the aircraft into position, shut off the engines, and then refuel. The engines were then restarted with portable units, and the aircraft taxied back to its parking space. If engines were not restarted, the aircraft was towed back to its parking space. Because this procedure required more personnel and equipment than truck refueling, it was considered less efficient. Refueling an aircraft with its engines idling eliminated the need for tow tractors, aircraft starting units, and other equipment, as well as reducing personnel requirements. Fuel consumed by idling engines was an insignificant factor, because fuel was relatively cheap and plentiful at the time.

The rapid rise in fuel costs has forced the Navy to reevaluate this refueling procedure. A June 1981 Navy study reported that from 2.3 to 3.6 million gallons of fuel per year could be saved at three air stations by adopting one of several alternative methods of refueling aircraft with their engines shut off. These alternatives included refueling by truck and towing aircraft to and/or from the fuel pits. The study claimed implementation costs were low and the fuel saved would cause a net dollar savings within 5 months. Navy aircraft at Miramar and Oceana are still extensively using hot refueling, while the recommended changes are being considered by the Navy.

At the Marine Corps Air Station in Beaufort, F-4 aircraft are refueled with both engines running 97 percent of the time. Marine Corps officials cited the lack of sufficient fuel trucks and dual-mission scheduling as reasons for hot refueling. We estimate that the Beaufort F-4s consumed an extra 800,000 gallons in fiscal year 1981 by hot refueling. Navy F-4s also generally run both engines when refueling. The Navy study concluded that no more than 15 percent of Navy land-based aircraft refuelings warranted hot refueling for faster turnaround time. Air Force fighters are hot refueled about 10 percent of the time, usually with only one engine running. Large Air Force aircraft shut off all engines when refueling occurs on the ground.

Local aircraft operating procedures should be improved

The quality, content, and consistency of local operating procedures addressing thrust/power management vary from unit to unit. Generally, the procedures of multiengine aircraft units are more detailed and address many thrust/power management concepts. This may be a result of the emphasis placed on thrust/power management by bomber, tanker, and transport major commands. For example:

--At Barksdale AFB, Louisiana, and Seymour-Johnson AFB (both locations have B-52 and KC-135 aircraft), detailed local procedures stress fuel conservation and advise aircrews how to save fuel, such as delaying engine starts, reducing power takeoffs, improving descent/landing procedures, and taxiing with several engines shut off.

--The F-4 local procedures at Seymour-Johnson AFB have little to do with fuel conservation, and at Beaufort there is no local instruction on aircraft fuel conservation techniques.

--At Miramar, one F-14 squadron instruction requires taxi on two engines after landing, while another squadron may shut off one engine.

--Instructions for F-15 operations at Bitburg Air Base, Germany, establish local wing standards, including takeoffs normally made without afterburners. Instructions for F-15s at Langley AFB, Virginia, have no similar standards.

MORE IMPROVEMENTS CAN BE MADE IN AIRCRAFT MAINTENANCE

Aircraft maintenance is a critical element in the thrust/power management concept. Engines, such as the F-100 used on the F-15/16 aircraft and the TF-30 used on the F/FB-111 and F-14 aircraft, have experienced considerable reliability and durability problems. Maintenance actions, such as trimming (adjusting) the engines to specification, allow the engine to operate more efficiently and last longer. Engine diagnostics and troubleshooting can provide early identification of parts degradation so that repairs can be made. When engines experience serious problems with component failure, the thrust may be mechanically reduced to lower engine temperature and reduce stress. Removing unnecessary external equipment can improve aircraft efficiency by reducing weight and drag. We identified several examples where the services could do more to improve the efficiency of their aircraft and engines.

Automated engine trim and diagnostic systems

The services have experienced problems in trimming engines under current manual methods. Consistent, accurate trims are hard to achieve when done manually because they take considerable time and use large amounts of fuel. For these reasons, the services are developing and procuring a variety of automated trim systems, some of which may also have diagnostic capability.

The Navy is acquiring a system to trim the TF-30 engine and could modify the system's software for use on other engines in its inventory. The Air Force is developing or acquiring several systems, some for specific engines like the F-100 and some for a broad group of engines. Although two of these systems may improve the trim process at the base level, actual extension of the systems to the field has been limited and slow, especially in the Air Force.

The Thrust Computing System for the J85-5 engine (T-38 aircraft) and the Programmable Automated Trim Test System (PATTS) for the F-100 and TF-30 engines have demonstrated, through lengthy testing or field use, considerable potential for saving fuel and reducing maintenance costs. But their field implementation has been strongly opposed by the Air Force

Systems Command's Aeronautical Systems Division (ASD). ASD contends that the Thrust Computing System is no better than the existing manual trim procedures and that PATTS does not satisfy all of the critical requirements wanted in an automated trim and diagnostic system. The operating commands which will use these systems strongly advocate their acquisition.

Thrust Computing System

We issued a report in October 1981 1/ on this system designed to trim J85-5 engines used by the Air Force's T-38 fleet. In May 1981, we sent a letter of inquiry to the Secretary of the Air Force identifying problems associated with the system's lengthy development, test, and evaluation process and requested the Secretary's written comments on the matters discussed in the letter.

In July the Deputy Assistant Secretary of the Air Force for Logistics responded:

> "We have reviewed the subject GAO report and concur that an inordinate amount of time has been expended in evaluating the capability and benefits of the Thrust Computing System (TCS). There have been some differences of engineering opinion which had to be resolved before a decision could be made * * * to modify the J85-5 inventory * * * . The impasse has been resolved, and a go-ahead decision on the system has been made.
>
> We propose to fully implement TCS, beginning with Laughlin AFB, TX. During the initial phase of modification, installed thrust trim requirements will be defined and system benefits verified. The program will be monitored for possible application on other engines. Preliminary work has been accomplished on the J79 and if the TCS functions as well as expected on the J85-5, a program will be initiated for the J79."

In our October report, we concluded that lack of funding could prevent actual implementation, despite high-level Air Force intentions to implement the system. The Congress appropriated $9 million in fiscal year 1982 so the Air Force could take action to procure and install this equipment.

1/"Potential Reductions in Aircraft Operation and Maintenance Costs by Using Thrust Computing Support Equipment" (PLRD-82-4, dated Oct. 27, 1981).

Programmable Automated Trim Test System

PATTS is intended to automate the engine trim process, provide more accurate, uniform trims, and shorten the trim process. It basically fulfills the following trim and test requirements:

--Measures, displays, and records required parameters.

--Calculates engine performance parameters.

--Determines deviations from normal engine values.

--Provides step-by-step trim instructions.

--Provides permanent typed record of trim runs.

The estimated fuel savings from shortened trim runs range from 425 to 1,000 gallons per trim. Also, benefits in the form of extended engine life are expected from more accurate, consistent trims.

The Navy is procuring 18 units to trim TF-30 engines (F-14 aircraft) both ashore and aboard aircraft carriers. Total cost is estimated at $5 million to $7 million. Officials believe PATTS can also be used to some extent as a diagnostic tool. The Navy could modify PATTS software to adapt the system to other type engines. A Navy estimate indicated that over 225,000 gallons of fuel could be saved annually at Miramar in TF-30 test cell trims.

The Air Force has used PATTS at seven F-100 engine bases since 1980. The systems were provided and maintained at no cost to the Air Force by Pratt and Whitney Aircraft through July 1981. For fiscal year 1982, the Air Force contracted with Pratt and Whitney to lease the seven systems and maintenance support.

The Air Force Logistics Command is procuring two PATTS units to trim SAC TF-30 (FB-111 aircraft) and J57 (B-52/KC-135 aircraft) engines at Pease AFB, New Hampshire, and at Plattsburgh AFB, New York. The estimated cost of these two units is $1.5 million. PATTS is projected to save over 136,000 gallons per year in trim runs at these bases. The added savings from extended engine parts life has not been quantified. At present, the Air Force has no plans to acquire additional PATTS for TAC F-111s, which also have the TF-30 engine, or for other SAC B-52 and KC-135 bases which use the J57 engine, although some SAC officials hope the command eventually could have about 25 PATTS units.

In December 1980, TAC requested that PATTS be furnished to all wing-sized F-100 engine bases for test cell use. ASD, the Air Force's cognizant F-100 engine activity, rejected the acquisition of any additional PATTS. ASD officials view PATTS only as an interim device for the F-100 engine until another system they believe is better, is available. That system, called the Automated Ground Engine Test Set (AGETS), has not yet been developed or tested, yet ASD appears to have already decided to adopt it. ASD officials claim PATTS does not satisfy critical requirements, such as deployability and extensive diagnostic capability, which AGETS will satisfy. These elements, however, are not among the essential characteristics identified by major commands as desirable features of an automated system. ASD officials also do not consider PATTS as cost effective since they believe AGETS will be available before PATTS pays for itself in 4-1/2 years. A Pratt and Whitney analysis estimated PATTS could pay for itself in 12 to 18 months. In deciding not to acquire additional PATTS, ASD did not:

--Develop estimates of potential savings from fleetwide use of PATTS.

--Analyze or summarize the use and evaluation of PATTS to date.

--Conduct any formal cost-benefit analysis on the feasibility of acquiring additional PATTS through various lease or purchase arrangements. After we inquired about ASD's analytical approach, a payback analysis was done, but the conclusion varied widely from the Pratt and Whitney analysis.

More management attention is required to insure that systems are adequately evaluated and considered and that system capabilities meet only essential requirements. Predisposition toward an as yet untested system which may be available 4 years from now, while not considering further extension of PATTS without a substantive, comprehensive cost-benefit analysis, could cost the Air Force millions of dollars in fuel savings and improved engine life. We are evaluating this and other engine trim and diagnostic system issues in a current audit.

Engine health monitoring

In the absence of automated diagnostic systems, engine performance trends are being monitored to various degrees in an effort to detect and correct problems before they become critical. SAC and the Military Airlift Command have the most active programs and gather engine performance data on each flight. Aircrews record data, such as fuel flow, exhaust gas temperature, throttle position, and oil consumption, during flight on B-52, KC-135, and C-141 aircraft. Similar data is recorded mechanically on C-5 aircraft. Maintenance personnel analyze this data to identify potential problems needing attention. A similar process is used for the Navy's P-3 patrol aircraft. SAC estimated tangible annual savings of $16 million in addition to reduced in-flight engine shut downs, numerous repairs while engines are still on the wing, and quicker repair since engine damage is not as extensive as before. The SAC program began in 1977, and a modified version was adopted by the Military Airlift Command. SAC also presented the idea to ATC and TAC. Both of those commands initially rejected the concept, although ATC recently began to reconsider the idea, and TAC uses a version for its larger aircraft, such as the EC-135 and E-3A.

Removal of unnecessary equipment

Wing tanks, weapons pylons, and other external items add weight and drag to the aircraft and cause greater fuel consumption. While the services are aware of the negative aspects of carrying unnecessary equipment, they frequently continue to operate with the items. For example:

--Air Force F-4s routinely carry external centerline fuel tanks on most missions. These tanks, however, were not designed for the frequent use and high-speed maneuvering stress factors which they experienced. After some serious incidents caused by tank failure, TAC suspended the use of these tanks for low altitude missions until a replacement could be found.

--Marine F-4s at Beaufort also frequently carry external centerline fuel tanks, even if they are empty. An F-4J/S consumes about 25 extra gallons of fuel during a climb to 35,000 feet because of the added drag caused by the empty tank.

--F-4s at Seymour-Johnson AFB still operate with camera pods that were installed during the Vietnam War. The pods do not contain their cameras, however. Base personnel estimated that over 340,000 gallons of fuel could be saved annually if the pods were removed when not needed. The pod could be removed in about an hour. A suggestion to remove the pods was submitted to TAC Headquarters in March 1980 and was rejected in May 1981. TAC stated the cameras are required for combat and should be used and maintained for realism. TAC also stated the suggestion was expensive and the benefit-to-cost ratio indicated savings would be minimal.

--Two years ago, a study estimated that the Navy could save 8.5 million gallons a year in its A-7 fleet by removing wing/fuselage pylons for missions where they are not needed. Some A-7 squadrons have been removing pylons for the past 3 to 4 years. The Navy plans to study the operational implications of pylon removal and may not fully implement changes in all squadrons until fiscal year 1984.

We believe the services should evaluate these practices to confirm whether it is cost beneficial to remove external equipment not needed for the mission. If savings are confirmed, the services should promptly remove this equipment, when appropriate, at all locations where these aircraft are based.

Air Force could save fuel by changing procedure to check for external fuel tank leaks

When external fuel tanks are installed on F-4 aircraft at Seymour-Johnson AFB, tests for fuel leaks are made by running one engine at 85 percent power for about 15 minutes. Each time an engine is run for this purpose, about 185 gallons of fuel are used. We estimate that the base uses $100,000 of fuel a year to perform tank leak checks in this manner. The technical order requiring the test also permits using an external compressed air unit to provide the necessary pressure, without having to run an engine. We were told there may also be opportunities to use compressors and save fuel at some of the other 37 TAC F-4 units, at European and Pacific F-4 bases, for other types of aircraft, and in other maintenance procedures requiring engine runup.

We sent a letter of inquiry to the TAC commander in December 1981, recommending that he

--confirm whether it is cost beneficial to purchase and use compressors in the fuel leak test,

--take action to obtain and use compressors in lieu of engine runups at all F-4 locations if savings are confirmed, and

--investigate the applicability of this procedure to other TAC aircraft and to other maintenance procedures requiring engine runup.

TAC has informed us that a 6-month test program will be conducted at Seymour-Johnson AFB to gather data in order to decide on the extent this concept could be extended to other locations.

OTHER INITIATIVES OFFER POTENTIAL FOR IMPROVED FUEL EFFICIENCY

The services have also undertaken other projects which will improve fuel efficiency and extend engine life.

Fuel saving system

Several flight management systems are commercially available to maximize fuel efficiency by optimizing flight speed and altitude on a continuous basis. These systems are onboard computers that evaluate in-flight data supplied by sensors and/or the aircrew. The systems may be coupled to the autothrottle and autopilot controls or may be advisory, informing the aircrew of the most efficient speed and altitude at which to fly.

The Air Force is acquiring sophisticated flight management computers for its C-5, C-141, and C/KC-135 aircraft. The C-5 and C-141 system will be linked to the aircraft autopilot and autothrottle to automatically make adjustments in flight to maintain the most fuel efficient flight profile. In June 1981, the Air Force awarded a contract to procure this system for 347 C-5 and C-141 aircraft. The Air Force has estimated that the system will cost $81.1 million for these aircraft.

The KC-135 system will advise the crew of optimum adjustments but will not automatically make changes. The Air Force has also awarded an initial contract for about $46 million to procure the advisory system for C/KC-135 aircraft. It plans to install the system on 726 aircraft at an estimated cost of $101.1 million. The Air Force estimates these fuel systems can save 3 percent in fuel consumption and unquantified savings in extended engine life.

In August 1981 a contractor visited the Military Airlift Command to present a fuel savings advisory system that could be used for C-130 turboprop aircraft. The estimated cost of the system was $10,000 per aircraft. The command was considering this system, but it has not decided whether to take any action. The Air Force has not seriously considered similar systems for its tactical fighter aircraft.

The Navy is investigating the development of flight performance management or advisory systems for a number of its aircraft, including the P-3, F-4, A-4, A-6, and A-7. However, the Navy is not yet ready to implement these systems into fleet aircraft.

Hand-held calculators

The Air Force plans to spend approximately $1.1 million for hand-held programmable calculators for its B-52, KC-135, C-5, and C-141 aircraft to advise aircrews of the most fuel-efficient methods to operate in the climb, cruise, and descent phases of flight. Unlike the onboard fuel savings system, all calculator inputs must be made by the aircrew. The Air Force estimates that the calculators could reduce fuel consumption on these four aircraft types by 2 percent per year (over 33 million gallons at the fiscal year 1980 projected rate) and pay for themselves in 45 days. There is no ongoing effort to expand the use of these calculators to other types of aircraft. The Air Force never conducted a comparative cost-benefit analysis of these calculators with the more costly, sophisticated fuel savings system to determine whether the extra 1-percent saving from the fuel savings systems was worth the added cost.

The Navy is using a programmable calculator for its P-3 patrol aircraft and is considering using calculators in A-6, A-7, F-4, F-14, F/A-18, and S-3 aircraft.

CONCLUSIONS

Most ongoing thrust/power management efforts in Defense are related to bomber, tanker, and transport aircraft with little attention placed on fighter type aircraft. More could be done, especially with fighter aircraft, to save fuel and reduce engine maintenance costs. We believe the absence of thrust/power management policy and an effective program in Defense contributes to the conditions noted and cause Defense to incur greater costs than necessary.

RECOMMENDATIONS

We recommend that the Secretary of Defense direct the Secretaries of the Air Force and Navy to:

--Conduct engineering analyses and flight tests to determine the extent to which fighter aircraft can use reduced power safely and economically. These analyses should evaluate the effects of reduced power on both fuel use and extended engine life. Flight manuals should be revised accordingly to show reduced power performance characteristics during takeoffs and climb. The importance and use of thrust/power management concepts, including reduced power takeoffs and limited use of afterburners, should be stressed to tactical fighter aircrews when such operations are warranted.

--Report how they plan to analyze and evaluate the use of reduced power by tactical fighter aircraft. These plans should identify the aircraft to be evaluated, the methods to be used in the evaluations, and target dates for completion. The plans should be provided to and monitored by the Secretary of Defense.

--Require that all appropriate aircraft, including tactical fighters, use reduced power when cost effective and consistent with safety and mission considerations.

--More effectively monitor efforts by subordinate commands and units--through such methods as review and comparison of local procedures and followup to efficiency studies and suggestions--to identify and implement fuel-efficient operating and maintenance procedures where possible.

--Insure fuel-efficient operating and maintenance procedures followed by one service are implemented by the other where applicable.

AGENCY COMMENTS AND OUR EVALUATION

Defense believed that we viewed safety as the only unanswered issue in whether reduced power operations should be extended to fighter aircraft. Cost effectiveness must also be considered according to Defense. Some Navy analyses had concluded that thrust reduction would actually increase fuel used during takeoff by tactical fighters. Defense agreed, however, that the services should reexamine the reduced power concept for fighter aircraft and implement the concept where feasible when consistent with safety, mission, and economic considerations.

We agree that cost effectiveness should always be a consideration when evaluating alternate concepts, procedures, or systems. We revised our recommendation to clarify that point. We also believe, however, that cost effectiveness analyses of reduced power operations must address the effect of reduced power on engine life as well as fuel consumption. Airline experience generally has shown that extended engine life derived from reduced power far exceeds any increases in fuel consumption.

We believe that the Secretary of Defense should direct the services to investigate the maximum extent reduced power operations can be used effectively. Once this is accomplished, the services should be required to use reduced power whenever appropriate.

Defense stated that existing procedures are adequate to identify, disseminate, and coordinate efficient initiatives within and between the services. While we recognize that the services do gather, monitor, and coordinate information, we believe these efforts need to be improved, as evidenced by the problems identified in this report. Our proposals were revised to reflect this need for improved monitoring and coordination as outlined in the recommendations in this chapter.

ACTIVITIES CONTACTED DURING OUR REVIEW

Office of the Assistant Secretary of Defense (Manpower, Reserve Affairs and Logistics) - Washington, D.C.

Air Force:

- Headquarters, U.S. Air Force - Washington, D.C.
- Headquarters, U.S. Air Forces in Europe - Ramstein Air Base, Germany
- Headquarters, Air Training Command - Randolph AFB, Texas
- Headquarters, Air Force Logistics Command - Wright-Patterson AFB, Ohio
- Headquarters, Military Airlift Command - Scott AFB, Illinois
- Headquarters, Strategic Air Command - Offutt AFB, Nebraska
- Headquarters, Tactical Air Command - Langley AFB, Virginia
- Headquarters, Aeronautical Systems Division - Wright-Patterson AFB, Ohio
- Air Force Wright Aeronautical Laboratories - Wright-Patterson AFB, Ohio
- Headquarters, 8th Air Force, Barksdale AFB, Louisiana
- Oklahoma City Air Logistics Center - Tinker AFB, Oklahoma
- San Antonio Air Logistics Center - Kelly AFB, Texas
- 1st Combat Evaluation Group (SAC) - Barksdale AFB, Louisiana
- 2d Bomb Wing - Barksdale AFB, Louisiana
- 4th Tactical Fighter Wing - Seymour-Johnson AFB, North Carolina
- 12th Flight Training Wing - Randolph AFB, Texas
- 36th Tactical Fighter Wing - Bitburg Air Base, Germany
- 55th Strategic Reconnaissance Wing - Offutt AFB, Nebraska
- 60th Military Airlift Wing - Travis AFB, California
- 68th Bomb Wing - Seymour-Johnson AFB, North Carolina
- 184th Tactical Fighter Group, Kansas Air National Guard - McConnell AFB, Kansas
- 384th Air Refueling Wing - McConnell AFB, Kansas
- 442d Tactical Airlift Wing (Reserve) - Richards-Gebaur AFB, Missouri
- 436th Military Airlift Wing - Dover AFB, Delaware
- 438th Military Airlift Wing - McGuire AFB, New Jersey

Army:

- Headquarters, U.S. Army - Washington, D.C.
- U.S. Army Aviation Research and Development Command - St. Louis, Missouri

Navy:
Headquarters, U.S. Navy - Washington, D.C.
Headquarters, Naval Material Command - Washington, D.C.
Naval Air Systems Command - Washington, D.C.
Naval Air Development Center - Warminster, Pennsylvania
Naval Air Propulsion Center - Trenton, New Jersey
Commander, Naval Air Forces Atlantic - Norfolk, Virginia
Commander, Tactical Wings Atlantic - Naval Air Station, Oceana, Virginia
Fighter Wing 1 - Naval Air Station, Oceana, Virginia
Commander, Naval Air Forces Pacific - San Diego, California
Commander, Fighter Airborne Early Warning Wing Pacific - Naval Air Station, Miramar, California
VF-124 - Naval Air Station, Mirimar, California

Marine Corps:
2d Marine Air Wing - Marine Corps Air Station, Cherry Point, North Carolina
Marine Air Group 14 - Marine Corps Air Station, Cherry Point, North Carolina
Marine Air Group 31 - Marine Corps Air Station, Beaufort, South Carolina
Marine Air Group 32 - Marine Corps Air Station, Cherry Point, North Carolina

Other:
Air Transport Association of America - Washington, D.C.
Defense Audit Service - Washington, D.C.
Delco Electronics - Milwaukee, Wisconsin
McDonnell-Douglas Corporation - St. Louis, Missouri
Trans World Airlines - Kansas City, Missouri

ASSISTANT SECRETARY OF DEFENSE

WASHINGTON, D.C. 20301

MANPOWER,
RESERVE AFFAIRS
AND LOGISTICS

22 APR 1982

Mr. Donald J. Horan
Director, Procurement, Logistics
and Readiness Division
U.S. General Accounting Office
441 G Street, N.W.
Washington, D.C. 20548

Dear Mr. Horan:

This is in reply to your March 17, 1982 letter to the Secretary of Defense concerning a GAO draft report entitled, "Aircraft Thrust/Power Management Can Save Defense Fuel, Reduce Engine Maintenance Costs and Improve Readiness," Code 943487 (OSD Case #5712).

We agree that use of reduced engine power in the operation of military aircraft can lead to substantial savings in fuel and engine maintenance costs. Accordingly, the Navy and Air Force have developed and implemented several initiatives involving thrust/power management since the 1974-1975 time frame which have led to reductions in fuel and maintenance costs. Although the report accurately notes the absence of a DoD or Service-directed program exclusive to thrust/power management, the concept has for some time been an integral part of the Services' aircraft fuel conservation programs which are directed under DoD Directive 4170.10, "Energy Conservation," March 29, 1979. This has been especially the case in transport and bomber operations, which are more readily adaptable to the types of initiatives successfully pioneered by the commercial airlines. We believe that savings realized in this area by the Military Services since CY 1974-75 are at least as significant as those experienced by the commercial airlines for the same period. In addition to fuel savings, we are acutely aware of the beneficial effect of reduced thrust/power management on aircraft engine maintenance costs.

Our primary concern with the report is the apparent supposition that reduced power is always beneficial, particularly with regard to tactical operations. The Services maintain that, in some cases, reduced power on takeoff can actually increase fuel consumption while also reducing required operational and safety margins to unacceptable levels. For example, certain tactical aircraft which take off without using afterburner or full military thrust would use more runway and take longer reaching their operational altitudes, thus increasing fuel consumption overall. Their position is not against the principle of thrust/power management per se, but reflects concern with the generalization that thrust/power management is beneficial in every case when, in fact, engineering analyses may prove otherwise. Therefore, we are reluctant to impose implementation of thrust/management as a separate program, but will direct that the concept continue to be emphasized as an integral part of the Services' energy conservation programs consistent with safety, mission and cost effectiveness considerations. Specific responses are attached for each recommendation.

We would also like to take this opportunity to provide corrected pie charts on DoD petroleum consumption for FY 1981 to replace those on page 3 of the draft report, which are in error. Corrected charts are shown at Attachment 2.

We sincerely appreciate GAO's efforts in addressing thust/power management. The report will be extremely useful in directing management attention, throughout DoD, to the possible beneficial effects of thrust/power management on fuel and aircraft engine maintenance costs.

Sincerely,

James N. Juliana

Attachments

James N. Juliana
Acting Assistant Secretary of Defense
(Manpower, Reserve Affairs & Logistics)

GAO note: Attachment 2 is not included.

Comments on Draft GAO Report

"Aircraft Thrust/Power Management Can Save Defense Fuel, Reduce Engine Maintenance Costs and Improve Readiness"
GAO Code 943487 (OSD Case #5712)

Recommendation #1: SecDef issue policy and guidance requiring that the Services establish and maintain an aggressive thrust/power management program to reduce aircraft fuel consumption and engine maintenance costs.

Comment: Do not concur with the recommendation as written. The Services already have active aircraft fuel conservation programs which embrace a wide range of possible fuel saving measures, including thrust/power management, as directed under DoD Directive 4170.10, "Energy Conservation," March 29, 1979. The recommendation implies that thrust/power management is not being aggressively pursued and presupposes that the concept will automatically result in fuel and engine maintenance cost savings when thorough analysis may prove that this is not always the case. We believe that specific actions should not be directed before savings are validated, and that these actions should be directed by the Services based on the results of validation. We therefore recommend that the recommendation be reworded as follows: "SecDef direct the Services to give greater attention to the benefits of thrust/power management as a possible means of reducing fuel and engine maintenance costs." We will direct that thrust/power management be emphasized more strongly as an integral part of DoD's energy conservation program.

Recommendation #2: SecDef issue policy and guidance requiring that the Services emphasize the importance of thrust/power management and its positive effects on fuel use and maintenance costs and readiness.

Comment: Do not concur. The recommendation's generalization about the positive effects of thrust/power management is an assertion which is unproven, particularly with regard to tactical aircraft. We feel that action taken in response to Recommendation #1 (if reworded as suggested) will suffice for Recommendation #2.

Recommendation #3: SecDef issue policy and guidance requiring that the Services require that all aircraft use reduced power when consistent with safety and mission considerations.

Comment: Concur in principle. However, Service analyses have concluded that reduced power on takeoff would actually increase fuel consumption in some cases. Fuel and maintenance cost savings should first be validated, model by model, before such a provision is imposed for all aircraft. Accordingly, it is recommended that the word "all" be eliminated from the recommendation and the phrase "where cost effective" be added at the end of the sentence. We will direct that the Services comply with the intent of the recommendation as reworded.

Recommendation #4: SecDef issue policy and guidance requiring that the Services actively monitor efforts by subordinate commands and units to identify and implement fuel efficient procedures where possible.

Comment: Concur in principle. The Services already actively monitor efforts by subordinate commands and promulgate successful initiatives through various media. Examples of vehicles used for this purpose are the Navy's Air Energy Officers Guide and the Air Force's Stan/Eval and Inspector General systems. Accordingly, we will instruct the Services to insure that monitoring activities are strengthened and expanded as necessary; however, no additional DoD policy/guidance is required other than DoDD 4170.10.

Recommendation #5: SecDef issue policy and guidance requiring the Services coordinate to insure fuel efficient procedures followed by one Service are implemented by the others.

Comment: Concur in principle. Such coordination in fact occurs on a regular basis between the Navy Energy Office (OP-413) and its counterpart on the Air Staff as well as among the various Service R&D centers. Specific instances of such coordination at the headquarters level are the disseminatioh of Air Force operational fuel efficiency recommendations throughout the Naval aviation community and the provision of the Naval Air Energy Officers Guide to the Air Force. In order to account for valid differences in Navy and Air Force aviation requirements, the phrase "where applicable" should be added at the end of the recommendation. No additional SecDef guidance is required, as such coordination is currently being done under the DoD energy conservation program.

Recommendation #6: SecDef issue policy and guidance requiring the Services to monitor existing fuel consumption data to identify and analyze trends and potential problems, and to take corrective action where necessary.

Comment: Concur in principle. The Services are already accomplishing the recommended task; however, we will direct that efforts by the Services be more comprehensive in this area.

Recommendation #7: SecDef require the Services to report how they plan to carry out their thrust/power management responsibility to ensure everything possible is being done to reduce aircraft fuel use and maintenance without jeopardizing safety and readiness.

Comment: Concur in principle. All Services currently submit annual reports, both written and oral, to OSD on all aspects of their energy programs. However, the recommendation implies that thrust/power management must be a part of these programs, whether the benefits of thrust/power management are validated or not. As pointed out under Recommendation #1, the concept may not always be beneficial, particularly in the case of tactical aircraft operations. The provisions of DoDD 4170.10 are sufficient to insure that the Services are complying with the intent of this recommendation.

Recommendation #8: SecDef establish meaningful criteria against which to evaluate Service progress in reducing their fuel consumption and maintenance costs.

Comment: Concur in principle. The Services already have meaningful criteria to evaluate the progress of their respective units in improving fuel efficiency. Such criteria were developed in connection with the DoD energy conservation program. Under the topic "Energy Conservation in DoD," ASD(MRA&L) has submitted an action item to the Defense Council on Integrity and Management Improvement (DCIMI) addressing energy productivity, with the intention of developing energy efficiency indicators. The Services possess the expertise to adjust fuel efficiency criteria to various operational and tactical practices; however, Service data is sufficiently available to DoD agencies for review/analysis as required. We will incorporate review/analysis of Service data in our DCIMI effort.

Recommendation #9: SecDef maintain oversight of the Services' programs to identify adverse fuel efficiency trends and other potential problems, ensure effective coordination of information and implement efficient procedures where possible.

Comment: Concur in principle. Such oversight is already being maintained by the DoD Energy Policy Directorate. No additional OSD action is required.

Recommendation #10: SecDef direct the Secretaries of the Navyand Air Force to conduct engineering analyses and flight tests to determine the extent to which fighter aircraft can use reduced power safely. Flight manuals should be revised accordingly to show reduced power performance characteristics during takeoff and climb.

Comment: Concur in principle. The recommendation tacitly assumes that only safety and not the purported economies of power reduction remain at issue. However, engineering analysis of two of the Navy's three tactical fighter aircraft concluded that thrust reduction would actually increase the amount of fuel used on takeoff. The GAO report appears to discount any evidence contrary to the position that power reduction would save fuel. Furthermore, the recommendation fails to take into account the substantial cost of revising flight manuals. We will request, however, that the Services reexamine those fighter aircraft where thrust/power management appears feasible, and that the concept be implemented where engineering analyses so indicate, consistent with safety, mission and economic considerations.

Recommendation #11: SecDef direct the Secretaries of the Navy and Air Force to initiate an education program for tactical fighter aircrews, stressing the importance and use of thrust/power management concepts including reduced power takeoffs and limited use of afterburners.

Comment: Concur in principle. The Services do in fact have positive programs to educate aircrews regarding proper operational procedures in accordance with flight handbooks, to include fuel management, where applicable. No additional OSD direction is required.

Recommendation #12: SecDef direct the Secretaries of the Navy and Air Force to evaluate aircraft operations and maintenance procedures to identify efficient initiatives which can be further expanded to other commands, bases, or units.

Comment: Concur in principle. However, as noted in the response to Recommendation #4, the Services already have adequate procedures for identifying and disseminating thrust/power management initiatives. No additional OSD action is required.

Recommendation #13: SecDef direct the Secretaries of the Navy and Air Force to conduct maximum thrust/power management information coordination within and between the Services to insure as much as possible is being done to reduce fuel consumption and engine maintenance costs.

Comment: Concur in principle. However, such coordination already occurs as a routine part of the DoD and Service energy conservation programs. No additional OSD action is required.

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