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REPORT BY THE

Comptroller General

OF THE UNITED STATES

The Air Force Can Reduce Its Stated Requirements For Strategic Airlift Crews

This report discusses how the Air Force estimates the number of strategic airlift aircrews needed under wartime conditions

GAO recommends changes to the process which should improve the requirements determination and result in worthwhile savings



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SEPTEMBER 19, 1979



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

B-146896

The Honorable John C. Stennis
Chairman, Subcommittee on Defense
Committee on Appropriations
United States Senate

SEN00302

Dear Mr. Chairman:

As requested by your July 13, 1978, letter, we have reviewed the Air Force's process for determining aircrew requirements for strategic airlift aircraft.

This report discusses changes to the process which should improve the requirements determination and result in savings in training and support costs.

As arranged with your office, we are sending copies of this report to the Chairmen, House Committees on Appropriations and on Government Operations; House and Senate Committees on Armed Services; and Senate Committee on Governmental Affairs. Copies of this report are also being sent to the Secretaries of Defense and the Air Force; and the Director, Office of Management and Budget.

Sincerely yours,

James B. Atchley

Comptroller General
of the United States

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COMPTROLLER GENERAL'S REPORT
TO THE SUBCOMMITTEE ON DEFENSE
SENATE COMMITTEE ON
APPROPRIATIONS

THE AIR FORCE CAN REDUCE
ITS STATED REQUIREMENTS
FOR STRATEGIC AIRLIFT
CREWS

D I G E S T

The Air Force invests millions of dollars annually to train and support crews to fly the C-5 and C-141 strategic airlift planes. In time of war, this force is responsible for deploying and employing combat forces, air logistics support, aeromedical evacuation, and augmenting theater airlift. The need to maintain sufficient crews for these missions is apparent. Maintaining more crews than necessary, however, is costly and unjustified.

The Air Force has determined it needs four crews for each C-5 and C-141 aircraft. However, because of the Air Force's decision to preserve the service life of the C-5 airplanes by limiting the flying hours of the fleet, only 3.25 aircrews are presently authorized for each C-5. The 3.25 crew ratio is scheduled to be increased to 4 by 1983.

The Air Force has developed and uses a computer model simulating the operations of the strategic airlift system under wartime conditions to determine crew needs. This is a rational approach, but a number of factors the Air Force uses are unrealistic and tend to overstate crew needs.

The Secretary of Defense has determined a utilization rate for strategic airlift planes which is equal to 12.5 hours per day per plane for the first 45 days of mobilization (surge rate) and 10 hours per day per plane thereafter (sustained rate). GAO found the Air Force's computer model improperly assumes that all crews fly at the surge rate for a

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longer period of time than established by the Secretary of Defense, thereby overstating crew ratio needs by at least 15 percent. Further, no provision is made for a transition period between peacetime and wartime in which reserves must be mobilized. (See p. 8.)

A key factor which affects the number of crews needed is the limit placed on their flying time for biomedical reasons. The Air Force assumes, in projecting these requirements, that aircrewmembers cannot effectively fly more than 125 hours within a 30-day period, or 330 hours within a 90-day period. GAO could find no documentation showing the basis for the limits which were established more than 20 years ago. Air Force medical officials strongly support the 90-day/330-hour limit. However, they feel the 30-day/125-hour limit is flexible and could be exceeded for a limited time with little danger of adverse effects. During the 1973 Yom Kippur War, for example, the 30-day/125-hour limit was raised to 150 hours.

GAO analyzed model simulations made by the Air Force and noted that during the first 45 days of an emergency, the period of highest demand, the utilization rate attained with a crew ratio of 3 to 1, with no flying hour limits imposed, was comparable to the rate attained with a 4 to 1 crew ratio with flying hour limits imposed. Where no flying hour limits were imposed, certain aircrews exceeded the 125 hours within 30 days limit, but none exceeded the 150-hour limit authorized during the Yom Kippur War. This action indicates a reduced crew ratio warrants serious consideration.

The change of one factor has a significant effect on operational costs. A reduction of the aircrew ratio from the currently authorized 3.25:1 to 3:1 for the C-5, and from 4:1 to 3:1 for the C-141, would lower the Air Force's annual funding requirement

by as much as \$105 million for the strategic airlift operational fleet if only active duty personnel were reduced, and \$66 million if only reserve personnel were reduced. (See p. 11.)

The Air Force omitted the effects of aircraft attrition in estimating required crews. At least three extra crews become available when each plane is lost. (See p. 15.)

It has made additional questionable assumptions and has not adequately evaluated all the principal factors in determining aircrew ratios. The Air Force:

- Indicates the extent of fatigue varies among aircrew positions. Therefore, maintaining the same aircrew ratio for all positions may not be justified or necessary. Further, the possibility for crew rest onboard during long flights needs more consideration. (See p. 12.)
- Does not consider ground times at home stations to perform aircraft maintenance in its latest model simulations. This omission may have inflated crew ratio requirements since, generally, increases in ground times reduce the hours available for flying. (See p. 13.)
- Assumes that all required crewmembers are fully qualified, onboard, and available for flying duties. This assumption understates the number of crews required because a percentage of the crews will be unavailable or not qualified. (See p. 16.)
- Assumes, in its computer model, that crews must perform staff duties as well as flying airlift missions. This assumption causes an increase in the estimated number of aircrews needed and appears unrealistic for wartime operations. (See p. 17.)

Staff and supervisory airlift pilots who maintain full combat readiness flying proficiency are not considered as resources to meet aircrew needs. If they were, it would allow a reduction in the number of crews which must be trained and maintained to meet airlift aircrew requirements.

RECOMMENDATIONS

To improve the process of determining strategic airlift crew requirements and achieve more valid ratios, the Secretary of Defense should require the Secretary of the Air Force to:

- Revise the airlift simulation model program to reflect a peacetime to wartime transition and achievable aircraft utilization rates which do not exceed those established by the Secretary of Defense.
- Reassess the established flying hour limits for aircrews to determine the feasibility of increasing them, especially the 125-hour/30-day limit.
- Include attrition rates for strategic airlift aircraft and assess the impact such attrition would have on the number of aircrews required.
- Evaluate the feasibility of establishing different aircrew ratios for each crew position based upon differing fatigue rates for the various positions. Also, crew rest while inflight on long flights should be considered.
- Reassess the need for airlift crews to perform staff duties during wartime to the detriment of flying operations.
- Recognize, in aircrew requirements estimates, that all crews will not be fully qualified and available at any point in time.

--Include ground times at home stations
in estimating the hours planes are
available for flying.

AGENCY COMMENTS

The Department of Defense (DOD) said that the Air Force had initiated a study involving strategic airlift model changes which incorporated many of GAO's recommendations.

DOD disagreed with GAO's recommendation that aircraft attrition should be considered since such estimates depend on scenarios and may range from near zero to a substantial number. The Air Force's simulation is based on a European scenario in which there could be high attrition, but other scenarios could have lower attrition. DOD said it must have sufficient aircrews to fulfill worldwide demands.

DOD considers the European scenario the most demanding, and the Air Force's simulation used to estimate aircrew requirements is therefore based on the higher plane use required there. GAO believes the aircrew ratio must be reduced to reflect expected attrition in the European scenario, or the ratio will not only be overstated there, but it will also be overstated for other scenarios where there are expected lower plane utilization rates.

DOD also disagreed with GAO's recommendation concerning the establishment of different crew ratios for each crew position. GAO believes that, since significant costs are involved and Air Force studies indicate the feasibility of having different ratios, the matter warrants further consideration.

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ABBREVIATIONS

GAO	General Accounting Office
MAC	Military Airlift Command

CHAPTER 1

INTRODUCTION

The Air Force invests millions of dollars annually to train and support aircrews to fly its strategic airlift aircraft, the C-5 and the C-141. The Air Force's Military Airlift Command (MAC) performs strategic airlift tasks which include deployment/redeployment of combat forces, air logistics support, aeromedical evacuation, and augmentation of theater airlift. The primary mission of strategic airlift is to support and participate in combat operations. Fundamental to the accomplishment of the wartime mission is an airlift posture which is capable of deploying large segments of the Armed Forces. In peacetime, emphasis is placed on achieving a readiness to respond quickly to the wartime mission. Training is oriented to ensure both an adequate base for wartime expansion and proficiency in operational procedures.

STRATEGIC AIRLIFT AIRCRAFT CREW RATIOS

The aircrews for the C-5 and C-141 aircraft are similar, with the exception of the number of loadmasters required. The crews for both aircraft consist of one pilot (aircraft commander), one copilot, one navigator, and two flight engineers. The only difference is that the C-5 has two loadmasters, while the C-141 has one.

The Air Force has stated that it requires four crews for each C-5 and C-141 aircraft, taking into account the aircraft utilization requirements established by the Secretary of Defense and other factors. The aircrew ratio authorizations consist of a 2 to 1 crew ratio for active duty personnel and the remainder for associate reserve crews. Because of the Air Force's decision to limit the flying hours of the C-5 fleet, only 3.25 aircrews for each C-5 are presently authorized. The aircrew ratio is scheduled to be incrementally increased during fiscal years 1981 to 1983 until it attains the 4 to 1 target ratio.

For fiscal years 1974 through 1978, the authorized aircrew ratio for the C-5 fleet remained at 3.25:1, while the ratio for the C-141s progressively increased from 3.25:1 to 4:1.

Crews are expensive

The costs associated with supporting airlift aircrews are substantial. The table below shows the annual amounts (exclusive of investment costs) necessary to maintain one strategic airlift aircrew.

<u>Aircraft</u>	<u>Active duty crew</u>	<u>Air Force reserve crew</u>
C-5:		
Average annual salaries	\$128,266	\$ 31,944
Operating costs (note a)	<u>761,310</u>	<u>687,486</u>
Total	<u>\$889,576</u>	<u>\$719,430</u>
C-141:		
Average annual salaries	\$104,334	\$ 29,154
Operating costs (note b)	<u>278,922</u>	<u>198,772</u>
Total	<u>\$383,256</u>	<u>\$227,926</u>

a/These costs include fuel, depot maintenance, spares, and maintenance labor (based upon 165 flying hours per year for active crews and 149 hours for reserve crews to maintain proficiency x \$4,614 per hour fiscal year 1978 operating costs).

b/These costs include fuel, depot maintenance, spares, and maintenance labor (based upon 174 flying hours per year for active crews and 124 hours for reserve crews to maintain proficiency x \$1,603 per hour fiscal year 1978 operating costs).

CONGRESSIONAL INTEREST

The Subcommittee on Defense, Senate Committee on Appropriations, in its continuing interest in matters pertaining to the strategic airlift requirements of the Department of Defense, asked us to review the Air Force's process

for determining aircrew ratio requirements of strategic airlift aircraft. The Committee acknowledges the need for maintaining the strategic airlift forces at an adequate level of capability and readiness, but it also recognizes that the cost of having crew ratios higher than necessary is prohibitive. The number of crews to be trained is a major factor used to justify flying hours, which in turn largely determines the amount of fuel, aircraft spares, supporting equipment, and maintenance personnel required to support the training effort. With respect to aircrew requirements, the Committee is particularly interested in the factors and constraints that are considered in determining the crew ratios, such as wartime aircraft utilization rates, attrition rates, ground times, flying hour limits, and use of total pilot resources.

SCOPE OF REVIEW

During our review, we evaluated the processes the Air Force used to determine the crew ratio requirements for strategic airlift aircraft under wartime conditions.

We reviewed applicable regulations, procedures, and practices pertaining to the determination of aircrew ratio requirements. We also reviewed various documents and reports relating to the human factors involved in flying hour limitations and crew rest requirements. Also, since a computer simulation model developed by the Air Force plays an important part in studying aircrew workload, we reviewed the various factors and constraints which were incorporated into the model.

The principal locations we visited were:

- Air Force Headquarters, Washington, D.C.
- MAC Headquarters, Scott Air Force Base, Illinois.
- Air Force School of Aerospace Medicine, Brooks Air Force Base, Texas.

CHAPTER 2

FACTORS AFFECTING NUMBER OF AIRCREWS REQUIRED

The process of determining the number of crews necessary for each strategic airlift aircraft under wartime conditions is complex and requires careful and frequent analysis. Human and aircraft limitations, as well as Air Force policies, affect the number of aircrews required. For example, the number of hours per day that airlift aircraft must fly is a key factor affecting the number of aircrews. Generally, as aircraft use increases, so does the need for aircrews.

In determining aircrew ratio requirements, the Air Force must consider the aircraft utilization rates, which were established by the Secretary of Defense and reported to the Congress in 1974. According to Air Force mobilization plans, the entire operational fleet of C-5 and C-141 aircraft should surge to an average of 12.5 flying hours per day per aircraft for the first 45 days of an emergency, and then sustain a 10-hour a day wartime rate after 45 days.

FACTORS RELATING TO AIRCRAFT

Numerous factors affect the ability of aircraft to fly at specified utilization rates. If, because of these factors, the aircraft cannot meet targeted utilization rates, the aircrews required could be reduced.

Aircraft ground times

Aircraft ground times occur when planes are down for maintenance, refueling, or the onloading and offloading of cargo. Generally, increases in ground times reduce the hours available for flying and the aircraft utilization rates.

Aircraft attrition

Aircraft attrition in wartime reduces the number of aircraft available to perform the airlift mission. Unless the attrited aircraft are replaced or greater use is attained by the remaining aircraft, the need for aircrews will be reduced as aircraft are lost or destroyed. Although it is difficult to predict the attrition rates for airlift aircraft, this factor must be evaluated to realistically estimate aircrew needs.

FACTORS RELATING TO CREWMEMBERS

In analyzing airlift operations for the purpose of establishing aircrew ratios, serious consideration must be given to the biomedical aspects of the rules and conditions under which MAC aircrewmembers fly airlift missions. The number of hours aircrewmembers can fly, from a biomedical standpoint, has a significant effect on the number of aircrews required. Consideration must also be given to such matters as crew staging policy and crew qualifications in establishing aircrew ratios.

Monthly and quarterly flying hour limits

To assure that crewmembers do not experience biomedical problems, MAC has limited the number of hours aircrews can fly within a given time frame. The maximum flying times for crewmembers are 125 hours within 30 days and 330 hours within 90 days. These limitations are crucial in determining the number of aircrews needed to meet expected utilization rates.

Length of crew duty day

The present crew duty day for strategic airlift aircrews is limited to 16 hours. This limit, we were told, considers operational needs, system and logistics characteristics, safety, and compassion.

Crew rest

MAC regulations are very precise in defining rest for crews under various conditions. These regulations specify predeparture rest periods for crewmembers at home stations and at enroute points. The regulations also prescribe rest after completion of missions.

Crewmembers returning to a home station, after being absent in travel status, are given sufficient time to rest and recover from the cumulative fatigue effects of the mission. Post-mission crew rest begins immediately upon return and will not be infringed upon in any manner. Crewmembers are not required to obtain immunizations, engage in ground training, perform squadron duties, monitor the telephone, or participate in any other activity which will encroach upon their crew rest. Crewmembers must complete their post-mission crew rest before they begin another mission.

Crew staging

In operating a strategic airlift fleet, crews are prepositioned at stage points according to Air Force policy. The size of staging crew pools influences the number of aircrews needed to operate the entire strategic airlift fleet.

Crew qualifications

Another important consideration in determining aircrew requirements is whether fully qualified crews (those checked out to fly in a contingency) are onboard and available for flying duties. Historically, between 85 and 90 percent of assigned crews have been fully qualified and onboard.

SUMMARY

All the factors presented affect the aircrew ratio requirements for airlift aircraft. We were told that some factors, such as the aircraft utilization rates and the crew flying hour limits, affect the ratio significantly, while other factors have little impact.

CHAPTER 3

QUESTIONABLE CREW RATIO

ESTABLISHED BY THE AIR FORCE

The Air Force uses a computer model to simulate the airlift system, and results of the simulation are reviewed by several levels within Air Force Headquarters. We believe the use of a simulation model to estimate the airlift aircrew ratio is a rational approach. However, a number of assumptions the Air Force uses in the model regarding aircraft and aircrew use and availability are unrealistic, and some key factors have been omitted from consideration entirely. Use of these unrealistic assumptions and omissions of important elements in determining aircrew requirements tends to overstate the aircrew ratio.

PROCESS FOR ESTIMATING RATIO

The Air Force School of Aerospace Medicine has developed a computer model which simulates the major operations of a typical MAC transport squadron and applies the results to the entire fleet. Given the resources (number of planes and crews), the workload (number and routes of missions), and the rules under which to operate (various regulations), the computer simulates the missions, selects the crews and planes, and flies the missions, inserting random fluctuations to represent delays and weather conditions. During the simulation, the computer tracks how the system is performing by acquiring operational data such as cancellations, flying time on each leg, and delays, which can be assembled later into such statistics as time away from home and time spent on duty. Thus, the computer evaluates how various management policies affect total system performance.

The Air Force has evaluated the model for accuracy, and it considers the data the simulation produces to be as close to the real-time operation of the strategic airlift system as possible. For the latest Air Force simulation runs, the model assumed a North Atlantic Treaty Organization scenario wherein the Air Force must be able to defend Europe against the Warsaw Pact nations. The Air Force considers this scenario to be a representative indicator because it is the most demanding.

Periodically, new and current operational data, updated workhours, revised aircrew wartime staging plans, aircraft maintenance policy, and other Air Force Headquarters directed criteria are loaded into the computer model.

Air Force officials said the simulation model is a management tool which assists in arriving at a decision on what the aircrew ratio should be for the strategic airlift fleet and does not give the final, or precise, ratio. They stated a great deal of reliance is placed upon the judgments and experiences of senior Air Force officers who review the aircrew determination studies and decisions. We were told the reviews are performed by the Airlift Panel, Priority Review Committee, Air Staff Board, and Air Force Council. Air Force officials, however, were unable to provide any documentation supporting the results of the reviews by these levels.

Computer simulation needs refinement

The Air Force's model, while of considerable value for establishing aircrew ratios, needs to be refined because it requires aircrews to fly aircraft at higher utilization rates for a much longer period than established by the Secretary of Defense. Therefore, the number of aircrews required is overstated because aircrews reach their flying hour limits sooner than they should. In addition, the model does not have a transitional period which considers the mobilization of Air Force reserves and all the other factors and events which are scheduled to occur during the change from a peacetime to wartime environment. This transitional period is necessary to more accurately simulate conditions that would be likely to exist.

The planned airlift aircraft utilization rates under wartime conditions are 12.5 hours per day per aircraft for 45 days and 10 hours per day per aircraft thereafter. These surge and sustained rates were established by the Secretary of Defense. We found that these rates were not adhered to in the current Air Force airlift simulation model. In the May 1978 runs, which were the latest available during our review, the Air Force used a constant surge rate of 12.5 hours per day throughout the 180-day program operational period 1/ even though, we were told, the model could be run at surge and sustained rates. As a result of using a constant aircraft surge rate for the 180-day period rather

1/In a 180-day simulation run, the Air Force considers the first 45 days are used for positioning aircraft and personnel throughout the airlift system. The model is run for 135 days to achieve statistical reliability.

than using a surge and sustained rate, the Air Force overstated flying time by about 15 percent. By overstating flying time for the aircraft, the Air Force overstated aircrew needs because it has limited the number of hours aircrews are authorized to fly within given time frames.

By maintaining a constant surge utilization rate, aircrews accumulate more flying hours during mobilization than the Secretary of Defense established. This has the effect of bringing aircrews up to their monthly and quarterly flying hour limits much sooner than necessary and increases the need for aircrews. We were unable to specifically determine the total effect constant surge utilization flying had on the number of aircrews required since the Air Force's simulation runs did not reflect the utilization rates imposed by the Secretary of Defense.

In addition to simulating flying at a constant mobilization utilization rate, the model presently does not properly reflect the conditions that are expected to exist during the period from the time mobilization commences to when it is fully accomplished. Mobilization of the strategic airlift fleet will not be accomplished overnight. Reserve forces must be assembled and positioned, and all the other considerations that go into the conversion from a peacetime to wartime posture must be met.

The peacetime daily utilization rates for the C-5 and C-141 aircraft averaged 1.8 and 3.3 hours, respectively, during fiscal year 1978. Before the programmed daily utilization rate of 12.5 hours is attained, a gradual transition from a peacetime to wartime posture must be accomplished. Air Force computer programmers advised us that this transitional period could be incorporated into the present model but that it would require significant program alterations.

In commenting on a draft of this report, the Assistant Secretary of Defense (Comptroller) stated that the Air Force simulated a 180-day operation in order to obtain statistical reliability and not for the purpose of determining the number of aircrews required. Irrespective of the stated intent of the 180-day run at surge utilization rates, the net result was that aircrews were subjected to a constant surge utilization rate of 12.5 hours daily for a longer period than the Secretary of Defense specified. This caused aircrews to reach the 125-flying hour limit sooner than expected. Also, Air Force officials advised us that the model definitely was used for the purpose of estimating aircrew requirements.

CREW FLYING HOUR LIMITS
ARE TOO INFLEXIBLE

The 30-day and 90-day flying limits of 125 and 330 hours have a profound impact upon aircraft utilization rates. The latest simulation runs available during our review showed that, with a programmed 4 to 1 crew ratio and the flying hour limits in force, the average daily utilization rate achieved over a 135-day period was 11.87 hours.

The Air Force also ran the above simulations without imposing aircrew flying hour limits, using programmed 3.5 to 1 and 3 to 1 crew ratios. Average daily utilization rates of 11.86 and 11.89, respectively, were attained. These results were essentially the same as those attained using a 4 to 1 ratio with flying hour limits.

In both instances, with and without flying hour limits, the failure to achieve the programmed utilization rate of 12.5 hours was not due to mission cancellations attributable to aircrew shortages. Air Force simulation programmers advised that aircraft were not available in the right place at the right time, principally because of normal airlift system ground-time delays, and this caused the daily utilization rate to be less than 12.5.

In its simulation runs, the Air Force used a constant 12.5 hour daily utilization rate which was higher than the surge and sustained rates the Secretary of Defense established. The Secretary's prescribed surge and sustained rates equate to only 45 days at 12.5 hours per day (surge) and 90 days at 10 hours per day (sustained), for an average of 10.83 hours per day.

The highest demand period for the strategic airlift forces is relatively short--estimated by the Secretary of Defense to be only 45 days. An analysis of the simulation runs, in which only the first 45 days of mobilization or war was considered and with no flying hour limits imposed upon aircrews, showed the following results.

<u>Programed crew ratios per squadron</u>	<u>Average flying hours attained in 30 days</u>			<u>Average daily utilization rate</u>
	<u>Under 125</u>	<u>125-149</u>	<u>150</u>	
	<u>Number of aircrews</u>			
3.0 (48 crews)	36	11	1	11.88
3.5 (56 crews)	56	-	-	11.84

During the MAC Mid-East Resupply Operation (Yom Kippur War, October through November 1973), the Air Force waived the 125-hour/30-day limit and increased the limit to 150 hours. The Air Force's School of Aerospace Medicine evaluated this operation and noted that (1) many of the crewmembers reached the 150-hour limit and were precluded from further flying before the 30-day time limit had expired and (2) the usual problems and normal mild stresses were encountered.

The 125-hour and 330-hour limits were established more than 20 years ago. Although there is no biomedical evidence to support the specific Air Force flying hour limits, medical personnel at the School of Aerospace Medicine firmly believe that sufficient data exist to support the fact that repeated cycles of flying and rest lead to cumulative effects of body fatigue and stress. They believe 330 hours within 90 days is the upper limit which aircrews can fly under every condition, except for the most extreme emergency. They also believe, however, that aircrews can be worked hard up to 45 days, at rates exceeding 125 hours per 30 days, with little or no concern for the dangers associated with flying under fatigue or stress. After 45 days, however, they state the cumulative effects of fatigue begin to progressively worsen and become a factor as to whether or not flying should be permitted.

The results of the Air Force's simulation runs indicate that increasing the 30-day flying hour limit to 150 hours during the 45-day surge period would permit lowering the crew ratio to 3 to 1 with little risk that any individual crew would exceed 150 hours. Reducing the crew ratio from 3.25:1 to 3:1 for the C-5 and from 4:1 to 3:1 for the C-141 would lower the Air Force's annual funding requirement. We estimate annual reductions of about \$105 million for the strategic airlift operational fleet would result if active duty personnel were reduced, and \$66 million if reserve crews were reduced. (See app. I.)

The Assistant Secretary of Defense (Comptroller) stated the 1973 Israeli airlift was a short, limited activity and was not comparable with a fully-mobilized situation. However, we believe the two to be analogous from the standpoint that both situations relate to only a relatively short period of high demand.

ESTABLISHING THE SAME CREW
RATIOS FOR ALL CREW POSITIONS
MAY NOT BE WARRANTED

Current Air Force limitations on flying hours apply to all crewmembers. However, Air Force studies on strategic airlift aircrewmembers indicate that the extent of fatigue varies between crew positions. Therefore, maintaining the same crew ratio for all crew positions may not be necessary or justified.

In the late 1960s and early 1970s, the School of Aerospace Medicine issued several reports on the physiological and psychological stress effects on aircrewmembers during operational exercises. These exercises were designed to determine the biomedical effects of assigning two crews (double crew) to a jet transport and flying a mission without staging through MAC's logistics delivery system.

A report on physiological stress effects concluded that there was evidence of a differential effect of flight by crew position. This report stated:

"The Aircraft Commanders and Flight Engineers evidently reacted similarly to flight, as did the Co-pilots and Navigators; and the intensity of the flight responses of these different groups differed slightly. The Loadmasters, however, showed little response to flight * * * Recovery rates also appear to vary with crew position."
[Underscoring supplied.]

A report on the psychological stress effects stated that a highly significant difference in fatigue ratings was found for crew positions. The School concluded that the greatest effect of fatigue was found in aircraft commanders and navigators and the least was found in loadmasters.

The Study Director for these projects said that, from a medical point of view, dissimilar crew ratios for different crew positions would be feasible. However, he would not recommend separate flying hour limitations for different crew positions for morale reasons. He said that in times of emergency, the flying hour limitations could be waived sooner and more frequently for crewmember positions where fatigue is less of a problem and less critical.

The Assistant Secretary of Defense (Comptroller) stated that the Air Force had not taken action to assign different

aircrew ratios for each crew position because it felt that each aircrew might have to accomplish a variety of missions in order to meet the demands of a fast moving conflict. The Air Force believed the same aircrew ratio should be maintained for all crew positions in order to provide this necessary mission flexibility.

We believe that since significant costs are involved and Air Force studies indicate the feasibility of having different ratios, the matter warrants further consideration.

Potential for onboard crew rest

In setting flying hour limitations for crewmembers and studying the differences in fatigue and stress on the various crew positions for C-5 and C-141 aircraft, the Air Force should also consider the potential for getting more flying hours from each crew position by planning for onboard crew rest, particularly on long flights.

Under current policy, crewmembers must rest a prescribed number of hours between flights, thereby decreasing their availability and increasing the number of crews required. Since rest facilities are onboard both the C-5 and C-141 aircraft, crewmembers can obtain at least part of the prescribed rest during flight and be available sooner for follow-on flights. While Air Force medical officials have indicated to us that onboard crew rest is not as effective as rest in ground quarters, we believe further study is needed to see if in-flight rest can partially offset onground rest.

GROUND TIMES AT HOME STATION FOR SCHEDULED MAINTENANCE OMITTED

Ordinarily, the airlift simulation model provides for ground times at home stations (used principally to perform aircraft maintenance). However, this factor was omitted from the latest Air Force simulation runs. This omission may have inflated crew ratio requirements since generally increases in ground times reduce the hours available for flying.

Assuming that MAC aircraft are fully ready for war, MAC estimates that during mobilization or war the C-5 and C-141 will require about 6.8 and 3.5 hours, respectively, at home stations for each round trip from the United States to central Europe. Based on the number of round trips per aircraft required to meet the surge and sustained utilization rates, both aircraft will require hundreds of

hours at home stations for maintenance during the first 3 months of mobilization and war.

As ground times increase, use of aircraft and crews generally decrease. Therefore, by omitting ground times at home stations for maintenance in the computer simulations, the Air Force may have developed unrealistically high aircrew requirements.

AIRCREW RATIOS BEING DETERMINED USING
QUESTIONABLE UTILIZATION RATES

One primary factor used in establishing current and projected aircrew requirements was the assumption that the C-5 and C-141 aircraft could, as required by the Secretary of Defense guidance, surge to 12.5 hours per day per aircraft for 45 days and maintain a sustained rate of 10 hours per day per aircraft thereafter. If these aircraft are unable to attain and maintain these rates because of maintenance problems, delays in onloading and offloading, and aircraft attrition, the number of aircrews the Air Force says is needed is overstated.

We previously reviewed the ability of the C-5 and C-141 aircraft to attain the Secretary of Defense's established surge and sustained utilization rates. We raised serious doubts concerning MAC's ability to fly the C-5, particularly at these high rates because of maintenance, ground delays, and attrition problems. 1/

We were advised that the flying hours on C-5s had been significantly reduced in peacetime because of the high C-5 operating costs, the need to conserve highly valuable planes, and the Air Force's desire to have these flying hours coincide with its wing modification program. The Air Force plans to modify the wings of the C-5 to extend the aircraft's service life. The modification program is scheduled to begin in 1982.

The Air Force is planning for both the C-5 and C-141 aircraft to undergo major modifications during the 1978-87 time frame. Individual C-5s are expected to attain 8,000 hours of service, the maximum hours considered to be within

1/"Determining Requirements for War Reserve Spares and Repair Parts--Importance of the Wartime Planning Process' (LCD-78-407, June 6, 1978).

safety limits, at the time they are scheduled for modification. The C-141 aircraft will be stretched and an air refueling capability will be added.

Air Force plans specify that a maximum of 12 C-5s and 30 C-141s will be modified and unavailable for wartime use at any one time. The Air Force estimates, however, that about 5 C-5s and 10 C-141s could be recovered from the modification lines if necessary.

AIRCRAFT ATTRITION NOT BEING
CONSIDERED

The Air Force did not consider the effects of aircraft attrition on aircrew ratio requirements in its computer simulation model. We believe consideration of attrition is important to ensure that the minimum number of aircrews is trained and maintained. For each plane lost during wartime, at least three and possibly four crews become available for flying other aircraft. Thus, in determining the maximum crew ratio needed, attention must be directed to the early stages of conflict rather than sustained operations.

MAC officials informed us that they presently do not have usable attrition factors for the C-5 and C-141 aircraft, but that the Air Force is currently reexamining its position on strategic airlift attrition. However, estimated attrition rates for the strategic airlift aircraft do exist. The Joint Chiefs of Staff uses airlift aircraft attrition rates in its strategic mobility studies. Whether these rates are valid or reliable was not our direct concern in this review. The important consideration in determining aircrew ratio requirements is that whatever attrition of strategic airlift aircraft is experienced, the effect will be that the three remaining aircrews from each attrited aircraft will be available to operate a reduced strategic airlift fleet.

MAC officials contend that as aircraft are attrited, the remaining aircraft will be expected to fly a higher daily utilization rate to make up for those lost, and some lost aircraft may be replaced by non-engaged aircraft. According to these officials, the Secretary of Defense requires MAC to fly a total block of hours within a given period of time. If planes are lost, the remaining fleet must absorb the slack. MAC officials contend the loss of aircraft and crews will result in an additional demand for aircrews. The crews allotted to the lost planes will be used in manning the remaining fleet.

The Air Force's plan to have the remaining fleet absorb the additional load appears to be lacking substantive support. We believe it would be difficult, if not impossible, to increase the utilization rates on the remaining aircraft to make up for those lost, and the number of non-engaged aircraft which could be used to replace the lost aircraft would be limited. As previously mentioned, there is considerable doubt that C-5s could even attain their presently established wartime utilization rates. (See p. 14.)

The Assistant Secretary of Defense (Comptroller) disagreed with us that aircraft attrition should be considered since such estimates are highly scenario dependent and may range from near zero to a substantial number. The Air Force's simulation is based on a European scenario in which there could be high attrition but other scenarios could have lower attrition. The Assistant Secretary said the Air Force must have sufficient aircrews to fulfill worldwide demands.

The Department of Defense considers the European scenario the most demanding, and the Air Force's simulation used to estimate aircrew requirements is, therefore, based on the higher plane use required there. We believe the aircrew ratio must be reduced to reflect expected attrition in the European scenario, or the ratio will not only be overstated there, but it will also be overstated for other scenarios where there are expected lower plane utilization rates.

FULL CREW COMPLEMENTS NOT
ALWAYS AVAILABLE FOR FLYING DUTIES

An important consideration in determining the number of aircrews required is whether fully qualified crews are onboard and available for flying duties. MAC officials advised us that 100 percent of fully qualified crews are rarely onboard at one time. A recent study by MAC of the C-141 fleet complements showed that an average of 90.7 percent of the assigned crews were fully qualified and onboard, based on the highest single monthly figure for the 18 months preceding the study. Historically, we were advised that the average rate was between 85 and 90 percent.

Crewmen are not fully qualified because they are

--undergoing training;

--assigned, but have not reported for duty;

--undergoing undergraduate training and awaiting re-assignment;

--attending graduate school; and

--injured, ill, or incapacitated in some way.

We were advised, if mobilization or war begins, that many of the above crewmembers could be recovered, but not all. Our review disclosed that the Air Force's simulation model assumed that all aircrews were fully qualified. As a result of this assumption, crew ratio requirements may be understated.

QUALIFIED AIRCREWMEMBERS
ASSIGNED TO STAFF DUTIES

The Air Force, in its computer simulation runs of May 1978, included a process of removing one aircrew from each squadron (16 aircraft) every 7 days for a week's time to perform staff duties. Therefore, at any one time, one aircrew was not available to perform its primary duty of flying. This practice contributed to a slightly increased crew ratio requirement since the remaining crews were required to fly those hours which would have been flown normally by the crew performing staff duties.

According to a MAC official, during peacetime aircrewmembers are periodically assigned air wing staff duties which generally involve training or planning for varying periods of time. However, these duties are management-type functions which would not be performed by line officers during war.

STAFF AND SUPERVISORY
PERSONNEL NOT CONSIDERED
FOR WARTIME FLYING DUTY

We previously reported (LCD-79-401, Mar. 27, 1979) that the Air Force did not consider staff and supervisory airlift pilots who maintain full combat readiness flying proficiency as resources to meet aircrew needs. We also stated that consideration of these pilots would allow a reduction in the number of aircrews, or a lower crew ratio, that must be trained and maintained to meet airlift aircrew requirements. We recommended that the Secretary of the Air Force adjust strategic airlift aircrew ratios to levels which take into account fully combat ready staff and supervisory pilots to the extent possible.

We noted in that report that 233 staff and supervisory pilots maintained currency in the C-141 aircraft. While not cited in the report, over 50 staff and supervisory pilots also maintained currency in the C-5 aircraft. The

staff and supervisory pilots in question included wing, squadron, and vice commanders, operations officers, plans officers, and a number of other positions.

As stated earlier, crew ratio requirements are expected to decrease after a period of emergency surge conditions. Many jobs performed by supervisory and staff pilots, such as simulator officers, would probably need not be done, or could be done by other personnel during the short surge period, making many of these pilots available for line duty until the situation stabilizes.

In commenting on our March 1979 report, the Air Force did not address the use of supervisory and staff pilots for strategic airlift aircraft, but did point out that staff and supervisory pilots assigned to tactical fighter wings are considered in wartime surge and sustained aircrew requirements. We do not understand why strategic airlift pilots are not also considered in fulfilling airlift aircrew requirements.

CONCLUSIONS

We recognize that maintaining the strategic airlift forces at an adequate level of capability and readiness is of paramount importance. However, maintaining aircrew ratios higher than necessary is extremely costly and not justifiable.

We believe that the use of computer simulations by the Air Force to determine aircrew ratios is a valid and sound approach. The process of matching aircraft, aircrews, materiel and personnel to be transported, flight routes, and staging areas is complicated and can be best studied by simulation runs. However, in order to realistically determine the number of aircrews needed, the simulation model must be programed as close as possible to expected actual conditions. We do not feel the current model meets this criterion.

We also believe that the Air Force has made erroneous assumptions in determining the airlift aircrew ratios and has not adequately evaluated all the principal factors affecting crew ratio determination. The Air Force must give more consideration to the (1) impact of problems inherent in attaining prescribed use rates, (2) potential aircraft attrition rates, (3) current flying hour limits on aircrews, and (4) aircrews' expected availability and qualifications.

The net effect of any changes to the crew ratio requirement cannot be precisely determined until the Air Force makes appropriate adjustments to its simulation model because of the interplay of various factors upon each other. However, we believe that the erroneous assumptions and the omission of key factors in the model generally tend to overstate aircrew requirements.

RECOMMENDATIONS

In order to improve the process of determining strategic airlift aircrew requirements and achieve more valid ratios, we recommend that the Secretary of Defense require the Secretary of the Air Force to:

- Revise the operational mode of the airlift simulation model to reflect a peacetime to wartime transition and to ensure that achievable working aircraft utilization rates do not exceed those established by the Secretary of Defense.
- Reassess the established flying hour limits for aircrews to determine the feasibility of increasing them, especially the 125-hour/30-day limit.
- Include ground times at home stations in estimating the hours planes are available for flying.
- Evaluate the feasibility of establishing different aircrew ratios for each crew position based upon differing fatigue rates for the various positions. Also, consideration of crew rest while inflight on long trips should be included.
- Develop attrition rates for strategic airlift aircraft and assess the impact such attrition would have on the number of aircrews required.
- Reassess the need for airlift crews to perform staff duties during wartime to the detriment of flying operations.
- Recognize, in aircrew requirements estimates, that all crews will not be fully qualified and available at any point in time.

AGENCY COMMENTS

The Assistant Secretary of Defense (Comptroller), in commenting on a draft of this report, stated that the Air Force had initiated a study involving strategic airlift

model changes which incorporated many of our recommendations. He stated that the results of the study would provide either data to support the current aircrew rates or justification for making adjustments to the future program. If the results of the study combined with experienced judgment indicate a lesser number of crews can adequately meet wartime requirements, then the Department of Defense will modify its program accordingly.

The Assistant Secretary pointed out the reasons why the Air Force had not considered attrition in its simulations and why the Air Force had not taken action on the use of different ratios for each crew position. Further, the Assistant Secretary pointed out some discussion in our report which he felt was misleading and could result in the readers of our report drawing erroneous conclusions. Our evaluation of the Assistant Secretary's comments is included in the body of the report in the applicable report sections.

The Assistant Secretary also felt that the report title was not supported by the contents of the report. We disagree. As discussed in the body of the report, simulating surge conditions longer than required, unduly restricting flying hours, ignoring attrition rates, having crews perform staff duties during wartime, and leaving out ground times in estimating plane availability all tend to overstate computed requirements. We, therefore, believe that the crew ratios authorized for the C-5 and C-141 can be reduced.

PROJECTED REDUCTION OF ANNUAL
AIR FORCE COSTS IF AIRCREW RATIOS
FOR THE STRATEGIC AIRLIFT FLEET WERE REDUCED

<u>Aircraft</u>	<u>Assumed crew ratio reduction</u>		<u>Number of crews reduced per aircraft</u> (a)	<u>Number of operational aircraft</u> (b)	<u>Annual costs to maintain one aircrew (note a)</u>		<u>Total annual reduction of aircrew costs for the entire operational airlift fleet</u>	
	<u>From</u>	<u>To</u>			<u>Active</u>	<u>Reserve</u>	<u>Active</u>	<u>Reserve</u>
					(c)	(d)	(a)x(b)x(c)	(a)x(b)x(d)
C-5	3 25 1	3 0 1	0 25	70	\$889,576	\$719,430	15,567,580	\$12,590,025
C-141	4 0 1	3 0 1	1 00	234	383,256	227,926	<u>89,681,904</u>	<u>53,334,684</u>
Total							<u>\$105,249,484</u>	<u>\$65,924,709</u>

a/Does not include costs associated with the acquisition of the aircraft and supporting facilities



COMPTROLLER

ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D C 20301

15 MAY 1979

Mr R W Gutmann
Director, Logistics and
Communications Division
General Accounting Office
Washington, D C 20548

Dear Mr Gutmann

This is in reply to your letter of March 28, 1979 to the Secretary of Defense regarding your draft report on, "The Air Force's Strategic Airlift Aircrew Requirements Can be Reduced" LCD 79-411 (OSD Case #5128) We appreciate your concern in this area and welcome the opportunity to comment on your report before it is transmitted to the Congress

As your report shows, determination of the wartime strategic airlift aircrew requirements for our C-5 and C-141 forces is not an easy task. Short of a fully-mobilized deployment, either real or as an exercise, we cannot predict with complete assurance that our program includes the necessary resources to meet our wartime flying hour utilization rate objective. Although computer simulations provide a useful tool for quantifying these resource requirements, the results are only approximations of the real world constrained by the data used and the number of variables considered. For this reason simulation results are just one of the inputs to the decision-making process. These data must be combined with experience and judgmental factors before a final decision is made.

Last summer the Air Force initiated an effort to reexamine the strategic airlift aircrew requirements. This study has involved considerable model changes as well as an examination of the sensitivity of results to the various parameters that the model considers. Parameters being examined include crew rest policies, availability of crews, and home station ground times. This on-going effort for the most part incorporates the recommendations from your draft report. The results of this effort will provide either data to support the current aircrew rates or justification for making adjustments to the future program.

The Air Force is not considering attrition in its simulations because such estimates are highly scenario dependent, and may range from near zero to a substantial number. The simulation addressed in the study was based on a European scenario in which we could suffer high attrition.

Other scenarios could have lower attrition. Since we must have adequate airlift capability to fulfill all worldwide strategic mobility demands, sufficient aircrews for the existing airlift fleet must be maintained 1/

The other recommendation that the Air Force has not taken action on is the feasibility of different aircrew ratios for each crew position. Its argument is that each aircrew may have to accomplish a variety of missions in order to meet the demands of a fast-moving conflict, therefore, the same aircrew ratio should be maintained for all crew positions in order to provide this necessary mission flexibility 2/

There is some discussion within the report that is misleading and could result in the reader drawing erroneous conclusions. The major areas of concern are identified below:

1. The title of the report is a statement not supported by the content of the report 3/

2. Based on the most current analyses, the Air Force is confident that the airlift aircraft can meet the programmed wartime utilization rates given sufficient crews, spares and maintenance manning.

3. Prior to a fully-mobilized deployment, there would be some warning time to increase the readiness and availability of airlift aircraft, therefore it is possible that most or all the UE aircraft would be available on M-day.

4. Simulating a 180-day operation was done in order to reduce the statistical variation and not for determining the number of aircrews required 4/

5. The 1973 Israeli airlift was a short, limited activity and is not comparable with a fully-mobilized situation 5/

Until the results of the Air Force effort, which incorporates most of the GAO recommendations, is completed, it is premature to make any program changes in our strategic airlift aircrew manning. If, however, these results combined with experienced judgment indicate that a lesser number of crews can adequately meet our wartime requirement then we will modify our program accordingly.

Sincerely,



Fred P. Wacker
Assistant Secretary of Defense

GAO note 1 See p 16 for GAO comments
 note 2 See pp 12 and 13 for GAO comments
 note 3 See p 20 for GAO comments
 note 4 See p 9 for GAO comments
 note 5 See p 11 for GAO comments

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