In the 1990s, the number of Air Force active-duty military personnel declined by 40 percent.\(^1\) During this period, the Air Force was deployed on a continual basis in Northeast and Southwest Asia. It was also deployed for peacekeeping in Bosnia and for evacuation operations and humanitarian assistance in Somalia, Bangladesh, Thailand, Cambodia, Rwanda, and Ethiopia.\(^2\) Many believe that this increased commitment, coupled with reduced resources, placed added stress on Air Force aircraft and personnel.

This belief may not apply to AMC for three reasons. First, the decline in AMC’s assets might not have been as large as the 40 percent drop in the number of personnel for the Air Force overall. The number of strategic airlifters in AMC (the C-5, C-141, and C-17) did decrease by 44 percent between 1981 and 1999 (see Figure 2.1).\(^3\) In many circumstances, however, airlift capacity is a better measure of overall capacity than number of airlifters. Because the newer C-17 has a larger capacity than the retiring C-141, for example, the strategic airlift capacity of AMC can be said to have dropped by only 24 percent to 35 percent, depending on whether Air Force capacity-planning factors or Gulf War experience\(^4\) is used to convert number of aircraft to airlift capacity.\(^5\) The number of

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\(^1\)This figure is based on a comparison of the number of personnel in 1999 with those in 1984.


\(^3\)These data appeared in annual issues of the *Command Data Book*, Scott Air Force Base, IL: Headquarters Air Mobility Command, Manpower and Innovation Flight.

\(^4\)The planning factors used by the Air Force based on Gulf War experience appeared in Jean Gehman, Lois Batchelder, and Katherine Poehlmann, *Finding the Right Mix of Military and Civil Airlift: Issues and Implications, Volume 2, Analysis*, MR-406/2-AF, Santa Monica: RAND, 1994, pp. 11 and 134. The airlift capacity for each type of aircraft in millions of ton-miles per day (MTM/D) is calculated by multiplying the following planning factors: speed (knots), utilization rate (hours per day), payload (tons per aircraft), productivity (miles with cargo versus miles without cargo), and number of aircraft.

\(^5\)See Figures A.1 and A.2 in the appendix. The Air Force has also entered into a follow-on agreement with Boeing for an additional 60 C-17’s, bringing the fleet’s total from 120 to 180. This addition is
The Peacetime Tempo of Air Mobility Operations

strategic airlift pilots declined by 25 percent between 1982 and 2000 (see Figure 2.2).

Second, peacetime operations for fighters and bombers differ from those for airlifters and tankers. Both are heavily involved in routine deliveries of personnel, supplies, and equipment to overseas bases even in the absence of small-scale contingencies. In the 1990s, however, the number of major U.S. military installations abroad declined by almost 75 percent\(^6\) and active-duty military personnel abroad decreased by 50 percent,\(^7\) significantly reducing the demand on airlifters and tankers for routine deliveries. Moreover, when contingency activities are high, AMC has the flexibility to hire commercial air carriers to share air mobility chores. In the opposite situation, when contingency activities are low, AMC can reduce commercial augmentation to retain flying hours for the training and aging of its pilots. In contrast, aside from some training

\(^6\)See Figure A.3 in the appendix.

\(^7\)See Figure A.4 in the appendix.
missions, the overall annual intensity of fighters and bombers depends on the frequency and level of contingency deployments. In the absence of special deployments, in other words, fighter and bomber units have fewer routine activities and do not have a commercial counterpart to help share their burden. Thus, the overall intensity of AMC peacetime operations can be less sensitive to special deployments and hence more stable through the years.

Third, although the total peacetime airlift operations in the 1990s seemed numerous and intensive, they should be compared to those during the 1980s to determine whether resources were truly more stressed.

This chapter addresses the question, Is AMC flying more or less? Although this question would appear to be straightforward, simple answers with plots of annual flying hours over time ignore how many aircraft and pilots are involved. Figure 2.3 shows three such curves for strategic airlifters (the C-5, C-141, and C-17), tactical airlifters (the C-130), and tankers (the KC-135 and KC-10), respectively. Thus, it would be better to pose the questions, Is AMC flying more per aircraft, and is AMC flying more per pilot? Even these questions, however, are too broad, as a C-141 would differ from its replacement, the C-17, both in capacity and in other characteristics. Also, an airlifter’s function is very different from that of a tanker. Yet an examination of flying hours per aircraft

Figure 2.2—The Number of Strategic Airlift Pilots Declined in the Mid-1990s
Annual flying hours


Annual flying hours

0 100,000 200,000 300,000 400,000 500,000 600,000

C-130
C-5/C-141/C-17
KC-135/KC-10

NOTE: The reasons for the missing 1980s data for the tankers and the mid-1990s data for C-130s will be given later in the chapter.

Figure 2.3—Annual Flying Hours for Airlifters and Tankers

for all aircraft types would not reveal the hours of a retiring aircraft decreasing or those of a newly deployed aircraft increasing. One must therefore refine the question as follows: Is AMC flying more per aircraft within a given aircraft type? Similarly, is AMC flying more per pilot within a given aircraft type?

We will use three measures to assess AMC flying: (1) the annual flying hours per aircraft of a given type during peacetime; (2) the monthly flying hours per CP of a given aircraft type during peacetime; and (3) the monthly flying hours per AC of a given aircraft type during peacetime. We have separated the data for CPs and ACs to reflect differences in flying requirements.

ANNUAL FLYING HOURS PER AIRCRAFT

The flying-hour data given herein are based on the annual spreadsheets of the Flying-Hour Program provided by Phil Widincamp, AMC/DOT. Figures 2.4 and 2.5 show the annual flying hours for AMC-owned C-5s and C-141s, respectively, from FY 1981 to FY 1999. Both figures show the highest number of flying hours in 1991, a period that includes the Gulf War. Although we show all data points
Is AMC Flying Less?

Figure 2.4—C-5 Annual Flying Hours

Figure 2.5—C-141 Annual Flying Hours
on these and subsequent graphs, we exclude the 1990 and 1991 data points in our determination of peacetime trend lines in subsequent graphs because our purpose is to examine peacetime, not wartime, OPTEMPO.

In 1994, a dip occurred in the total number of annual flying hours of C-5s, C-141s, and C-17s (see Figure 2.3). This raises the question of whether the 1994 data point should be included in the determination of peacetime trend lines. On May 14, 1993, after the Air Force Scientific Advisory Board reported that the weep-hole cracks in C-141 wings were more extensive than had previously been estimated, General Ronald Fogelman restricted all 260 C-141s in the active and reserve forces to a maximum payload of 55,000 pounds, or about 14,000 pounds below normal peacetime loads. On August 9, 1993, General Fogelman also grounded 45 C-141Bs and restricted another 116 from in-flight refueling. By November 30, 1994, the weep-hole repair had been completed on all C-141s. Because the C-141 wing crack was as rare an event as an MTW and resulted in a large drop in C-141 flying during 1994 (see Figure 2.5), we excluded the incident from our peacetime trend analysis. Thus, while the 1994 data point will continue to be shown in subsequent graphs, it is not included in the determination of trend lines. It should be noted that if the 1994 data point were included, the resulting trend lines would not change significantly. In sum, while all annual data points will be displayed in the graphs throughout this report, FYs 1990, 1991, and 1994 will be excluded in the determination of peacetime trend lines.

By contrast, we did include the Kosovo air war (which took place between March 24 and June 10, 1999) as part of peacetime operations because it did not involve any large-scale ground operations. Without a large airlift requirement for Army operations, the airlift intensity of the Kosovo conflict was far below

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8On August 2, 1990, Iraq invaded Kuwait, and on August 7 President Bush issued a deployment order sending U.S. forces, including airlifters and tankers, to the Persian Gulf. On January 17, 1991, allied forces began Operation Desert Storm, and Kuwait was liberated on February 26. The data points in Figure 2.4 were based on total flying hours on a fiscal-year basis. Because FY 1990 covers the period from October 1, 1989, to September 30, 1990, its data point includes flying hours during the initial two months of the buildup (August and September 1990).


10C-141 operational impacts were much smaller in FY 1993 and FY 1995 than in FY 1994. We can interpret the impacts on FY 1993 and FY 1995 as part of “normal” peacetime operations, so the data points for these two years need not be excluded in the determination of trend lines.

11For each of the figures and tables in this report showing trend lines, averages, or rates of change, there will be a note indicating which years’ data points were excluded from the determination. We adopt the convention that if the data points for FYs 1990, 1991, and/or 1994 were not available in the first place, we do not mention that they are excluded, because nothing to exclude. In Figure 4.1, for example, data made available to us include those for FY 1990 and FY 1994 (represented by open symbols in the figure) but not for FY 1991. Thus, the corresponding note will read that data points for 1990 and 1994 were excluded from the determination of the trend lines.
what an MTW such as the Gulf War would have demanded and also fell below that of OEF, our demarcation for peacetime and wartime.\textsuperscript{12} As far as airlift is concerned, we therefore treated the Kosovo air war as a small-scale contingency that did not demand high air mobility support and included it in our trend analysis of peacetime operations.

Data on the number of AMC-owned aircraft (primary aircraft authorized, or PAA) in the inventory by type and by year from 1980 to 1999 were obtained from the annual \textit{Command Data Books}.\textsuperscript{13} Figure A.5 shows the PAA aircraft inventory for the C-5 as well as for other aircraft. On the basis of the data shown in Figure 2.4, we calculated actual flying hours per aircraft.\textsuperscript{14} During the 1990s (excluding 1990, 1991, and 1994), the average number of flying hours per year per C-5 was 756 hours.\textsuperscript{15} The regression line shows an increase of 3.3 hours per year. If we use the average number of annual flying hours of 700 during 1981–1989 as our base, however, we find that this increase was 0.5 percent per year (see Figure 2.6).\textsuperscript{16} One might not consider this increase negligible because annual flying hours could increase 10 percent over the two decades. More signifi-

\textsuperscript{12}The air mobility intensity of OEF is higher than that of the Kosovo air war in terms of both total flying hours for the campaign and monthly flying hours per aircraft during the campaign.

\textsuperscript{13}In this study, we measure the number of aircraft in units of PAA. The numbers of PAA belonging to AMC has appeared in the authoritative annual \textit{Command Data Books} over the past two decades. PAA is the number of operating aircraft that are authorized to be staffed with aircrews. On the other hand, some might prefer to use total aircraft authorized (TAA). TAA is the sum of PAA and backup aircraft inventory (BAI), while BAI is the number of spare or backup aircraft that can be operational but are not budgeted for aircrews. Unfortunately, for large portions of the past two decades, TAA numbers are available only in aggregate over different commands; in other words, they are not segregated for AMC. Yet this study seeks to compare the peacetime operation of AMC assets during the Cold War and post–Cold War periods. We employed those TAA numbers that are available on AMC to repeat the calculation of flying hours per aircraft, and we then made a comparison to our results employing PAA. We noted little difference in the trends of flying hours per aircraft based on TAA or PAA. This comparison bolsters our findings based on PAA.

\textsuperscript{14}See also Figure A.5 in the appendix. When we calculated annual flying hours per AMC aircraft, we included the flying hours of associate reservists, who do not have aircraft of their own and fly AMC aircraft. Moreover, all flying hours are included whether they are on operation and maintenance (O&M) missions or Transportation Working Capital Fund (TWCF) missions—e.g., channel, exercise, contingency, and special assignment airlift missions (SAAMs).

\textsuperscript{15}There was a relatively large increase in flying hours for FY 1993. Indeed, actual monthly flying hours exceeded those planned from the start of that fiscal year. Operation Restore Hope, the United Nations–sanctioned military intervention in Somalia to safeguard the delivery of food to starving Somalis from December 9, 1992, to May 4, 1993, contributed to this increase. As discussed earlier, the restriction on C-141 maximum payload was announced on May 14, 1993, and the grounding and cessation of in-flight refueling of some C-141s on August 9, 1993. The first operational C-17s were introduced on June 4, 1993, and the C-17 fleet barely began to contribute to the flying duty during FY 1993. The combined effects of C-141s and C-17s also forced C-5s to fly more to compensate.

In addition to the FY 1990 and FY 1991 data points associated with the Gulf War, the FY 1994 data point was excluded in determining the peacetime trend line for the reasons discussed earlier.

\textsuperscript{16}See also Table 2.1.
Annual flying hours per aircraft


NOTE: Data points for 1990, 1991, and 1994 were excluded from the determination of the trend line.

\[ y = 3.3x - 5,874.1 \]
\[ t = 1.2 \quad \text{I.s.} = 0.25 \quad r = +0.5\%/\text{year} \]

Figure 2.6—C-5 Annual Flying Hours per Aircraft During Peacetime

Significantly, however, Figure 2.6 shows that the trend is not statistically significant—that is, the increase of 0.5 percent per year is not significantly different from a 0 percent increase. Therefore, there is no basis for arguing that the C-5 was flying more in the 1990s than in the 1980s.

For all trend line analyses, we performed a t-test to determine whether the coefficient of the independent variable (the slope) is zero. The standardized t-test statistic (t), the level of significance (I.s.), and the rate (r) are shown below the regression equation. The I.s. is the probability of type I error, or the probability that the slope is actually zero. However, our sample results led us to erroneously reject a zero slope. Thus, the smaller the I.s., the smaller the probability that there is no trend or the higher our confidence that there is a nonzero trend. To highlight those likely nonzero trends in the figures and tables throughout the following chapters, we have boldfaced the t, I.s., and r numbers whenever the I.s. is 0.05 or less. In other words, there is a probability of 95 percent or higher that the trend or slope is not zero. To calculate the rate, we first determined the average annual value of the 1980s (or those years in the 1980s for which data were available) as the reference value or base. The rate is the annual change or the slope of the linear regression line divided by the average value (i.e., 3.3/700 = 0.5 percent in the current case). If there were no data for the 1980s, we used the average value for the years in the 1990s (excluding 1990, 1991, and 1994). It should also be noted that the regression software often gives the coefficients of the linear equations throughout this report more digits than their numbers of significant figures.
Table 2.1

Annual Flying Hours per Aircraft During Peacetime

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Data Period (fiscal years)</th>
<th>Average During the 1990s (hours/year–aircraft)</th>
<th>Rate of Change (%/year)</th>
<th>t-Test Statistic</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-5</td>
<td>1981–1999</td>
<td>756</td>
<td>+0.5</td>
<td>1.2</td>
<td>0.25</td>
</tr>
<tr>
<td>C-141</td>
<td>1981–1999</td>
<td>929</td>
<td>−1.3</td>
<td>6.2</td>
<td>0.00</td>
</tr>
<tr>
<td>C-17</td>
<td>1994–1999</td>
<td>937</td>
<td>+18.0</td>
<td>5.9</td>
<td>0.01</td>
</tr>
<tr>
<td>C-130</td>
<td>1981–1999</td>
<td>609</td>
<td>−0.2</td>
<td>0.4</td>
<td>0.70</td>
</tr>
<tr>
<td>KC-135</td>
<td>1993–1999</td>
<td>388</td>
<td>−1.1</td>
<td>0.6</td>
<td>0.61</td>
</tr>
<tr>
<td>KC-10</td>
<td>1992–1999</td>
<td>748</td>
<td>−0.7</td>
<td>0.3</td>
<td>0.77</td>
</tr>
</tbody>
</table>

NOTE: Data points for 1990, 1991 and 1994 were excluded from the determination of the numbers in the third to sixth columns. Bold entries indicate that the probability of a nonzero trend (rate of change) is 95 percent or higher.

We similarly calculated annual flying hours per C-141, which are shown in Figure A.6 in the appendix and in Table 2.1.\(^\text{18}\) The C-141 did not fly more in the 1990s, and its annual flying hours fell by 1.3 percent per year (see Table 2.1). The C-141 aircraft inventory was stable throughout the 1980s and until 1992. Thereafter, it declined quite rapidly, from 220 in 1992 to 74 in 1999 (See Figure A.5). However, even this seemingly sharp decline was less rapid than that in flying hours, thus causing a decline in flying hours per aircraft in the 1990s.

During 1995–1999, the annual flying hours per C-17 increased by 18 percent per year (see Table 2.1).\(^\text{19}\) For a newly deployed aircraft, it is normal for annual flying hours per aircraft to increase initially. Moreover, the trend indicates that the flying hours per C-17 will be higher than those per C-141 or C-5.\(^\text{20}\) However, more data points are needed to confirm this trend. The annual flying hours per C-130 did not increase over the past two decades (see Table 2.1).\(^\text{21}\) Nor did those for the KC-135 and KC-10 (Table 2.1).\(^\text{22}\)

Overall, none of the aircraft examined except the C-17 showed a statistically significant increase in annual flying hours per aircraft in the 1990s. Indeed, we found that C-5, C-141, and C-130—aircraft for which comparable data were

\(^{18}\text{For our analysis of each aspect of operations, we often show only the C-5 graph in the text and refer the reader to specific graphs in the appendix for other aircraft (the C-141, C-17, C-130, KC-135, and KC-10). However, we discuss the characteristics and trends of all these aircraft in the text. Moreover, for many statements made in the text, we refer to graphs in the appendix for data support.}\n
\(^{19}\text{See also Figure A.7 in the appendix.}\n
\(^{20}\text{See Figure A.7 in the appendix.}\n
\(^{21}\text{See Figure A.8 in the appendix.}\n
\(^{22}\text{See Figures A.9 and A.10 in the appendix.}\n
available for the past two decades—were not flown more in the post–Cold War era than during the Cold War.

One might argue that the actual number of flying hours per aircraft is not relevant to AMC because military airlifters and tankers in any case fly far less than do their commercial equivalents, such as the B-747. These military aircraft can be flown substantially more per year without stressing the aircraft. However, more flying per year would increase the maintenance cost in returning aircraft to their wartime readiness status.

**MONTHLY FLYING HOURS PER COPILOT**

Thus far we have shown that aircraft did not fly more in the post–Cold War era than during the Cold War, but whether CPs and ACs have been subject to increased flying demand remains to be discussed.

Craig Vara at AMC/DOT provided us with annual data on the number of AMC CPs and ACs and their monthly flying hours. Figure 2.7 shows the monthly flying hours per C-5 CP. The aging requirement for a C-5 CP is 30 flying hours per month. Over the past two decades, monthly flying hours showed no significant trend of either rising or declining and were on average slightly above the aging requirement. After the Cold War and the Gulf War, frequent peacetime contingencies and normal airlift activities yielded as much flying as C-5 CPs had experienced during the Cold War. However, lower overall peacetime demand from time to time and increased competition from commercial carriers can prevent CPs from meeting their aging requirement. In fact, the CPs of all six aircraft studied here had trouble meeting the requirement during FY 2000 and FY 2001. During FY 2000, average monthly flying hours per C-5 CP dropped to 26 (indicated as a star in Figure 2.7), well below the required 30 hours per month.

In general, the frequency and intensity of peacetime contingencies in the post–Cold War era are hard to predict and the counterterrorism initiative adopted after September 11 has not made such prediction any easier. Both variables will likely fluctuate so that for some years flying will be considerably below the aging requirement, while for other years it will be above. AMC’s corrective measures for the recurring shortage of organic flying hours consist of cutting commercial augmentation, flying organic aircraft with lesser loads, and putting more CPs on

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23 Flying hours of any mission type or flying distance can be used to satisfy the aging or proficiency requirement. The trend line was based on data points from 1982 to 1999, excluding 1990, 1991, and 1994. For this and Figures A.11 to A.15, the determination of the trend lines was based on the annual data up to and including FY 1999.
Is AMC Flying Less?

Figure 2.7—C-5 Monthly Flying Hours per Copilot

a flight. Commercial augmentation is airlift business contracted to commercial carriers during peacetime. It has been used as an incentive to participate in the Civil Reserve Air Fleet (CRAF) to help meet wartime airlift requirements.24

NOTE: Data points for 1990, 1991, 1994, and 2000 were excluded from the determination of the trend line.

\[
y = -0.015x + 60.077
\]

\[
t = 0.1 \quad I.S. = 0.93 \quad r = -0.1\%/year
\]

24The CRAF program was established by a 1951 executive order. It was activated only during the Gulf War and cost $1.35 billion. It transported 62 percent of passengers and 27 percent of cargo during the deployment phase, as well as 84 percent of the returning passengers and 40 percent of cargo during the redeployment phase (bringing troops and equipment home after the completion of the ground campaign). CRAF Stage I could involve as many as 90 long-range international aircraft; Stage II, a cumulative total of 286 international, aeromedical, and national aircraft; and Stage III, 592 international, aeromedical, and national aircraft, including those in Stages I and II. (See Defense Science Board, Report of the Defense Science Board Task Force on Strategic Mobility, Washington, D.C., August 15, 1996, pp. 66–67.) The three stages of CRAF were intended to provide 19.5 MTM/D of the 49.7-MTM/D mobility requirement planned for major contingencies. Thus, CRAF could provide as much as 40 percent of the capability. The latest revision on requirements, the Mobility Requirements Study 2005 (MRS-05), calls for a minimum of 51.1 MTM/D, which is not significantly different from the 49.7 MTM/D determined during the Mobility Requirements Study Bottom-Up Review Update (MRS-BURU) in 1995. However, variations in assumptions examined in MRS-05 generated a range of airlift demands up to 67 MTM/D. (See MRS-05 Executive Summary and Transmittal Letter from Defense Secretary William Cohen to Congressman Bob Stump, Chairman of the House Committee on Armed Services, January 10, 2001.) As a prerequisite to CRAF membership, an air carrier must maintain minimum long-range international fleet commitment levels: at least a 3500-nautical-mile range and a 10-hour-per-day utilization rate, and at least 30 percent of its passenger fleet and 15 percent of its cargo fleet. (See Fact Sheet on Civil Reserve Air Fleet, Public Affairs Offices, Scott Air Force Base, IL: Air Mobility Command, August 1997.)
When the demand for organic airlift unexpectedly drops during a fiscal year, AMC can reduce its commercial expansion buy and thus generate additional organic flying hours.\textsuperscript{25} Of course, no commercial carrier would like a reduction in airlift business. However, whether the reduced incentive has to be compensated depends on whether there has already been significant growth in incentives in recent years as well as on whether the overall incentives even after the reduction are still adequate. On the other hand, flying aircraft less full always costs more. Putting more CPs on a given aircraft will provide less piloting experience despite the current accounting rule that credits all flying hours on a flight to each working CP irrespective of how many working CPs and ACs are on the aircraft.\textsuperscript{26} A long-term solution is needed to resolve the recurring problem of inadequate flying hours or piloting experience to meet the aging requirement.

During the 1980s, the aging requirement for a C-141 CP was 40.7 flying hours per month.\textsuperscript{27} In recent years, this requirement has declined to 29 hours per month.\textsuperscript{28} In the 1980s and 1990s, actual flying hours on average matched the

\textsuperscript{25}In this report, a commercial buy is defined as one for international (not domestic) airlift. We focus on international long-distance flights because they are less costly in generating flying hours for strategic airlifters and tankers. There are two types of commercial buys. A fixed buy is made before the beginning of a fiscal year and is not expected to be canceled. An expansion buy is made throughout the fiscal year, when the need arises. If the need disappears, AMC can decide not to issue the buy and incur no penalty.

\textsuperscript{26}We will introduce a metric—average number of pilots per flight—to determine whether a pilot is getting less piloting experience during training. If this occurs and starts to affect the quality of training, AMC should refine its aging and proficiency requirements to ensure that pilots receive enough flying hours in piloting.

\textsuperscript{27}See Figure A.11 in the appendix.

\textsuperscript{28}The reduction from 40.7 to 29 took place over time and in multiple steps. From 1981 to 1990, the number of C-141 aircraft (PAA) held relatively steady, declining from 250 in 1981 to 234 in 1990. Then, C-141s were on their way to retirement and declined sharply from 231 in 1991 to 74 in 1999.
During FY 2000, however, C-141 CPs averaged only 24.1 hours, a level that fell below even the already-reduced requirement of 29 hours. Thus, there were not enough flying hours for aging during that period. Although C-141s are now being retired, insufficient flying will thus delay the promotion of C-141 CPs whether they are flying C-141s or, at a later point, other aircraft.

The aging requirement for a C-17 CP is 35 hours. From 1995 to 1999, the newly deployed C-17 increased its flying hours per CP to about 35, thus meeting the aging requirement. Yet during FY 2000, the number of flying hours per CP dropped to 27.8, well below the aging requirement of 35.

In the 1980s, there were sufficient C-130 flying hours to meet the aging requirement. Yet during the 1990s this number declined, and by FY 2000 the number of flying hours per CP was 24.3—below the requirement of 29 hours per month.

In contrast, the monthly flying hours per KC-135 tanker from 1994 to 1999 stood comfortably above the aging requirement of 25 hours. There was also minimal fluctuation during this period. Although commercial augmentation competes for airlift business with organic airlifters (the C-5, C-141, C-17, and C-130), AMC tankers (the KC-135 and KC-10) face no such competition. This may be one of the reasons KC-135 CPs, unlike those of organic airlifters, flew considerably in excess of their aging requirement. When overall demand was low during FY 2000, however, even KC-135 CPs flew only 24.8 hours per month, slightly below the requirement of 25.

In the 1990s, AMC needed CPs and ACs to man its sharply decreased fleet of C-141s. In addition to reducing the hiring of C-141 CPs, AMC reduced its monthly flying-hour requirement in order to lengthen the number of years for CPs to be promoted to ACs. This had the effect of reducing the number of ACs and of better matching the lower manning requirement.

In sum, the CPs of airlifters (the C-5, C-141, C-17, and C-130) and tankers (the KC-135 and KC-10) all had insufficient flying hours during FY 2000.

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29 See Figure A.12 in the appendix.
30 See Figure A.13 in the appendix.
31 See Figure A.14 in the appendix.
32 The expenses of flying tankers (KC-135s and KC-10s) and the tactical airlifter (C-130s) are not reimbursed by TWCF.
33 See Figure A.15 in the appendix.
MONTHLY FLYING HOURS PER AIRCRAFT COMMANDER

ACs’ flying-hour requirements are significantly less than those of CPs.\textsuperscript{34} For example, a CP is required to fly from 1000 to 1400 hours before he can become an AC, but an AC is required to fly only 200 to 500 hours more to become an instructor pilot. An instructor pilot faces no further flying-hour requirement to become a flight examiner.\textsuperscript{35} Both CPs and ACs are, however, required to meet their own Pilot Semiannual Flying Requirements (PSFRs).\textsuperscript{36} CPs can easily meet these requirements if they fulfill their aging requirement of 25 to 35 hours per month. ACs, by contrast, must first understand PSFRs before they can determine whether these requirements can be easily met. Some of the requirements for C-5 ACs are the number of practices every six months in overseas sorties, takeoffs, landings, instrument approaches, night landings, three-engine miss approaches, and night receiver air refuelings. Many PSFRs can, however, be met in flight simulators. For C-5 ACs, only events such as overseas sorties, Have Quick radio procedures, Secure Voice operations, and some air refueling missions need be performed in an aircraft.\textsuperscript{37} Generally, ACs of C-5s or other airlifters or tankers can meet these requirements with monthly flying hours numbering in the teens. In reality, however, the ACs of airlifters and tankers fly considerably more, as a CP must be accompanied by an AC on every flight, and AMC seeks to maintain similar numbers of full-time ACs and CPs in the force. Thus, even during FY 2000, when CPs flew below their aging requirements, ACs had no trouble flying a sufficient amount to meet their PSFRs. Still, it would be of interest to estimate the trend of ACs’ flying hours.

Table 2.2 shows monthly flying hours per AC during the past two decades.\textsuperscript{38} For the C-5, both the number and the trend of flying hours per month per AC during the 1980s and the 1990s were very similar to those for CPs. The monthly

\\[\textsuperscript{34}\text{In this sentence, we continue to refer to both ACs and CPs as two pilot categories. The AC pilot category includes the following crew positions: aircraft commander, instructor pilot, and flight examiner. The CP category includes copilot and first pilot.}\]

\\[\textsuperscript{35}\text{These are crew positions. The flying-hour requirements to become an AC are 1400, 1300, 1200, and 1000 hours for the C-5, C-141, C-17, and C-130, respectively. The corresponding flying-hour requirements to become an instructor pilot are 300, 300, 200, and 500.}\]

\\[\textsuperscript{36}\text{We now return to pilot categories as opposed to crew positions.}\]

\\[\textsuperscript{37}\text{ACs are classified into four experience levels: A to D. Regardless of experience level, an AC is required to perform four overseas sorties, two Have Quick radio procedures, and two Secure Voice operations semiannually. ACs must also receive aerial refueling in four, five, six, or seven missions (up to two of which may be in simulators) for experience levels A, B, C, or D, respectively. See C-5 Aircrew Training, AFI 11-2C-5, Vol. 1, January 1, 1999.}\]

\\[\textsuperscript{38}\text{See also Figures A.16 to A.21 in the appendix.}\]
### Table 2.2
Monthly Flying Hours per Aircraft Commander

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>Data Period (fiscal years)</th>
<th>Average During the 1990s (hours/month-AC)</th>
<th>Rate of Change (%/year)</th>
<th>t-Test Statistic</th>
<th>Level of Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>C-5</td>
<td>1982–1999</td>
<td>30.1</td>
<td>-0.1</td>
<td>0.4</td>
<td>0.73</td>
</tr>
<tr>
<td>C-141</td>
<td>1982–1999</td>
<td>30.3</td>
<td>-1.6</td>
<td>3.5</td>
<td>0.00</td>
</tr>
<tr>
<td>C-17</td>
<td>1995–1999</td>
<td>31.1</td>
<td>+4.1</td>
<td>1.5</td>
<td>0.23</td>
</tr>
<tr>
<td>C-130</td>
<td>1982–1999</td>
<td>24.6</td>
<td>-1.1</td>
<td>3.4</td>
<td>0.01</td>
</tr>
<tr>
<td>KC-135</td>
<td>1994–1999</td>
<td>27.9</td>
<td>-1.1</td>
<td>0.6</td>
<td>0.60</td>
</tr>
<tr>
<td>KC-10</td>
<td>1994–1999</td>
<td>28.9</td>
<td>+2.9</td>
<td>1.6</td>
<td>0.21</td>
</tr>
</tbody>
</table>

NOTE: Data points for 1990, 1991, and 1994 were excluded from the determination of the numbers in the third to sixth columns. Bold entries indicate that the probability of a nonzero trend (rate of change) is 95 percent or higher.

The latest data reinforce the finding of a shortage.

When there is an unexpected shortfall in flying hours during a fiscal year, cutting the expansion buy as opposed to the fixed buy is often preferable because AMC has already made a commitment for fixed buys before the start of the year. During the flying-hour shortage of FY 2000 and FY 2001, AMC cut the cargo rather than the passenger expansion buy (see Figure 2.8) because it does not have organic, dedicated passenger carriers and depends on commercial carriers to transport most passengers.

Figure 2.8 shows that the cargo expansion buy went up in FY 1994 and stayed at a higher level than in 1992 and 1993 until 1999. The question thus arises as to why the increase in cargo buys from 1994 to 1999 did not go to AMC organic assets instead. If it had, the shortage in organic flying hours probably would not have occurred in 2000. In point of fact, the sharp rise in 1994 was due to the
The rare occurrence of weep-hole cracks in C-141 wings.\footnote{The wing-crack problem was described earlier in this chapter.} As shown in Figures 2.3 and 2.5, both total strategic airlifter and C-141 flying levels were below normal during 1994, and AMC used commercial expansion buys to fill the gap. This was consistent with AMC’s traditional approach toward meeting flying demand: Each year, AMC prefers to fly the number of hours that meets the pilot training requirement, and if demand exceeds that number, it prefers to contract commercial fixed and expansion buys rather than to fly more itself. As shown in Figures 2.7 and A.11, C-5 and C-141 CPs were already flying in excess of their flying requirements during 1995–1999.\footnote{The only exception was the C-5 during 1995. C-17s are not included here because during the same period, C-17s were still in the buildup phase and could not fly more.} AMC thus turned to the commercial air carriers during that period to meet the excess flying demand.

Figure 2.9 takes a closer look at the cut in the cargo expansion buy depicted in Figure 2.8.\footnote{We have included the combination buy (a mix of cargo and passenger buys) in the cargo as opposed to passenger buy because AMC does so in tallying the total cargo expansion buy.} A sharp cut occurred in July 2000, and the cut continued to the point at which the buy was near zero by the early months of calendar year 2001.
Is AMC Flying Less?

Figure 2.9—The Cargo Expansion Buy Declined Sharply in July 2000 Until August 2001

It then remained low until activities surged after September 11. Unfortunately, even with such a large cut in the cargo expansion buy, CPs for all airlifters and tankers still failed to meet their monthly flying-hour requirement during FY 2000 and FY 2001.

In point of fact, in the face of the flying-hour shortage during FY 2000 and the first half of FY 2001, AMC tried to increase organic flying during the second half of FY 2001 (see Figure 2.10). The average monthly flying hours per CP for airlifters during the second half of FY 2001 thus increased from 16 percent to 23 percent over those during the first half of that fiscal year. While these efforts did not eliminate the shortage, they did reduce it considerably. For example,

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43Figure 2.9 shows the surge in the cargo expansion buy during September 2001, at which time it was close to $14 million, or about $12 million above normal. In contrast, the cargo fixed buy stayed at $12 million in September 2001 and changed little from prior months. This is to be expected because the fixed buy is contracted at the beginning of the fiscal year, whereas the expansion buy is contracted much closer to the time of need and is designed to meet unexpected demand.

44See Chapter Eight for details.

45In contrast, the monthly flying hours per pilot during the second half of FY 2000 showed a decline from the first half (see Figure 2.10).
Figure 2.10—AMC Increased Monthly Flying Hours per Pilot During the Second Half of FY 2001

Table 2.3
AMC Was Able to Reduce but Not Eliminate the Flying-Hour Shortage

<table>
<thead>
<tr>
<th></th>
<th>Monthly Flying Hours per Pilot</th>
<th>Aging Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Full Year FY 2001</td>
<td>First Half FY 2001</td>
</tr>
<tr>
<td>Copilots</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-5</td>
<td>28.3</td>
<td>26.2</td>
</tr>
<tr>
<td>C-141</td>
<td>24.9</td>
<td>22.6</td>
</tr>
<tr>
<td>C-17</td>
<td>32.0</td>
<td>28.7</td>
</tr>
<tr>
<td>C-130</td>
<td>21.2</td>
<td>19.6</td>
</tr>
<tr>
<td>KC-135</td>
<td>23.5</td>
<td>23.2</td>
</tr>
<tr>
<td>KC-10</td>
<td>22.1</td>
<td>22.4</td>
</tr>
<tr>
<td>Aircraft commanders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-5</td>
<td>22.4</td>
<td>20.7</td>
</tr>
<tr>
<td>C-141</td>
<td>24.0</td>
<td>22.7</td>
</tr>
<tr>
<td>C-17</td>
<td>29.2</td>
<td>28.1</td>
</tr>
<tr>
<td>C-130</td>
<td>21.8</td>
<td>20.6</td>
</tr>
<tr>
<td>KC-135</td>
<td>20.7</td>
<td>20.4</td>
</tr>
<tr>
<td>KC-10</td>
<td>21.2</td>
<td>21.6</td>
</tr>
</tbody>
</table>

aBold entries indicate failure to meet aging requirement.
bNot applicable.
such efforts brought the monthly hours per C-5 CP up from 26.2 during the first half to 30.4 during the second half of FY 2001, resulting in an average of 28.3 hours for the full year (see Table 2.3). However, this average was still 1.7 hours short of the required 30 hours per month per CP. C-141 CPs were on their part 4.1 hours short; C-17 CPs, 3 hours; C-130 CPs, 7.8 hours; KC-135 CPs, 1.5 hours; and KC-10 CPs, 6.9 hours. Shortfalls will recur from time to time because one cannot know when and how many peacetime deployments will occur in any given year.\textsuperscript{46} On the other hand, ACs do not have an aging requirement, and monthly flying hours numbering in the teens will satisfy their proficiency requirement. Although ACs flew less during FY 2000 and FY 2001 than during FY 1999, they still had no trouble meeting their proficiency requirement.

**ENGAGEMENT VERSUS READINESS MISSIONS**

As shown in the previous two sections, AMC pilots did not fly more in the 1990s than in the 1980s. However, they may still be flying more short-notice missions as opposed to routine missions with advance notice. Yet it is harder and more costly for AMC to assemble the necessary aircraft and personnel for short-notice missions, and pilots prefer not to fly missions with little advance notice.

If such missions are occurring more frequently, AMC might either have to endure the situation or contract more of them to commercial carriers.

The AMC Flying-Hour Program divides missions into two groups: O&M and TWCF.\textsuperscript{47} O&M missions are not reimbursed by customers, but TWCF missions are. O&M missions are further divided into test, training, and ferry (TTF) and joint airdrop/air transportability training (JA/ATT). TWCF missions are divided into channel, exercise, contingency, and SAAMs. Channel missions are scheduled deliveries between established aerial ports of embarkation (APOEs) and aerial ports of debarkation (APODs). The other TWCF missions are generally unscheduled, have shorter notice,\textsuperscript{48} and deliver passengers and cargo to support joint exercises, small-scale contingencies, humanitarian relief operations,

\textsuperscript{46}The OEF has significantly increased AMC flying hours. However, OEF is considered a contingency with a high air mobility demand, not a peacetime operation. In any case, it will eventually end. Nor does one know at what level U.S. counterterrorism efforts as a whole will be sustained and for how long. AMC cannot count on these continuous, heightened activities to solve the flying-hour shortage.

\textsuperscript{47}The TWCF is “(t)hat part of the Defense Business Operations fund operated by AMC to finance the operating costs of the airlift services provided by AMC, who is reimbursed for such costs by authorized customers to whom airlift services are rendered. Formerly known as DBOF-T.” See Command Data Book, November 1999, p. 144.

\textsuperscript{48}It is possible that as contingencies mature and as schedules become set, missions are no longer short notice. Unfortunately, AMC has not used a classification that separates short-notice from long-notice missions. Nor is “short notice” defined. One can still say, however, that other TWCF missions, on average, have shorter notice than channel missions.
presidential travel, and the like. Pilots prefer channel missions because they are scheduled well in advance, so pilots are not called out of town unexpectedly. AMC management prefers such missions as well because it can reliably and accurately schedule pilots to fly them to satisfy aging and proficiency requirements. AMC also knows that many training elements will be accomplished in channel missions. We believe, however, that short-notice missions can be used to train pilots for short-notice wartime missions.

We have classified missions into three categories: channel, engagement, and O&M. Channel missions are TWCF missions that AMC favors for maintaining and upgrading pilots’ flying skills. Engagement missions consist of the other TWCF missions that AMC is expected to perform to support U.S. peacetime operations. O&M missions refer to those that are not reimbursed by customers or are dedicated to training (without airlifting items for customers at the same time). Flying hours for missions in any of these three categories can be used to satisfy pilots’ flying-hour requirements. The military annual flying-hours for the airlifters (the C-5, C-141, C-17, and C-130) during peacetime declined 63 percent between 1981 and 2000 (see Figure 2.11).

When we compared the annual engagement missions conducted during 1981 and 1989, we found an increase of 35,000 flying hours, or 32 percent. Conversely, we found annual channel missions to have declined by 57,000 hours, or 27 percent, and O&M by 24,000 hours, or 15 percent.

It is instructive to see how AMC managed airlift demand and supply during 1981–1989. When the engagement demand rose, AMC used its own assets to

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49 Paul Killingsworth classifies peacetime missions into two categories: engagement and readiness. The former has high priority and short notice and is composed of small-scale contingencies, expedientary Air Force support, banner operations (presidential support), humanitarian relief operations, short-notice SAAMs, and mission support. The latter has lower priority and advance planning and consists of local training, exercises, JA/ATT, channels, long-lead SAAMs, and efforts such as air evacuations. (Information is derived from a private communication with the author in January 2001.) We do not use Killingsworth’s mission categories here for two reasons. First, the data in the authoritative Flying-Hour Program cannot be readily reclassified into these two categories. Second, missions in Killingsworth’s engagement category, like the channel missions in his readiness category, can be used to meet flying-hour requirements, which can be considered readiness requirements. In this important sense, Killingsworth’s engagement missions are not distinct from his readiness missions. In any case, our O&M and channel missions combined should approximate Killingsworth’s readiness category, while our engagement missions should be similar to his engagement category.

50 See Figure A.22 in the appendix. To understand why engagement flying hours increased, one would have to examine and tally the numerous activities every year during those years. For example, the rise in engagement missions in FY 1984 was caused by several major events (on top of other more typical engagement activities): the U.S. intervention in Grenada from October 25 to November 19, 1983; airlift missions conducted in association with U.S. Airborne Warning and Control System (AWACS) aircraft deployment to help Egyptians monitor Libyan threats to their country, from March 19 to April 9, 1984; President Reagan’s trip to China from April 7 to May 2, 1984; and the deployment of U.S. minesweeping assets to the Red Sea from August 7 to October 2, 1984.
perform these activities, as it would do traditionally. At the same time, AMC preferred to fly just enough hours to meet its pilots' training requirements. Therefore, when AMC pilots flew more engagement missions than expected, AMC reduced the organic flying of channel missions, which indeed happened during this period. The question remains, however, as to why the 57,000-hour decrease in channel missions exceeded the 35,000-hour increase in engagement missions. This was because C-5, C-141, and C-130 CPs generally flew in excess of their requirements during 1981–1989 even with the larger reduction.51 In other words, if AMC had reduced channel as well as O&M flying any less, its pilots would have had to fly even more than they were required. Our recommendations52 for alleviating flying-hour shortages follow AMC’s approach of favoring organic assets to fly engagement missions and using commercial ser-

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51See Figure 2.7 and Figures A.11 and A.13 in the appendix.
52This will be discussed in Chapter Eight.
vices as shock absorbers while also focusing on creating new avenues for AMC to fly more when it needs to. Channel flying also declined faster than engagement and O&M over the past two decades. This trend can be unfavorable for AMC given its preference for using channel flying for pilot training.

Figure 2.12 shows the three mission categories for the C-5. During the past two decades, O&M missions remained stable at about 20 percent of C-5 pilots’ flying hours. On the other hand, channel missions steadily declined at a rate of 5.6 percent per year, and engagement missions rose by 13 percent per year. By 1999, annual engagement missions constituted 68 percent of the total missions flown on a flying-hour basis, compared to only 11 percent in 1981. In the 1980s, in other words, the annual flying hours for channel missions were significantly higher than those for engagement missions, while in the 1990s the situation was reversed. C-5 pilots had been flying many more short-notice missions.

For the C-141, the shares of flying hours in the channel-mission category declined by 2.5 percent per year, while O&M missions increased by 2.7 percent per year and engagement missions increased by 2.1 percent per year. C-141 channel missions and engagement missions showed trends similar to those of the C-5, but with less intensity. Thus, a similar concern arises that the C-141 is bearing an increasing portion of short-notice missions.

The trend lines also reflect the penetration of the new C-17 during the second half of the 1990s. These trends do not reflect how the mission percentages changed for a matured airlifter such as the C-5 or C-141. The end points (in 1999) may be more illustrative of future trends for a maturing C-17. In 1999, channel missions accounted for 31 percent of all annual flying hours, O&M for 23 percent, and engagement missions for 46 percent. As with the C-5 and C-141, engagement missions accounted for the largest share of AMC’s C-17 peacetime flying hours. It should be emphasized, however, that there are too few data points to justify any definitive statements about C-17 trends.

The O&M share of C-130 flying hours was stable and accounted for about half of all flying hours. Channel missions showed a steady decline of 4.5 percent per year, while engagement missions exhibited an increase of 4 percent per year.

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53 They are shock absorbers because AMC will use commercial air carriers to take care of the excess when there is an unexpected airlift demand. Likewise, when there is a deficit in demand, commercial services will be cut to allow more flying hours for AMC’s own pilots.

54 See Figure A.22 in the appendix.

55 See Figure A.23 in the appendix.

56 See Figure A.24 in the appendix.

57 See Figure A.25 in the appendix.
In sum, for all four airlifters (the C-5, C-141, C-17, and C-130), engagement missions accounted for a growing share of flying hours. Moreover, for the C-5, C-141, and C-130, channel missions, which are favored by AMC management and pilots, declined. The O&M shares of flying hours for the C-5, C-141, and C-130 remained relatively stable over the past two decades. We do not have data on the KC-135 and KC-10 tankers with which to address trends in various mission categories.

![Figure 2.12—C-5: Growing Engagement Missions and Declining Channel Missions](image_url)

**NOTE:** Data points for 1990, 1991, and 1994 were excluded from the determination of the trend lines.