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Testimony

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Committee on Armed Services,  
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MILITARY AIRLIFT

The C-17 Proposed Settlement  
and Program Update

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Mr. Chairman and Members of the Subcommittee:

I am pleased to be here today to discuss the status of the C-17 program. Based on the continuing work that we have been doing for the House and Senate Committees on Armed Services, we will provide updated information on C-17 cost, schedule, and performance issues and our observations on the Department of Defense's (DOD) proposed settlement agreement with McDonnell Douglas Corporation, the prime contractor on the C-17 aircraft. We will also discuss efforts to identify alternatives to the C-17 program.

#### RESULTS IN BRIEF

The C-17 program continues to experience cost, schedule, and performance problems. Total program costs continue to grow; the current \$43 billion estimate for the 120-aircraft program now exceeds by \$1.3 billion the last DOD estimate to acquire 210 aircraft. In addition, the average unit price the government has negotiated with McDonnell Douglas to build the C-17 continues to increase. Also, delivery schedules have slipped but are improving. Aircraft have been delivered with unfinished work or known deficiencies that need to be corrected after government acceptance.

Estimates of flight test completion appear to be optimistic. Also, C-17 reliability is significantly less than expected. This is important because the aircraft must achieve planned reliability and maintainability rates to demonstrate the life-cycle cost advantage that is key to its cost-effectiveness. Furthermore, the C-17 cannot meet current payload/range specifications. Finally, while the contractor is fixing technical problems involving the wing, flaps, and slats, other problems continue. These include immature mission computer software, insufficient airdrop capability, and inadequate built-in-test (BIT) capability.

In addition to our review, the Defense Science Board (DSB) assessed the C-17 program last summer. The DSB also reported a number of problems that beset the program: poor contractor performance, overly ambitious cost and schedule goals, too much concurrency, greater than anticipated complexity, and poor Air Force management.

In December 1993, the Secretary of Defense announced a decision to stop the C-17 program at 40 aircraft unless the contractor made significant investments in management and productivity improvements. On January 6, 1994, DOD and McDonnell Douglas agreed to a settlement designed to continue the program to 120 aircraft. However, DOD has not established specific cost, schedule, and performance criteria against which to evaluate the improvements in the contractor's performance. These improvements are called for in the proposed settlement and would enable DOD to make an informed decision on whether to continue the program beyond 40 aircraft. The program's schedule calls for this decision to be made before the effects of the desired improvements can be assessed with any

certainty. Actually, the first 40 C-17s will not benefit significantly from the settlement.

In an overriding effort to eliminate the contentious relationship between the government and the contractor, the government agreed to waive all of its potential claims against the contractor for the contractor's failure to meet the contract specifications and delivery schedule for the first 6 aircraft, without establishing the value of those claims. On the other hand, the contractor agreed to give up filed and unfiled claims against the government. In our opinion, more complete information is needed on the details of (1) the consideration due the government for the contractor's failure to meet contract specifications and delivery dates and (2) the contractor's claims.

With respect to the value of potential government claims because of the contractor's failure to meet contract specifications and delivery schedules, members of a DSB team developed estimates that ranged from \$750 million to \$3 billion. However, the assumptions they used were not documented, and they never reached consensus on the amount of consideration due the government. No further effort was made to establish the magnitude of specific potential government claims against the contractor.

Prior to the settlement agreement, McDonnell Douglas had filed claims against the government totalling \$472 million. McDonnell Douglas stated that it had also planned to file an additional \$1.25 billion in claims. These additional claims were neither filed nor reviewed by any government entity. The government agreed to resolve all filed and unfiled contractor claims by adding \$237 million to the contract price.

Aside from the unfiled claims for which we have found no basis, we question the \$237 million in claims recognized in the settlement. One claim, valued at \$234 million, represents a contractor claim that the Air Force had already denied prior to the settlement. The claim stems from McDonnell Douglas' assertion that the government directed it to subcontract a package of wing components in 1986. Because of the Air Force's decision to deny the claim and the fact that the DSB did not perform any legal or price analysis on the claim, we question the DSB's recommendation that the government pay 100 percent of the claim. We believe that without additional information on both the contractor and government claims, it would be difficult for Congress to decide to endorse the settlement.

The settlement indicates that the cost to the government is \$348 million and the cost to McDonnell Douglas is \$454 million. However, when the \$454 million is reduced by the \$237 million contract price increase and other adjustments, we believe the net out-of-pocket cost to the contractor is only \$46 million.

Based on a recent cost and operational effectiveness analysis (COEA) sponsored by DOD, there are alternatives that can now meet DOD's airlift shortfall at a lower cost than the full C-17 program. DOD has acknowledged that the COEA identified significantly cheaper alternatives that can get the job done. However, DOD has decided to execute a settlement with the contractor and to launch a new study to determine yet another strategy for a mixed force of C-17s and nondevelopmental aircraft. By doing so, DOD will effectively delay making a decision on the most cost-effective mix of aircraft for meeting its airlift requirement until November 1995.

Delaying a decision on the quantity of C-17s until November 1995 will leave the government with another \$5 billion invested in this problem-plagued program with little more additional information upon which to make an informed decision. At that time, DOD will have programmed about \$21.3 billion, including the settlement costs, or about 50 percent of the total estimated program cost for only 40 of the 120 planned C-17s. We believe DOD should immediately determine the minimum number of C-17s needed to provide specialized military airlift capabilities and pursue a strategy to acquire nondevelopmental wide-body aircraft to meet the additional airlift requirement.

For the reasons stated above, we believe the proposed settlement is not in the best interest of the government. Congress should not endorse any settlement until the issues we have raised are resolved.

#### BACKGROUND

The C-17 military transport, being developed and produced for the Air Force by the McDonnell Douglas Corporation, is being designed to airlift substantial payloads over long ranges without refueling. The Air Force is intending the C-17 to be its core airlifter and the cornerstone of future airlift forces. The Air Force originally planned to buy 210 C-17 aircraft. However, in April 1990, the Secretary of Defense reduced the program to 120 aircraft. DOD intends to procure 40 C-17 aircraft prior to the full-rate production decision planned for November 1995. DOD considers 40 aircraft an appropriate commitment to evaluate whether demonstrated program cost, schedule, and performance warrant completing the 120-aircraft program.

Through fiscal year 1994, the Congress has appropriated over \$15 billion for the C-17 program, including (1) \$5.5 billion for research, development, test and evaluation; (2) \$9.8 billion for procurement; and (3) \$163 million for military construction. Although some of these funds have been used to cover government costs, such as management and testing, the majority of funds have been for development and production contracts with McDonnell Douglas. Through fiscal year 1994, the Congress has authorized the procurement of 26 production C-17 aircraft (P1 through P26) and

provided the advance procurement funds for another 6 aircraft (P27 through P32). Advanced procurement involves buying parts that need to be ordered the year before production is scheduled to start.

In addition to the development contract, which included a test aircraft and low-rate initial production of 6 aircraft, the Air Force has awarded three contracts for subsequent low-rate initial production lots totalling 14 aircraft. The Air Force has also awarded McDonnell Douglas advance procurement contracts for another 12 aircraft. The Air Force has accepted delivery of the test aircraft and 11 (P1 through P11) of the 20 production aircraft. The test aircraft and five of the production aircraft are being used in flight testing. The six remaining production aircraft have been delivered to the Air Mobility Command.

#### UPDATE ON COST, SCHEDULE, AND PERFORMANCE ISSUES

Total C-17 program costs continue to grow; the current \$43 billion estimate for the 120 aircraft program is now \$1.3 billion more than DOD's last estimate to acquire 210 aircraft. Delivery schedules have again slipped, but are improving, and estimates of flight test completion remain optimistic.

#### Cost Issues

For the fiscal year 1991 President's budget, DOD estimated that total program costs would be \$41.8 billion to acquire 210 aircraft. Three years later, in the 1994 President's budget, DOD estimated that total program costs would be \$39.5 billion for the reduced C-17 program of 120 aircraft. An August 1993 Congressional Budget Office study showed that decreases in inflation and the reduced aircraft buy decreased program costs by \$15.5 billion. However, this reduction was offset by \$13.2 billion in cost growth. The C-17 Program Director recently estimated that total program cost would increase by another \$3.5 billion, from \$39.5 to \$43 billion. Thus, the total program cost estimate to acquire 120 aircraft now exceeds the last DOD estimate to acquire 210 aircraft by \$1.3 billion.

#### Production Cost Growth Continues

In March 1993, we testified that contractor development and production costs continued to increase as efficiency deteriorated. The Cost Performance Index (CPI), which measures the value of work performed per dollar expended, is an indicator of cost efficiency. There has been a decline in the CPI over the development and lot III contracts.<sup>1</sup> In addition, while the efficiency under the new lot IV contract is higher, the trend for lot IV is downward.

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<sup>1</sup>The development contract includes production lots I and II.

Since March 1993, the cumulative CPI for the development contract decreased slightly from 0.67 to 0.66. In part due to this decrease, the Defense Plant Representative Office (DPRO) increased the government's estimate-at-completion (EAC) for the development contract from about \$7.9 billion to \$8.3 billion, about \$1.5 billion over the contract ceiling price of \$6.8 billion. The cumulative CPI for the lot III contract also showed a downward trend from 0.91 to 0.85 from March 1993 to January 1994. Again, the DPRO increased its EAC for the lot III production contract another \$100 million, from \$1.1 billion to \$1.2 billion, which approximates the contract ceiling price of \$1.216 billion.

As of January 1994, the cumulative CPI for the lot IV contract was better than the lot III contract, but the lot IV CPI is showing the same downward trend since contract award in May 1993. Even though the cumulative CPI trend for lot IV is decreasing and is virtually the same as the contractor's performance on lot III at the 85-percent expended level, the DPRO projects that the contractor will make a profit of approximately \$100 million. However, the principal reason for the contractor's improved financial position on lot IV is that the government negotiated a target price of \$121 million more to build the same number of aircraft under lot IV as compared to lot III.

Table 1 shows the unit price comparison for the lot III, IV, and V contracts at the target and ceiling prices.

Table 1: Price Comparison for Production Lots III, IV, and V  
(Dollars in Millions)

Lot	Number of aircraft	Unit price		Total price	
		Target	Ceiling	Target	Ceiling
III <sup>a</sup>	4	\$238.1	\$281.8	\$952.3	\$1,127.3
IV	4	268.4	302.4	1,073.8	1,209.5
V	6	270.7	303.7	1,624.3	1,821.9
Price increase lot III to IV <sup>b</sup>		30.4	20.6	121.5	82.2
Price increase lot III to V <sup>b</sup>		32.6	21.9		

<sup>a</sup>Lot III engine prices have been excluded for purposes of comparison. Engines are government furnished equipment on lots IV and V.

<sup>b</sup>Totals may not add due to rounding.

Normally, one would anticipate that as the production processes improve and the aircraft design matures, the average unit prices would decline from production lot to production lot. However, as shown in table 1, the average target unit price the government has negotiated with the contractor has increased, not decreased.

#### Productivity Remains Inadequate

In the past, we reported that McDonnell Douglas' production efficiency, as measured by the learning curve, was improving with each successive aircraft, but the rate of improvement had not increased enough to meet program cost and schedule objectives. We noted that the C-17 program has had severe personnel disruptions because of bumping by senior workers on commercial projects and that this bumping would continue to prevent achieving needed improvement in the learning curve.

During 1992, 1,448 workers, or 42 percent of the C-17 assembly work force, were displaced through bumping. During the first three quarters of 1993, 1,567 workers were displaced. As a result, a little over three-quarters of the assembly work force had been newly assigned to the program since January 1992. The effects of this turnover in assembly personnel were reflected in a recent DPRO analysis that showed improvement in the learning curve rate between



production lots II and III, but that the improvement was still not sufficient to achieve cost and schedule goals for lot III. The displacement of C-17 assembly workers declined significantly in the third quarter of 1993 and, if this trend continues, should not be a significant obstacle to improving the learning curve in the future.

In April 1992, we reported that contractor officials believed that out-of-position work--work performed at other than the designated work station--was a major contributor to the low learning curve. The contractor has since reduced out-of-position work. For example, the amount of out-of-position work on aircraft P4 to P16 decreased from 13 percent to 3 percent at major join (where major sections of the aircraft fuselage and wings are joined together).

However, the DPRO believes a better indicator of production efficiency is at the major assembly tool level. While the contractor has improved his out-of-position work at this level, a significant amount of work is still being accomplished out-of-position. For example, eight major assembly tools are used to manufacture the aft fuselage. The contractor reported that for P16, 13 percent to 48 percent of the required work to assemble the aft fuselage was done out-of-position as the fuselage assembly moved through the eight major assembly tools. While improvement in the contractor's learning curve reflects a decrease in the amount of out-of-position work at major join, the improvement would have been greater if more work had been completed in-position as the major sections of the aircraft moved from one assembly tool to the next.

Last year, we discussed the impact of assembly quality as measured by off-standard hours (primarily for rework and repair) on cost and schedule trends. Since then, off-standard hours have declined from approximately 40 percent, for the first 5 aircraft delivered, to about 34 percent on the 10th production aircraft. This trend shows improvement, but the various goals established by the company are still not being achieved. Scrap, rework, and repair costs for all departments, including assembly, were about \$44 million in 1993. This adds about \$7.3 million per aircraft at a production rate of six equivalent aircraft per year. In August 1993, the Acting Deputy Assistant Secretary of Defense for Production Resources recommended that a 50-percent reduction in scrap, rework, and repair costs over a 12-month period be tied to the next major C-17 program funding decision.

The DSB, in its mid-1993 review of the C-17 program, observed that if the contractor continued with its then-current manufacturing and quality assurance processes, it could not maintain the planned production schedule and at the same time reduce unit cost.

### Schedule Issues

During 1993, the contractor delivered five aircraft. The last lot II aircraft, P5 and P6, were each delivered about 5 months late. Also, even after the Air Force significantly extended the contract delivery schedule for lot III aircraft, the contractor missed the scheduled delivery for two of the three lot III aircraft delivered in 1993 by a month.

Between January and April 1994, the contractor delivered two additional aircraft (P10 and P11) 8 days after the contract delivery date. The DPRO is currently forecasting that the next two aircraft (P12 and P13) are at risk of being delivered up to 1 month late and the next 7 aircraft will be delivered on schedule.

Aircraft P7 through P11 have been delivered within one month of the contract delivery date; however, with the exception of P11, the aircraft were delivered with increasing amounts of unfinished work or known deficiencies that had to be corrected after government acceptance. For example, the uncorrected deficiencies on P9 included minor inspection items, such as loose screws and missing fasteners, while major deficiencies included a cargo ramp that would not unlock and open. At the time of our review, the contractor had not yet quantified the number of work hours involved in completing this work. However, the contracting officer withheld \$10,000 for P7, \$65,000 for P8, over \$3 million for P9, and \$2.6 million for P10 for the unfinished work at the time of delivery. The amount of unfinished work on P11 decreased significantly.

These aircraft were also delivered with a number of major waivers. For example, P10 had 127 major waivers for which the contracting officer withheld about \$7.5 million. The government defines a major waiver as acceptance of an item not conforming with contract or configuration requirements involving, among other things, performance, reliability, or maintainability. Both the Air Force and the contractor had hoped to reduce the number of major waivers required to deliver the aircraft. We found, however, that the number of major waivers granted remained relatively constant from P5 to P10. The number of major waivers for P11 decreased to 114, for which the government withheld about \$4.8 million.

### Estimated Date For Completing Flight Test Is Optimistic

In March 1993, we reported that the C-17 flight test program had slipped at least 13 calendar months to January 1995 with a high probability of additional slippage. The Air Force now estimates it will complete the flight test program by March 1995. We believe even this is an optimistic estimate.

In April 1993, the Air Force rebaselined the test program from the original 80 aircraft-month (27 calendar month) program, which ended

in November 1993, to a 135 aircraft-month (42 calendar month) schedule ending in March 1995.<sup>2</sup> Air Force and contractor officials believe that the flight test program is generally tracking to the 135 aircraft-month schedule. However, they point out that it is difficult to determine the exact status of the flight test program due to the uncertain nature of developmental testing.

The Air Force and the contractor use a variety of indicators to judge the status of the test program, such as test points, credit flight hours (time to perform a specific task), and flight test milestones. Through March 1994, the Air Force had completed about 78 percent of the 6,898 test points and about 75 percent of the required 1,887 credit flight hours, which is ahead of schedule. The Air Force had completed approximately 70 percent of key flight test milestones.

Overall, test aircraft have averaged a monthly flight rate below the assumed 40-flight hour average rate per aircraft per month identified as a necessary requirement for completion of the flight test program as scheduled. From April 1993 through February 1994, overall flight credit hour efficiency averaged 48.3 percent, which is below the 62-percent efficiency rate the Air Force assumed for the remainder of the 135-month rebaselined program. Additionally, the flight test program is still experiencing a significant amount of aircraft downtime. For example, through March 1994, nearly half (1,444 days) of the available test days (3,086 days) were lost because the aircraft were being worked on. Of the remaining test days, 585 days were lost because technical problems and other conditions kept the aircraft from completing intended missions.

The DSB found the 135 aircraft-month program at risk. It recommended adding 17 aircraft-months to increase the flight test program from 135 to 152 aircraft-months. Although the Air Force plans to manage the flight test program against the 135 aircraft-month schedule, it has developed a preliminary 152 aircraft-month (45 calendar month) schedule that extends the flight test program to June 1995--3 months beyond the currently planned flight test completion date. (In March 1993, we projected the test program would not be completed until July 1995.)

While a series of Air Force and contractor reports, through January 1994, show the test program is generally on schedule, the Air Force has identified the following areas of concern that we believe may present a substantial risk to the completion of the program as scheduled:

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<sup>2</sup>For test purposes, an aircraft month is defined as the use of one aircraft for one calendar month.

- Software immaturity has restricted assessment of the operationally representative two-pilot flight crew.
- Paratroop and airdrop problems could delay the test schedule.
- Completion of developmental testing for selected critical mission systems and some significant aero performance milestones (such as completion of short field landings) are scheduled at the end of the test program.

Air Force operational test reports and officials have also expressed concerns that the Air Force may not be able to independently maintain the aircraft during operational testing, a reliability, maintainability, and availability (RM&A) evaluation requirement. They indicate that the Air Force may have to request a waiver if their ability to maintain the aircraft does not improve. Air Force personnel estimated that the contractor currently provides about 33 percent of flight test aircraft maintenance. The lack of a working BIT system and inadequate technical manuals are key contributors to the Air Force's concern regarding its ability to independently maintain the aircraft during operational testing.

#### Performance Issues

DOD has proposed relaxing payload and range specifications to levels that both the Air Force and the contractor believe can be achieved. In addition, initial operational capability (IOC), which is scheduled for January 1995, may slip because the Air Force may not have 12 similarly configured aircraft. Finally, test results to date show reliability values to be about half of expected requirements.

#### Specifications

In March 1993, we reported that the C-17 could not meet its payload and range specifications primarily because of growth in aircraft weight, increase in aircraft drag, and failure of engines to meet specific fuel consumption expectations. Since then, DOD has proposed relaxing the C-17 specifications to levels that the C-17 will probably be capable of achieving. The Air Mobility Command has asserted that, although several of the proposed specification changes do not meet current objectives, aircraft performance and mission capability will not be significantly degraded. The C-17 is expected to meet the threshold requirement for the Command's key payload/range mission.

Table 2 shows that the proposed specification changes do not meet current C-17 operational objectives for the heavy logistics, maximum payload, medium logistics, and ferry range missions.

**Table 2: Comparison of Current and Proposed Range and Payload Specifications with Operational Requirements**

		Payload/range (Thousand pounds/nautical miles)		
Mission	Threshold <sup>a</sup> or objective <sup>b</sup>	Operational requirement	Specification	
			Current	Proposed
Heavy logistics	Threshold	110/3,200	130/3,200	120/3,200
	Objective	130/3,200		
Maximum payload	Objective	160/2,400	160/2,400	157/2,400
Medium logistics	Objective	120/2,800	120/2,800	114/2,800
Ferry mission	Objective	0/4,600	0/4,600	0/4,300

<sup>a</sup>A threshold is a minimum acceptable operational requirement, below which the utility of the system becomes questionable. Failure to meet a threshold is cause for the system to be re-assessed or terminated.

<sup>b</sup>An objective value is an operationally significant improvement over the threshold.

Although the basic design of the C-17 is nearly complete, the aircraft does not meet contracted payload/range specifications. DOD now defines the C-17's key performance mission as the 3,200 nautical mile (heavy logistics) mission. The contract specification currently requires the C-17 to carry 130,000 pounds 3,200 nautical miles. The settlement proposes revising this specification to 120,000 pounds, while the Air Mobility Command's threshold requirement is 110,000 pounds.

The DSB found that the C-17's performance on the 3,200 nautical mile mission is only 93,345 pounds. The primary reasons for the payload shortfall are still aircraft weight growth, aircraft drag increase, and failure of the engine to meet specific fuel consumption expectations. McDonnell Douglas has proposed several initiatives to improve payload/range performance. According to the DSB, these initiatives are feasible and, if implemented, the C-17 will carry 101,796 pounds 3,200 nautical miles--still below the threshold requirement.

The DSB recommended that the method for calculating C-17 payload and range performance be changed from a traditional methodology to

an operational methodology. Differing assumptions between these methods pertain to fuel consumption rates. While the operational methodology shows how the C-17 would actually perform, it eliminates any margins for weight growth or reduced engine performance that are included in the more stringent traditional methodology. Using the operational methodology, the C-17 would deliver a 123,330-pound payload a distance of 3,200 nautical miles. In other words, it would achieve the threshold requirement, but it would still fall short of the current contract specification of 130,000 pounds. Therefore, the settlement proposes reducing the specification to 120,000 pounds and measuring performance based on the operational methodology.

In agreeing to these reduced standards, DOD directed the contractor to implement the following initiatives:

- Use the Pratt & Whitney 94 commercial engine that includes commercial improvements to increase specific fuel consumption by 0.4 percent.
- Implement low-risk weight reduction initiatives to reduce aircraft weight by 1,500 pounds.
- Reduce total aircraft drag by 1 percent.
- Increase maximum takeoff gross weight by 5,000 pounds, to 585,000 pounds, to allow for additional fuel.

The DSB found that successful implementation of these initiatives was necessary for the aircraft to meet even the revised payload and range specifications, including the key heavy logistics mission. According to a contractor official, while McDonnell Douglas has been pursuing weight reduction initiatives, it has been unsuccessful at reducing the net aircraft weight and believes many of the proposed initiatives would be too expensive to implement. Program and contractor officials stated that flight testing has demonstrated that drag can be reduced at least 2 percent. These officials believe that the increased payload achieved by the additional drag reduction would offset any lost payload capacity should the weight reduction measures be unsuccessful.

#### Planned IOC May Slip

The current program plan calls for the commander of the Air Mobility Command to declare IOC in January 1995. This requires 12 similarly configured aircraft to support the RM&A evaluation which follows. In preparation for IOC, the aircraft delivered during 1993 will undergo modifications to configure them to an as yet unspecified design. Five aircraft (P5 through P9) are expected to spend up to 3 months being retrofitted with new flaps and slats and will undergo major wing and fuel system modifications. The retrofits are scheduled to be completed in December 1994.

The DSB, however, concluded that there was insufficient time to retrofit all of the design changes in the aircraft, evaluate them in flight test, and incorporate them into the production aircraft to provide 12 similarly configured aircraft for IOC and the RM&A evaluation. It, therefore, recommended slipping the start of IOC 5 months, from January to June 1995. However, Air Force officials, while agreeing that the contractor's retrofit plan is high risk, believe that it is achievable. They, therefore, plan to keep the January 1995 date as a target for starting IOC.

#### C-17 Reliability and Maintainability

RM&A is critical to peacetime availability, wartime utilization, and the ability to keep operations and support costs near budgeted levels. The Air Force plans to conduct an RM&A evaluation after the start of IOC between February and July 1995. The RM&A evaluation is a 30-day evaluation requiring about 1,750 flying hours. However, we believe that if C-17 reliability does not improve sufficiently in the next few months, the Air Force should consider delaying the RM&A evaluation until reliability improves.

Aircraft testing has already revealed that C-17 reliability is less than expected based on contractual growth curves, although maintainability is substantially better than expected. The DSB concluded that based on current reliability values, the likelihood of the C-17 successfully completing a mission does not meet requirements.

Table 3 shows that actual aircraft reliability at 1,202 flight test hours and 25 hours of initial squadron operations is substantially below the expected reliability.

Table 3: Actual C-17 Reliability and Expected Reliability

Reliability measure	FLIGHT HOURS					
	Flight test (1202 hours)			Initial squadron (25 hours)		
	<u>Expected</u> (hrs)	<u>Actual</u> (hrs)	Percent of <u>expected</u>	<u>Expected</u> (hrs)	<u>Actual</u> (hrs)	Percent of <u>expected</u>
MTBM(I), inherent <sup>a</sup>	0.99	0.43	43	0.95	0.46	48
MTBM(C), corrective <sup>b</sup>	0.48	0.24	50	0.46	0.15	33
Mean time between removal	1.70	1.53	90	1.62	1.70	105

<sup>a</sup>Mean time between maintenance (MTBM) inherent is unscheduled maintenance required on a component due to its own internal failure.

<sup>b</sup>Corrective maintenance is the sum of inherent, induced and no defect maintenance actions. Induced maintenance is unscheduled maintenance on a component due to some induced condition rather than an inherent failure. No defect maintenance results from a false indicator or isolation reading.

C-17 reliability data show that a large variety of different failures have occurred with no one particular item driving the low reliability numbers. This means the contractor will have to find corrective solutions for a substantial number of failures to improve reliability. In other words, there is no simple fix. In addition, there is insufficient data to track trends for some components because they are seldom used, failed but not fixed, not yet installed, or operating with restrictions.

While reliability performance is less than expected, aircraft maintainability appears to be substantially better than expected. However, some Air Force flight test officials believe that the higher than expected maintainability numbers are partially due to the maintenance support that contractor employees provide both at flight test and at the initial squadron operations at Charleston Air Force Base. These officials are concerned that given the immaturity of the aircraft BIT system and the incomplete maintenance manuals, repairs by Air Force personnel will take longer.



## Other Technical Issues

As we reported last year, technical problems continue to occur in the C-17 program. These problems may result in decreased aircraft performance, increased program cost, and/or extended program schedules.

### Paratroop and Airdrop Capability

During flight testing, the C-17 has experienced severe airflow problems that prevent paratroopers from safely conducting static line jumps from the side troops doors when the cargo door or ramp are open. Airflow problems also preclude static line jumps from the rear cargo door. This problem limits the aircraft's ability to simultaneously deliver airdrop bundles with the paratroopers and is likely to prevent the C-17 from meeting the specification requirement to airdrop 102 paratroopers and 8 bundles in 55 seconds. Due to these problems, the Army notified the Air Mobility Command on March 31, 1994, that its requirement had been lowered to 102 paratroopers and 8 bundles in 70 seconds.

In March 1994, the Army canceled scheduled paratroop drop tests of 70 and 102 jumpers because parachutes were striking the side of the aircraft. Army testers confirmed that over 60 percent (29 of 48) of test dummy parachutes actually hit the aircraft. The Army is pursuing a number of corrective solutions that will require retesting and may delay the flight test program. The 70 paratroop drop is a key milestone because it is a congressional requirement governing release of C-17 production funds for more than six aircraft after fiscal year 1995.

### Built-in-Test

The C-17 has been experiencing excessively high BIT false alarm rates. BIT provides for electronic fault isolation to individual line-replaceable units. The C-17 air vehicle specification requires a BIT false alarm rate of not more than 5 percent. However, the Air Force has experienced BIT false alarm rates as high as 97.9 percent for production aircraft operating at Charleston Air Force Base.

Current problems with BIT provide extremely limited capability to maintenance personnel troubleshooting the aircraft. In addition, immaturity of BIT software has limited the ability to fully test the BIT system itself, and additional problems may exist within the system that have yet to be identified. It also impacts critical maintenance training to be accomplished as part of initial squadron operations. This problem, if not corrected, will have a significant impact on the ability of the aircraft to pass operational testing and RM&A evaluations.

The contractor agreed to take responsibility for developing and managing a corrective action plan to reduce the number of BIT false alarms by January 1994. However, BIT data, as of the end of February 1994, show the number of false alarms is still very high, with the number occurring at Charleston Air Force Base increasing to its highest level.

#### Wing Failure

In October 1992, both wings on the static test article failed at approximately 128 percent during a 150-percent load test. After retrofitting the static article's wings, the contractor resumed static testing in July 1993. In September 1993, the left static wing failed again at 144 percent. The initial damage occurred on the outer part of the wing where the upper spar cap did not meet specifications. However, based on an engineering analysis, McDonnell Douglas and an Executive Independent Review Team, which was appointed by Secretary of the Air Force to review the test results, concluded that the wing had passed the 150 percent load test. The static test program, which began in November 1991, was completed on April 7, 1994.

Due to the 1992 static wing failure, the contractor is retrofitting the production wings. Basically, this retrofit involves reinforcing the wing by adding stainless steel straps to the wing stringers and stiffeners to various ribs and spars on the wing. Some Air Force and DOD officials, however, were not entirely satisfied with this approach. Therefore, as a part of the proposed settlement, the contractor, at its own expense, agreed to redesign the wing to eliminate the need for supplemental straps and stiffeners by using stronger components to build the wing. The new wing is to be incorporated as soon as possible, but not later than aircraft P29.

If 120 C-17 aircraft are purchased, approximately one-fourth of the fleet will have wings using the supplemental straps and stiffeners. DOD officials warn of possible corrosion problems with the currently implemented solution because of attaching dissimilar materials--stainless steel straps and aluminum stringers. They stated that potential corrosion problems could limit the service life of these wings.

#### Flap and Slat Redesign

In March 1993, we testified that C-17 flaps and slats were susceptible to heat damage from engine exhaust, which can ripple the skin and weaken the structure. Since then, the contractor has redesigned the slats by changing the material to titanium in the slat ribs and skins, and the flaps by changing the trailing edge to titanium. The hinge fairings on the flap are being changed to high temperature composite materials. Redesigned flaps and slats with

titanium skins and substructures have been installed on test aircraft P2 and are currently undergoing flight testing.

The redesigned flaps and slats will add approximately 1,100 pounds to the weight of the aircraft. P11 will be the first in-production aircraft to receive both the new flaps and slats. The contractor will retrofit existing production aircraft with the new flaps and slats.

#### Main Landing Gear and Tires

The C-17 continues to experience problems with the main landing gear. These problems include (1) retraction, (2) post interference, and (3) tire wear. Testing has shown that, on occasion, the main landing gear has not retracted satisfactorily in level flight and while banking. In addition, during heavy-loaded ground maneuvering and braking, the large shock strut compression allows interference between the post and axle beam of the main landing gear. The Air Force has also found that the tire service life does not meet specification even after adjusting the actual test data to reflect a more normal operational mission profile than experienced during tests.

#### EVOLUTION OF C-17 SETTLEMENT AGREEMENT

Concern over continuing C-17 cost, schedule, and performance problems resulted in the Congress restricting the release of procurement funds and imposing various reporting requirements. The Fiscal Years 1993 and 1994 Defense Authorization Acts required DOD to conduct a special Defense Acquisition Board (DAB) review and report on the adequacy of the C-17's requirements, cost and operational effectiveness, and affordability. Subsequently, the Under Secretary of Defense for Acquisition tasked the DSB to evaluate the program and report back on what had to be done to put the 120 C-17 aircraft program back on track. The DAB conducted an extensive review of the program between August and December 1993.

In December 1993, the Secretary of Defense and Under Secretary of Defense for Acquisition announced a decision to stop the C-17 program at 40 aircraft unless the contractor made significant management and productivity improvements. They also outlined a proposal to resolve C-17 issues between the government and the contractor. On January 6, 1994, McDonnell Douglas agreed to DOD's proposed settlement.

The settlement, which according to its terms requires enactment of specific authorizing legislation and appropriations approval, provides for:

- A provisional 2-year program during which McDonnell Douglas must
  - (a) introduce major management and manufacturing process

changes, (b) demonstrate an ability to deliver aircraft on schedule and at cost, (c) successfully complete the flight test program, and (d) satisfy all other contract specifications including RM&A requirements.

-- A resolution of all outstanding C-17 business and management issues as of the date of the agreement.

According to DOD, the estimated cost to implement the proposed settlement is \$348 million to the government and \$454 million to the contractor. A breakout of proposed settlement costs is shown in table 4.

Table 4: DOD's Estimate of Settlement Costs (Dollars in millions)

Item	Government	McDonnell Douglas
Flight test extension	\$61.5	\$61.5
Redesign wing	0	32.0
Computer Aided Design/Computer Aided Manufacturing	20.0	20.0
Management Information System	15.0	15.0
Advanced Quality System	2.5	2.5
Product improvement projects	0	100.0
Other	12.0	52.0
Nonrecurring engineering	0	171.0
Claims	237.0	0
<b>Total</b>	<b>\$348.0</b>	<b>\$454.0</b>

GAO'S ASSESSMENT OF THE SETTLEMENT

Our review indicates that the out-of-pocket cost of the settlement to McDonnell Douglas is \$46 million, not \$454 million as the proposed settlement indicates. The stated cost to McDonnell Douglas should be offset by \$237 million that the government would add to the target cost and ceiling price of the development

contract to settle unspecified contractor claims. In addition, we believe that the \$171 million for nonrecurring engineering costs should also be excluded from the \$454 million estimate. The \$171 million is not additional funding that the contractor will have to provide to implement the settlement, but rather, according to the DSB, full-scale engineering and development costs that the contractor had inappropriately allocated to current and future production contracts. These engineering costs either have been or will be incurred whether or not the settlement is implemented. The proper charging of the nonrecurring engineering costs to the development contract will increase the total cost of that contract. However, because the development contract is over ceiling, the contractor would not have been reimbursed for these costs anyway.

The proposed settlement recommends changes designed to ensure completion of a viable 120-aircraft program. On the basis of our analysis of the proposed settlement, we have several concerns.

First, DOD has not established specific cost, schedule, and performance objectives that must be met by McDonnell Douglas if the program is to continue beyond 40 aircraft. Second, in an effort to improve the management environment and continue the program, the government reduced payload/range specifications and agreed to waive potential claims against the contractor without an in-depth analysis of the value of the claims. Also, DOD agreed to pay McDonnell Douglas an additional \$237 million to settle all outstanding claims, filed and unfilled, without attempting to evaluate the validity of such claims or to establish realistic estimates of the government's exposure. Third, the impact of productivity improvements cannot be realized unless the program continues beyond 40 aircraft.

#### DOD Has Not Established Cost Or Schedule Criteria

The proposed settlement states that McDonnell Douglas must demonstrate an ability to deliver aircraft on schedule and at cost, as well as successfully complete the flight test program and all other contract specifications, including RM&A requirements. However, DOD has not established any specific cost or schedule criteria it intends to use to decide whether to continue beyond 40 aircraft. For example, DOD does not define targets or goals for delivering aircraft "at cost." The DSB recommended that specific target unit costs be established for C-17 production lots.

The proposed settlement states that the delivery schedule under contract for aircraft beginning with P7 shall remain the same. However, as I discussed earlier, in order to meet delivery schedule, the Air Force accepted aircraft with unfinished work or uncorrected deficiencies. In addition, aircraft P12 and P13 are at risk of being delivered up to 1 month late. DOD officials told us that consideration was being given to slipping the delivery

schedule several months. Thus, even before the proposed settlement can be implemented, the delivery schedule may slip. The Fiscal Year 1994 Defense Authorization Act prohibits DOD from obligating funds for more than four C-17s in any given fiscal year subsequent to the act, unless all aircraft scheduled for delivery in the prior 6 months are delivered within 1 month of the contract delivery date. DOD officials told us that they believe DOD can continue to obligate the funds if it changes the schedule and the contractor is able to meet the revised schedule.

During our review, DOD officials said that a decision on whether the C-17 program proceeds beyond 40 aircraft will not be based upon any single set of criteria or key parameters. It will be a judgement based on an evaluation of all pertinent data. We believe this situation provides DOD too much latitude in determining program performance and undermines accountability. The DSB reported that to create a new program environment there was a need for accountability. As such, we believe DOD should clearly spell out specific criteria that will be used to recommend to the Congress whether the C-17 program should proceed beyond 40 aircraft. DOD officials recently told us that they agree with the need for specific criteria and that they are preparing to submit criteria to Congress. At this time, the timing on when the criteria will be submitted to Congress is uncertain.

#### Claims Resolution Was Key to Settlement

A major objective of the settlement was to resolve contractor claims. Prior to the settlement agreement, McDonnell Douglas had filed 12 claims against the government, totaling \$472 million. When the settlement agreement was signed, none of these claims had been resolved; they were either under consideration by the contracting officer or in litigation at the Armed Service Board of Contract Appeals.

The settlement states that McDonnell Douglas was planning to submit an additional \$1.25 billion in claims against the government. According to the DSB, these claims were based on delay and disruption to the program caused by the government. The \$1.25 million in claims was never filed or reviewed by any government entity. In testimony before the House Committee on Appropriations, Subcommittee on Defense, in March 1993, the Air Force Principal Deputy Assistant Secretary for Contracting said that he knew of no basis for these claims.

In the DSB's opinion, the government was liable for \$237 million of the \$472 million in claims filed by the contractor. The settlement provides that DOD will make this payment through contract modifications, increasing the target and ceiling prices of the full-scale development contract. In return for the \$237 million, McDonnell Douglas agrees to release the government from all C-17

claims it may have as of January 6, 1994, the date of the settlement, whether filed or not. Of the \$237 million settlement, \$234 million was based on McDonnell Douglas' assertion that the government requested the company to subcontract a package of wing components. The DSB concluded that the government should pay 100 percent of this claim. We question the decision to pay this claim without DOD performing a legal or price analysis of the claim.

Air Force Determined Wing  
Breakout Claim Had No Basis

At the time of the DSB review, the Air Force was reviewing McDonnell Douglas' wing breakout claim for \$234 million. On November 10, 1993, the Air Force issued its final decision, stating that "the government is not liable for any of the costs" alleged in McDonnell Douglas' claim. According to the decision, the claim was denied on the basis that (1) the government did not direct McDonnell Douglas to subcontract the wing components, but rather that McDonnell Douglas voluntarily agreed to a plan to select a cost-effective source, and (2) McDonnell Douglas had guaranteed that subcontracting the manufacture of wing components would not result in any increase in target cost, target price, and ceiling price. Correspondence between the Air Force and McDonnell Douglas discussed this guarantee on numerous occasions, and the guarantee was incorporated into the contract through a contract modification.

On December 30, 1993, McDonnell Douglas appealed the Air Force's decision to the Armed Services Board of Contract Appeals. This and all other appeals before the Board have been suspended pending congressional action on the settlement. Given the fact that the DSB did not perform legal or price analysis of McDonnell Douglas' claim and in light of the Air Force's decision that the government was not liable for any of the costs alleged in the claim, we do not believe the DSB had any basis for recommending that the government should pay 100 percent of the claim amount.

DSB Did Not Establish  
The Value of Claims

As part of the settlement, the government also agreed to revise various specifications and the delivery schedule for P6 and prior aircraft. The government also agreed to waive all claims against the contractor for failure to meet the original contract specifications and delivery schedule. The consideration due the government for agreeing to these waivers and contract modifications is difficult to estimate. We were told that members of a DSB team estimated the value based on several different assumptions. Members' estimates ranged from \$750 million to \$3 billion. No further effort was made to establish the magnitude of the specific government claims against the contractor. DOD officials told us that avoiding protracted litigation with the contractor was a primary factor in the claims settlement.

We believe that, in an overriding effort to eliminate the contentious relationship between the government and the contractor and to continue the C-17 program to 120 aircraft, the government has made concessions without establishing the value of potential claims both parties have against each other. Without any effort to establish the realistic value of the claims of both parties, the true cost of this settlement is not known. In addition, we believe that the contract specification revisions and the change to an operational methodology for calculating payload and range were driven by the C-17's current performance capabilities in an effort to maintain the 120 aircraft program.

#### Benefits From Productivity Improvements Are Uncertain

According to the DSB, McDonnell Douglas' corporate infrastructure is antiquated and lacks an effective quality system. These problems limit the efficiency of the C-17 program. As such, the DSB recommended that McDonnell implement computer aided design/computer aided manufacturing (CAD/CAM), a management information system, and an advanced quality system along with other productivity improvements to modernize business practices so as to improve the efficiency of the C-17 program. The estimated costs of these improvements is \$175 million. The settlement proposes that the government pay \$37.5 million of these costs.

DOD officials contend that some of the planned contractor improvements may be in place by early 1995. However, our review indicated that it could take several years before benefits resulting from productivity improvements and management process changes are realized. The first installment of specific product improvement projects to be proposed by McDonnell Douglas is not scheduled to be completed until December 31, 1995, and the second package will not be completed until a year later. Given these time frames, little if any benefit from these programs will occur prior to fiscal year 1996 when the Congress will be faced with the decision on proceeding with production beyond a 40 aircraft program.

Similarly, actions intended to modernize McDonnell Douglas' manufacturing and management structure will have only limited impact during the first two years. While the CAD/CAM system for engineering changes may be fully functional by 1996, full implementation of the system is not proposed to start until 1997. Finally, the advanced quality system will be a phased change in quality control that will take several years to implement.

#### Legislative Action to Implement Settlement

On February 10, 1994, the Under Secretary of Defense testified that the settlement "requires special authorizing legislation from the



Congress." DOD recently submitted proposed legislation to Congress. The proposed legislation would enable the Secretary of the Air Force to modify the C-17 contracts "without regard to requirements of law relating to the making, performance or modification of contracts" as necessary to implement the terms of the C-17 settlement agreement.

#### ALTERNATIVES TO THE C-17

DOD's proposed settlement with McDonnell Douglas also discusses the need to consider commercial wide-body aircraft or new C-5B production as part of a successful strategic airlift program. Based on congressional direction, DOD directed that a COEA be conducted to determine alternatives to the C-17. As announced by the Secretary of Defense, the analysis showed that a combination of C-17s and C-5Bs, or C-17s and commercial wide-body aircraft can get the job done. The analysis showed that if the C-17 program were stopped at 40 aircraft, 64 commercial wide-body aircraft would have to be added to the existing airlift fleet to maintain adequate lift capacity. The COEA estimated life-cycle cost savings at about \$6 billion when compared to a fleet of 120 C-17s.

Although DOD has acknowledged that there are significantly cheaper alternatives that can meet airlift requirements, it has decided to execute a settlement with the contractor designed to ensure a viable 120 C-17 aircraft program and to launch a new study to determine the optimum strategy for a mixed force of C-17s and nondevelopmental aircraft. By doing so, DOD will effectively delay making a decision on the most cost-effective mix of aircraft for meeting its airlift requirement until November 1995. At that time, DOD will have programmed about \$21.3 billion, including the settlement costs, or about 50 percent of the total estimated program cost for only 40 of the 120 planned C-17s.

The Fiscal Year 1994 Defense Authorization Act made available to DOD up to \$100 million to initiate procurement of nondevelopmental military or commercial wide-body aircraft as a complement to the C-17. The act made available an additional \$300 million that could be used either for the wide-body nondevelopmental procurement or for the procurement of two additional C-17s. DOD has determined that the procurement of additional C-17 aircraft in fiscal year 1994 will contribute more to intertheater lift modernization than procurement of additional complementary nondevelopmental wide-body aircraft at the same funding level. DOD recently submitted its notification to the congressional defense committees that it intends to transfer up to \$300 million to the C-17 program.

The Air Force has developed a preliminary acquisition strategy to procure nondevelopmental aircraft. The strategy, which has been presented to the Under Secretary, is closely related to the C-17 full-rate production decision that is scheduled for November 1995. In our opinion, it appears that a decision on the number of non-

developmental airlift aircraft will depend on the outcome of that decision. In the interim, DOD will assess the operational utility and cost-effectiveness of wide body aircraft in moving military bulk and oversize cargo. An Air Force official estimated that these efforts will cost around \$20 million, substantially less than the \$100 million available. DOD plans to compete the C-17 against nondevelopmental military and/or commercial wide-body aircraft in another cost and operational effectiveness analysis in 1995.

In 1987, we reported that the C-17 was the most cost-effective alternative to meet our airlift requirements if the program came close to meeting its cost and performance objectives, especially the cost advantages achievable through its planned reliability and maintainability capability, and was used for routine direct delivery in wartime. The changed world environment, as well as rising costs, less than anticipated performance, and lengthy delays in this concurrent acquisition program, raise serious doubts about the C-17's cost-effectiveness. Even though the C-17 is 9 years into full-scale engineering development, significant uncertainties about its cost, schedule, and performance continue, and in our opinion, undermine the program's credibility.

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Mr. Chairman, that concludes my statement. I will be happy to answer any questions you or Members of the Subcommittee may have.

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