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MILITARY AIRLIFT

C-17 Flap Requires Additional Testing

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Mr. Chairman and Members of the Subcommittee:

As you are aware, the General Accounting Office is nearing completion of a report on the status of the design and testing of the wing flaps for the C-17 military transport aircraft. This statement for the record highlights the findings and conclusions from our work to date. We are pleased to provide this information to assist you in your oversight hearing of the C-17 program.

The C-17 military transport aircraft is being developed by the Douglas Aircraft Company to carry the full range of military cargo directly into small, austere airfields, a capability that distinguishes the C-17 from other airlift aircraft. This direct delivery capability is provided by a set of interrelated technologies that will enable the C-17 to approach runways at much slower speeds and steeper descents than conventional transport aircraft. It is being designed to land within very short distances with very heavy cargo loads. One of the key technologies is powered lift, which involves a unique use of flaps.

A flap--the movable attachment to the trailing edge of an aircraft's wing--increases the lift of the aircraft. To produce powered lift, the flaps are extended into the engine exhaust to deflect the exhaust stream. The deflection of the exhaust stream converts the engine thrust into lift, which permits reduced approach speeds for landing and changes the normal techniques required for aircraft flight path and airspeed control. Standard flaps do not interact with the engine exhaust stream.

Because powered lift creates significant heat and acoustic stress (vibrations caused by sound) on the C-17 flaps and flap performance is vital to an essential mission of the C-17, we reviewed the results of temperature and acoustic testing to determine whether the flap designed for the C-17 would withstand damage from heat and acoustic vibration, and would meet the 30,000-hour service life expectancy required by the aircraft development contract.

Heat can ripple or buckle the flap skin and weaken the internal flap structure. Acoustic vibration can stress the metal and cause cracking, structural damage, or weakening. The C-17's original flap design was based on testing done in 1986. That testing consisted of exposing a flat metal plate to the exhaust of a commercial jet engine, which indicated a maximum expected temperature of 150 degrees Fahrenheit.

However, a flap is a curved box structure, not a flat plate.

Tests in February 1991, using a test article configured more like a wing flap, showed that the flap would be subjected to maximum temperatures in the 300 degree Fahrenheit range, or twice the temperature for which the flap was designed. These higher temperatures were attributed to the different test article configuration and a channeling effect of other portions of the wing on the engine exhaust plume.

The temperature on the extended flap during flight tests has reached more than 400 degrees Fahrenheit, which is higher than anticipated. As a result, Douglas is adding titanium and additional composite materials to the inboard flaps.

Acoustic vibration tests in June 1990 on a 5-foot-long wing box section, which included the metallic trailing edge structure but did not duplicate the entire 25-foot-long flap, produced internal cracking after 5 minutes of acoustic exposure, indicating a need to strengthen the flap. A subsequent test in September 1990 on a strengthened test article showed that cracks occurred after one hour of exposure to acoustic vibrations, and the test was discontinued after the article had been exposed to the equivalent of about 1,500 flight hours. Based on this test, Douglas concluded that the life expectancy of the flap would be only 400 hours. Temperature, which could also affect flap durability, was not considered. Although Douglas has since strengthened the flap further, it has not retested to demonstrate the life expectancy of the strengthened flap.

Acoustic data collected during both ground and flight testing of the developmental aircraft suggest that the strengthened flap will be exposed to a lower level of acoustic stress in actual service than was earlier believed. However, the Air Force has not been able to obtain adequate acoustic data on the flap trailing edge because heat destroyed the test monitors.

Based on the test results and the importance of the flap to the C-17, we concluded that test plans should be established to determine whether the flap meets the contract service life requirement before the C-17 enters full-rate production.

In addition to our work, an independent Air Force review team commissioned by the C-17 System Program Office reviewed the available data on the flap and concluded that the initial structural design of the flap was unacceptable because the flap could not withstand the acoustic and temperature environment expected for the required life of the aircraft. The review team concluded that the final design of the flap should be tested through a combined heat and acoustic environment test to prove that the flap will achieve the 30,000-hour service life expectancy requirement.

In response to these conclusions, Douglas argued that data gathered during the February 1991 tests, during which temperatures over 300 degrees Fahrenheit were recorded and which were completed after the Air Force review team had completed its work, showed that the flap would operate in a less acoustically stressful environment than prior tests had indicated. However, Douglas did not address the effects of the higher temperatures. Three of the four members of the review team informed us that the February 1991 test results would not have changed their conclusion about the need for environmental testing.

In commenting on our findings, the Department of Defense stated that the results of the February 1991 tests as well as other testing plans already in place, such as developmental and initial operational testing, provide a sufficient basis to conclude that the specific life expectancy testing on the C-17 flap is not necessary. As we finalize our report, we will further evaluate the test results cited by the Department of Defense in its comments and the Air Force's plans for determining whether the flap will meet the contract requirement for 30,000 hours of service life.

However, while the current plans to acquire actual acoustic and temperature environment data from the flight test program and future developmental and initial operational test and evaluation plans will result in important assessments of aircraft performance, they will not yield flap life expectancy estimates. To result in life expectancy estimates, the acquired data would have to be used in an environmental test, which would take into account the combined effect of acoustic stress and heat on the flap over time periods representative of life-cycle experience.

We appreciate the opportunity to provide the results of our work to date for the record of this hearing. We will be pleased to respond to any questions you may have.