

C-5M

Executive Summary

- In February 2012, the Air Force completed a Force Development Evaluation of Operational Flight Program (OFP) 3.5 software combined with modifications to the engine thrust reversers. The C-5M with these upgrades is operationally effective, but it is still not operationally suitable.
- The C-5 Program Office is addressing deficiencies identified during previous operational tests, including problems with training systems and devices, Information Assurance, additional nuisance faults, the mission computers, the automatic throttles, and various maintenance Technical Orders through an extensive correction action plan. The Air Force plans to begin operational testing of OFP 3.5.2 in August 2013.
- The Air Force intends to award a contract for Core Mission Computer and Weather Radar upgrades in FY13.

System

- The C-5 is the largest four-engine military transport aircraft in the United States. The C-5 has 36 standard 463L pallet positions and airline seats for 81 passengers. It can carry a maximum payload of 270,000 pounds. The typical C-5 crew size is seven (two pilots, two flight engineers, and three loadmasters).
- The C-5M designation is the result of two separate but related modernization efforts:
 - The Avionics Modernization Program incorporates a mission computer, a glass cockpit with digital avionics (including autopilot and automatic throttles), and state-of-the-art communications, navigation, and surveillance components for air traffic management.
 - The Reliability Enhancement and Re-Engining Program provides over 50 reliability enhancements, plus commercial engines with new nacelles, thrust reversers, and pylons.



Mission

- Units equipped with the C-5 perform strategic airlift, emergency aeromedical evacuation, transport of brigade-size forces and equipment in conjunction with other aircraft, and delivery of outsize or oversize cargo (cargo that does not fit on a standard pallet).
- Units equipped with the C-5 execute missions at night, in adverse weather conditions, and in civil-controlled air traffic environments around the world. The units are capable of completing extended-range missions because the C-5 can receive in-flight aerial refueling.

Major Contractor

Lockheed Martin Aeronautics Company – Marietta, Georgia

Activity

- In February 2012, the Air Force completed a Force Development Evaluation of OFP 3.5 software combined with modifications to the engine thrust reversers in accordance with the DOT&E-approved test plan. OFP 3.5 is the second major modification to C-5M software.
- The Air Force made hardware modifications to the thrust reversers to address known deficiencies with deployment and retraction of the reversers.
- The Air Force began developmental testing of the next C-5M software version, Block 3.5.2, in May 2012 and plans to conduct operational testing in August 2013.
- The C-5 Program Office continues to address deficiencies identified during the C-5M initial operational tests in 2010, including training systems and devices, Information Assurance, additional nuisance faults, the mission computers, the automatic throttles, and various maintenance Technical Orders through a long-term corrective action plan.
- The Air Force intends to award supplier contracts for a new Core Mission Computer and a new Weather Radar in early FY13.

Assessment

- The C-5M is operationally effective with limitations. OFP 3.5 mitigates Environmental Control System Deficiency Reports, reduces nuisance faults related to the Engine Electronic Control, and marginally improves performance of the automatic throttles.
 - Operational problems remain that constrain throttle usage and increase pilot workload, including the automatic throttle's inability to "capture" a pre-set airspeed and the extent of airspeed deviations during critical flight conditions, such as final approach. OFP 3.5 modifications to the Environmental Control System and automatic throttles mitigated cabin pressure and cabin temperature fluctuations and reduced the very large throttle movements associated with the use of automatic throttles. However, failure to maintain a commanded airspeed during critical phases of flight remains a problem. The automatic throttle response improved with OFP 3.5 but still deviated outside specified criteria. During gusty or turbulent wind conditions, the automatic throttle had difficulty maintaining the set speed.
 - Prior to the recent modifications, the thrust reversers did not deploy reliably in flight due to the freezing of condensed water within the Center Drive Units of the thrust reversers. This condition limited the aircraft's capability for procedures such as rapid descent from high altitude and tactical descent in a combat zone. The Air Force installed a computer-controlled heater blanket on the Center Drive Units, which prevented ice formation and significantly increased the reliability of thrust reverser deployment in flight.
 - During developmental tests of the heater blanket, the thrust reversers exhibited retraction problems. If the reversers do not fully retract, the likelihood of a subsequent unintended deployment increases. Therefore, the engineers increased the retraction force and added mechanical snubbers (devices used to absorb excess force) to the thrust reversers. Now, the reversers deploy and retract reliably in flight, but require additional inspections.
- The C-5M is still not operationally suitable. The aircraft's ability to conduct the strategic airlift mission is hindered by deficiencies in the Automatic Flight Control System, by problems with the Embedded Diagnostics System (EDS) and built-in test (BIT) functionality, by inadequate support equipment, and by a lack of dedicated training systems.
 - Deficiencies in several aspects of C-5M support functions, identified before the 2010 OT&E began, had a significant effect on suitability, specifically the maintainability of the aircraft. Planned fixes for the deficiencies described below remain in development:
 - BIT – a very high false alarm rate combined with a low fault isolation rate increased the time needed to troubleshoot and complete maintenance actions. BIT detections of critical faults did not meet the requirement of 99 percent during operational testing. Incremental improvements are underway.
 - Training Systems and Devices – aircrew and maintainer training devices specific to the C-5M are just becoming available two years after the Full-Rate Production decision. The Air Force uses one simulator and on-aircraft training to mitigate the shortage of aircrew simulators. Maintainers still have insufficient simulators and must conduct training on the aircraft, which is restricted by the aircraft availability. The Air Force intends to accredit simulators for both aircrews and maintainers in FY13.
 - Information Assurance – the C-5M is susceptible to Information Assurance problems. The additional risk from information operations on the EDS is low. Air Mobility Command is addressing the Information Assurance deficiencies in the interface of the EDS. Improvements are anticipated in the Block 3.5.2 and the Core Mission Computer upgrades.

Recommendations

- Status of Previous Recommendations. The Air Force is addressing all previous recommendations.
- FY12 Recommendations. The Air Force should:
 1. Continue to pursue comprehensive remediation programs for known capability deferrals/deficiencies in the C-5 modernization programs.
 2. Aggressively seek timely and technically accurate aircrew and maintenance training systems and documents for the C-5M.
 3. Regularly report on suitability improvements and shortfalls in both new and legacy C-5M subsystems.
 4. Correct the remaining BIT, EDS, and engine support equipment deficiencies.