



## Winner

Lockheed Martin Aeronautics

## Achievement

First manned flight of an aircraft fitted with a total electric actuation system

**T**he judging panel was unanimous in selecting Lockheed Martin Aeronautics as the winner of the Engineering, Maintenance and Modification category for successful test flights of the manufacturer's 'power-by-wire' flight control system. From 24 October to 29 November 2000, the Advanced Fighter Technology Integration (AFTI)/F-16 aircraft successfully completed seven test flights of the Lockheed Martin system. The flights marked the first time that a manned aircraft of any type had flown with a total electric actuation system, without hydraulic or mechanical backups. The aircraft was flown by two Lockheed Martin test pilots from Fort Worth, Texas.

The flights followed extensive modifications of the AFTI/F-16 from 1997 to mid-2000 which saw the integrated servo actuators for the flaperons, horizontal tails and rudder on the existing primary flight control system replaced with electro-hydrostatic actuators. The aircraft was also modified with a new power generation and distribution system, while the aircraft instrumentation system was modified to record and transmit test data from the new systems.

All test objectives were achieved during the flights, according to Lockheed Martin. These included clearing the flight envelope in just four flights to supersonic conditions – Mach 1.3 at 30,000ft (9,150m) – and high q conditions – 500ktCAS at 15,000ft – performing classical flying quality manoeuvres. Handling qualities tested included air-to-air tracking, formation flying, simulated air-to-air refuelling and different landing approaches.

The new system performed "flawlessly", according to Lockheed Martin, adding that system reliability was due to extensive supplier ground testing – more than 200h of electric actuator integration testing and 800h of endurance testing. During the flights, the electric actuators proved to be more efficient in power usage than projected for steady state and peak demands, increasing the potential benefits of the system.

The flight tests were part of the Joint Strike Fighter/Integrated Subsystems Technology (J/IST) programme which is designed to reduce the risk of high-payoff technologies for the JSF programme. Lockheed Martin, Boeing and a joint US Air Force/Navy team had identified electric actuation as a key enabler for an integrated subsystem for the JSF. Integrated subsystems are more reliable, maintainable and affordable, resulting in 13% lower aircraft life-cycle costs. Integrated subsystems can also provide a 6% reduction in gross take-off weight, improved range and manoeuvrability and reduced fuel costs. Safety and combat survivability is also improved through the elimination of critical hydraulic pumps. The flight tests resulted in electric actuation being reduced to low risk and emerging as a strong candidate for inclusion in the JSF.

In addition to Lockheed Martin, the programme involved the USAF Research Laboratory at Wright-Patterson AFB, Parker Aerospace, Hamilton Sundstrand, Honeywell Engines and Systems, TRW Aeronautical Systems, Eagle Picher and BAE Systems.

"Power-by-wire will revolutionise aircraft design and manufacture, much as hydraulic flight controls did in the 1950s. Proper utilisation of this technology should reduce aircraft weight, increase maintainability, increase overall system safety and reduce the demand for toxic hydraulic fluid," said one judge.

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**The power-by-wire system performed "flawlessly" during flight tests on the AFTI/F-16**