NASA Facts

National Aeronautics and
Space Administration

Dryden Flight Research Center
P.O. Box 273
Edwards, California 93523
Voice 661-276-3449
FAX 661-276-3566
pao@dfrc.nasa.gov

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F-15B Research Testbed

Project Summary

NASA's Dryden Flight Research Center, Edwards, Calif., uses a modified F-15B aircraft as a testbed for a variety of flight research experiments. Coupled with either its Flight Test Fixture or Propulsion Flight Test Fixture mounted underneath the aircraft, the F-15B Research Testbed aircraft provides a unique flight research capability.

Dryden's modified F-15B (above), which has been outfitted with a Dryden-developed flight test fixture (pictured below) serves as an ideal testbed for a variety of flight research experiments.

Aircraft Description

Dryden's F-15B is a two-seat version of the F-15 tactical fighter aircraft built by the McDonnell Aircraft and Missile Systems division of the Boeing Company. The aircraft was obtained in 1993 from the Hawaii Air National Guard. In addition to flying research missions, Dryden's F-15B also is used for crew training, pilot proficiency and safety chase support for other research aircraft.

Bearing NASA tail number 836, the F-15B is about 64 feet long and has a wingspan of just under 43 feet. It is powered by two Pratt and Whitney F100-PW-100 turbofan engines which can produce almost 24,000 pounds of thrust each in full afterburner. It is capable of dash speeds of Mach 2.3, or 2.3 times the speed of sound, at altitudes of 40,000 to 60,000 feet. With the Flight Test Fixture mounted beneath the fuselage in place of the standard external fuel tank, speeds are limited to Mach 2.0. The aircraft has a full-fuel takeoff weight of about 42,000 pounds and a landing weight of about 32,000 pounds. It has aerial refueling capability for extended-duration research missions.

In 1997, installation of a new data acquisition system in the aircraft added a capability that makes the F-15B one of the most versatile testbed aircraft NASA flies. An on-board video system monitored from the rear seat of the cockpit provides a high-speed airborne video and photo capability that can be downlinked to researchers on the ground.

The data system includes a research airdata system for the aircraft itself, as well as a Global Positioning System (GPS) navigation package; a radome with a nose boom which contains an airdata probe; a digital data recorder; and telemetry antennas.

Flight Test Fixture II

The F-15B carries a test fixture to help conduct aerodynamic research experiments. The fixture, known as Flight Test Fixture II, is a fin-like structure mounted on the centerline of the aircraft's lower fuselage. Built primarily of carbon/epoxy materials, the fixture is in two sections: an upper avionics pylon and a lower test article. The avionics pylon is a permanent structure housing avionics, research instrumentation and other support equipment. Individual experiments are mounted on the lower section for flight testing. When needed, a removable air data probe is installed near the bottom of the test article's nose. Since the lower section is removable, it may be replaced by other aerodynamic shapes for specific experiments. The fixture is 107 inches long, 32 inches high and eight inches wide.

Propulsion Flight Test Fixture

A Propulsion Flight Test Fixture (PFTF) allows the aircraft to carry and test advanced prototype engines and propulsion technology. The PFTF, which contains fuel tanks and instrumentation for experimental engines, is a "flying engine test stand," allowing actual flight data on experimental engines that would otherwise be gleaned from traditional ground test stands. A critical component of the PFTF is called the force balance, a device consisting of two instrumented attachment points below the PFTF for attaching small test engines. The force balance instrumentation can measure just about everything on an experimental engine: test engine thrust, inlet drag, and aerodynamic movement.

Research Missions Highlight: Aerostructures Test Wing

A flight experiment called the Aerostructures Test Wing (ATW) conducted at Dryden successfully demonstrated a new software data analysis tool, the flutterometer, which is designed to increase the efficiency of flight flutter testing.

The experiment consisted of an 18-inch carbon fiber test wing with surface-mounted piezoelectric strain actuators. The test wing was mounted on a special ventral flight test fixture and flown on Dryden's F-15B.

The five-flight series consisted of increasing speeds and altitudes leading to the final test point of Mach .85 at an altitude of 10,000 feet. At each Mach and altitude, stability estimations of the wing were made using accelerometer measurements in response to the piezoelectric actuator excitation. The test wing was intentionally flown to the point of structural failure, resulting in about a third of the 18-inch wing breaking off. This allowed engineers to record the effectiveness of the flutterometer over the entire regime of flutter testing, up to and including structural failure.

The data acquired during the Aerostructures Test Wing experiment helps improve the way engineers model aircraft structures, and helps to validate the flutterometer concept. The data that was created from these flights may be invaluable to future flight flutter test engineers for research and training.

Potential benefits of this research include reduced time and cost associated with aircraft certification by lowering the number of flights required to clear a new or modified aircraft for flight, and provision of a structural dynamics database for industry and university flutter research.

Shuttle External Tank Insulation Tests

F-15B flight tests in January 1999 demonstrated that a new type of insulation foam used on the Space Shuttle's giant external tank remains intact under some of the dynamic environments seen during the initial stage of the Shuttle's ascent.

Mimicking a Space Shuttle launch profile, the F-15B flew a series of missions to evaluate the dynamic response characteristics of the new insulation material. The Shuttle External Tank Experiment involved six research flights over a two-week period by Dryden's F-15B in partnership with NASA's Marshall Space Flight Center, Huntsville, Ala., and the Michoud Assembly Facility near New Orleans, La.

On each flight, the F-15B was put through a series of side-to-side yaw maneuvers beginning at 7,300 feet altitude. Speed and altitude were increased in a stair-step approach, finally zooming up to 61,000 feet at speeds of up to Mach 1.5 before descending for landing.

RLV Technology Demonstrator Support

Included among F-15B research missions were studies of Thermal Protection System (TPS) materials for Reusable Launch Vehicle (RLV) technology demonstrator contract competitors. Flights supporting NASA's RLV program involved flying advanced ceramic and metallic TPS tile materials which were installed on a special nose section of the Flight Test Fixture. The materials were mounted at several angles to simulate impacts of rain drops, ice crystals or cloud droplets on a proposed RLV thermal protection system. The F-15B was flown through such weather conditions at different speeds while its video cameras recorded the condition of the TPS materials. These flights also validated the durability of different TPS materials at flight velocities for shear and shock loads similar to those the proposed RLC was expected encounter in flight.