

# **The X-51 Waverider**

## **What is the Waverider**

A hypersonic aircraft capable of operating continuously on jet fuel and accelerating through multiple Mach numbers.

The previous version, X-43, was fuelled by hydrogen and ran less than 2 min.

## **Who are involved**

Boeing and Pratt & Whitney Rocketdyne. The customers are U.S. Air Force Research Laboratory and the Defense Advanced Research Projects Agency (DARPA), with support from NASA.

## **How fast**

Up to Mach 7 – approx. 5,000 mph

## **Why – advantages**

Operate for much longer time and cover far greater distances

## **How's it work?**

The waverider is designed such that the bow shock is attached along the outer leading edge.

The attached shock wave creates an efficient compression lifting surface with no flow spillage from the lower surface to the upper surface.

The nose of the vehicle would create a conical shock around the body; such a shock results in significant pressure drag and must be overcome by propulsion systems. If the lower portion of the vehicle could keep the outer wing tips even slightly attached to the bottom portion of the conical shock, then the resulting total pressure on the bottom of the wing would be much higher than the top. This is the basic idea behind a waverider.

Aircraft body also creates a sideways, component. If deflected downward, lift could be further increased. Tip flaps or wing tips that deflect downward about a hinge line parallel to the flow direction accomplish this.

## **Some applications**

Applications for hypersonic vehicles are superfast airplanes, missiles and reusable space launch vehicles.

### **Testing (optional 1)**

Four or five flights starting any time now, continuing through fall.

Launch by a B-52 at about 35,000 ft, accelerate to the Mach 4.5 scramjet ignition speed by a solid-propellant rocket. Estimated target speed for the X-51A is between Mach 6 and 7.

Fuelled by military fuel JP-7, the scramjet engine of X-51 is designed to run for 5 min.

### **Engines (optional 2)**

Normally, as air enters a jet engine, it is compressed, and heats up

Need materials that can survive extremely high temperatures, therefore engines heavier, reduces the amount of fuel that can be burnt to avoid melting the gas turbine section, reduces thrust at high speed.

Key design feature for the Scimitar engines is the precooler, a heat exchanger that transfers the heat from the incoming air into the fuel.

Cools the air, allows the engines to burn more fuel even at very high speed, allows the engines to be made of lighter materials.

The rest of the engine is a high-bypass turbofan.

Good efficiency and quiet exhaust at low speeds.

X-51 uses the same JP-7 fuel that powered the SR-71 and engine could be adapted to use other hydrocarbon-based fuels.