Bumblebee

In November, 1944, the Navy's Bureau of Ordnance assigned the Applied Physics Laboratory of the Johns Hopkins University, Silver Spring, Maryland, to undertake the development of guided missiles to counteract the Japanese Kamikazee suicide plane threat, such as the manned Ohka bomb, against U.S. shipping in the Pacific Theatre in which the enemy craft flew beyond conventional anti-aircraft range. This project became known as Bumblebee which entailed several missiles. A facsimile of a test version of one of these missiles, shown here, was the ramjet-powered test vehicle known itself as Bumblebee, or more popularly called "the Flying Stovepipe," because its long propulsive tube which emitted exhaust gases resembled an old-fashioned stovepipe. The full-scale version of the Bumblebee was to be ship-launched and guided by radar.

Dimensions:

L.: 64 in. ramjet
L.: 4 ft . (total 9.3 ft.)
D.: 10 in. (ramjet)
Wid.: 2 ft. (booster)

Description:

Facsimile of a test model of the Bumblebee ramjet-powered missile consisting of the air intake tube and diffuser combination and separate booster cluster of four standard 5-in. solid-fuel High Velocity Antiaircraft Rockets (HVAR) with cruciform fins attached. The intake tube also serves as the combustion chamber and exhaust nozzle. Painted red and white checkered pattern for ease in tracking during its supersonic test flight.

History:

In July, 1944, the Navy's Bureau of Ordnance requested Section T of the Office of Scientific Research and Development (OSRD) to study anti-aircraft missiles to counteract the Japanese Ohka and other suicide weapons sent against U.S, shipping in the Pacific. The requirement was for a missile to shoot down a plane at a range of 20,000 yards at an altitude of 30,000 ft. On 30 November 1944, Dr. Merle A. Tuve, Chairman of Section T, submitted his report on supersonic and subsonic missiles to the BuORD, recommending the supersonic type missiles. He favored the ramjet since it was the only one capable of instantaneous and extremely fast (supersonic flights) though ramjets require a powerful rocket booster to get them up to immediate operating speed for air to be rammed through the air-intake tube. It also had no moving parts. Ramjet propulsion systems are thus very simple and economical though research needed to be

done on ramjet combustion and supersonic flight of the missile. The basic principle of ramjets had been known as early as 1908 in the writings of the French engineer Rene Lorin and during World War II the Germans had conducted experimental work but their results were not available until after the war. Tuve's recommendations were accepted, initiating Project Bumblebee.

Bumblebee's flight test program began in February, 1945. At first, non-burning 6-in. diam. Model 1 models were tried to study stability, drag, and launching techniques. Later in the year, hot rounds were fired using hepane. The original of the full-scale replica of the test vehicle shown here made a demonstration flight on October 16, 1945 at Island Beach, N.J. and reached a speed of 1,400-mph.

Even after the hostilities ended, the work was promising enough that it was continued. Larger engines were designed and built and in less than two years after the start of the program, the first 18-in. diameter test vehicle was launched and burned kerosene. All these test flights were low-altitude flights and the vehicles were equipped only with rudimentary fuel controls. During the course of this testing, a Bumblebee test vehicle attained supersonic speed of 1,500 mph (Mach 2) within seconds, becoming the first ramjet to reach supersonic velocity. Altitude flights were conducted later that eventually led to a beam-riding ramjet missile family that included the Talos. Other missiles that evolved from Bumblebee, not all ramjet powered, were the Terrier, Triton, Tartar, and Typhon.

Bumblebee test vehicle replica shown here, was donated to the National Air and Space Museum by the Johns Hopkins Applied Physics Lab in December, 1950. The original was used in the early phase of Bumblebee's aerodynamic flight testing, ca. 1945-1946, which included the use of HAVAR's (High Velocity Antiaircraft Rockets) for boosters since more powerful booster rockets were not yet available. Such test vehicles proved the feasibility of controlled flight at supersonic speed. Aerodynamic studies were also conducted in wind tunnels but the test vehicles obtained data under actual flight conditions. The vehicle traveled about five miles in its test and was tracked by radar, camera, and telemetry. It used gasoline and was unguided. The ramjet portion weighed about 70 lbs. The ramjet portion of the tests were conducted by Curtis-Wright. General Motors contributed toward research in fuel injection and mixing.

Later test vehicles used a combination of six HVARs as boosters. There were also combinations of four British UP-3 rockets for control test vehicles (CTV's) and four T10E1 rockets. Because of their low impulse-to-weight ratios, these clustered boosters were adequate for small test vehicles but infeasible for the planned larger missiles. With the introduction of much larger, single boosters, such as Aerojet's 2-AS-AS-65,000, producing 65,000 lbs thrust for 2 seconds, test flights were conducted with larger ramjets at the Naval Ordnance Test Station at Inyokern, Calif. The first large, single booster Bumblebee flights were

made in June, 1947, with Alleghany Ballistics Laboratory (ABL) cast double-base solid-propellant boosters.

In the meantime, from 1946, requirements for Bumblebee had considerable expanded its scope and called for long range (400 miles or more) ship-launched missiles for land bombardment targets, besides anti-aircraft missions. This led to the evolution of other missiles under a Bumblebee II program.

Sources:

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Author: Space History Division