

50 Years of Excellence in Space and Missile Defense

The Homing Overlay Experiment

The first 'hit-to-kill' kinetic energy interceptor missile

SMDC/ARSTRAT Historical Office

On its fourth attempt the Homing Overlay Experiment (HOE) intercepted a target vehicle over the Pacific Ocean — the first successful “hit-to-kill” intercept in ballistic missile defense history.

Until the 1980s all missile defense interceptors used a nuclear explosive warhead to compensate for the system's inability to achieve a precise intercept of incoming enemy ballistic missiles. In the 1970s the U.S. Army began studying the feasibility of hit-to-kill vehicles, where an interceptor missile would destroy an incoming ballistic missile just by colliding with it. These kinetic energy kill vehicles were possible with the advances made in infrared sensors and computer technology. The first such effort was the Homing Overlay Experiment Task Force, charted by the Ballistic Missile Defense System Command (later to become SMDC/ARSTRAT) in March 1977.

The two-phased HOE effort began with technology verification, followed by the flight demonstration program scheduled for 1982-1983. Engineers designed the experiment to resolve specific development issues. These were Search, Acquisition, and Detection; Discrimination (including scan-to-scan correlation); Designation; Homing Guidance Accuracy; D3 and Track in the Natural and Induced Environments; and, Sensor to Sensor Handover/Correlation). The overall objective was to demonstrate the exo-atmospheric intercept of a mock ICBM reentry vehicle using infrared homing sensors and a non-nuclear kill vehicle. With these parameters, existing hardware was used wherever possible.



U.S. Army photo

The HOE team poses for a post-launch celebration photograph.

The basic program consisted of four flight tests that were intended to demonstrate interception within the exo-atmosphere as well as provide target acquisition, designation, and track capability. In all cases, the target vehicle was a reentry vehicle or missile launched from Vandenberg AFB on a trajectory so that intercept would occur more than 100 nautical miles above the Earth and would impact several degrees north of Kwajalein Atoll in the central Pacific.

Launched by a two-stage Minuteman booster, the HOE kill vehicle consisted of a computer, a long wavelength infrared optical sensor package for guidance and a unique kill device. The HOE measured 70.6 feet and weighed a total of 68,081 lbs. The kill vehicle alone weighed 2,600 lbs.

When the missile reached a point above the atmosphere, onboard computers projected the target's position ahead in time to provide pointing commands to the cryogenic infrared sensor mounted in the

kill vehicle. Once the target was detected by the kill vehicle, a sophisticated set of computer algorithms produced a highly refined trajectory estimate based on the sensor data acquired in real time.

During this time of observation and trajectory refinement, all objects appearing in the field of view were assessed automatically to determine which was the real target.

In the final stage before intercept, the kill vehicle would unfurl the spokes of a 13-foot radial net that would capture the reentry vehicle.



Courtesy of Lockheed Martin Missiles and Space

Artists concept of the HOE “radial net” which unfurled before intercept.

To make the test as realistic as possible, the launch was delayed until ground-based radars detected the target launch, 4,500 miles away at Vandenberg AFB. The ALCOR radar on Roi-Namur, in the Kwajalein Missile Range, acquired and tracked the target before the HOE was launched, about 20 minutes into the target flight. Three sources confirmed the destruction of the target, radar and optical sensors on Kwajalein and a specially instrumented aircraft. The three earlier test flights, although not completely successful, provided 90 percent of the required data and contributed to the successful intercept on the fourth try.

On June 10, 1984, in its fourth and final flight, the HOE successfully completed the first kinetic kill intercept. Launched from Meck Island, the HOE kill vehicle intercepted a mock ICBM reentry vehicle at more than 15,000 feet per second, and telemetry data shows that they smashed into each other nose to nose. This was an incredible feat when it is realized that the combined velocity of the HOE and the incoming missile was more than four miles per second (an M16 bullet travels at approximately 2/3 of a mile per second).

As principal deputy assistant secretary of the Army, Amoretta Hoerber explained, “We tried to hit a bullet with a bullet and it worked.” Ultimately, the evolution from nuclear to kinetic energy intercepts, represented by the HOE system, was the first major revolution in ballistic missile defenses since the United States began BMD research in the 1940s.

The technological significance of the Homing Overlay Experiment was considered so important that the government-industry team responsible for the success received the 1986 American Defense Technical Achievement Award.



U.S. Army photo

HOE lifts off at Kwajalein Missile Range.

Members of the team who shared the award included: U.S. Army Strategic Defense Command, Lockheed Missiles and Space Company, Honeywell International, Rockeddyne, Space Vector Corporation, McDonnell Douglass, Teledyne Brown Engineering, Nichols Research Corporation, Aeromet Incorporated, MIT Lincoln Laboratory, and the Sandia National Laboratory.

The success of the Homing Overlay Experiment was marred eight years later when missile defense pundits at *The New York Times* suggested that the intercept test had been rigged by placing a transponder or “radar beacon” in the target missile.

The Times stated that the rigged test was an effort to deceive Congress into providing more funding for missile defense testing. Les Aspin, the Secretary of Defense under President Bill Clinton, authorized a thorough investigation.

An investigation team, headed by Brad Hathaway of the General Accounting Office, provided their report to Congress on July 21, 1994. The principle finding of the investigation was straightforward: “Our conclusion then, was that the experiment was not rigged and, in fact, could not be rigged by the presence of the radar beacon.”

The report went on to explain: “There was a radar beacon aboard the target vehicle. We also found that there was no receiver on board the interceptor for this radar. The beacon had been placed to assist in range and safety tracking of the target from the ground. The beacon was of a type not capable of giving final guidance to an interceptor.”

Although *The Times* and other newspapers trumpeted the original accusations against the experiment, the conclusions of the General Accounting Office's investigation were widely unreported.

Despite the comments of naysayers, nothing can detract from the accomplishments of the Homing Overlay experiment and the first hit-to-kill intercept of an ICBM. The concept that was proven by the HOE became the foundation of hit-to-kill technology that was refined by later experiments and projects and was eventually deployed as part of the Ground Based Mid-Course Defense System.