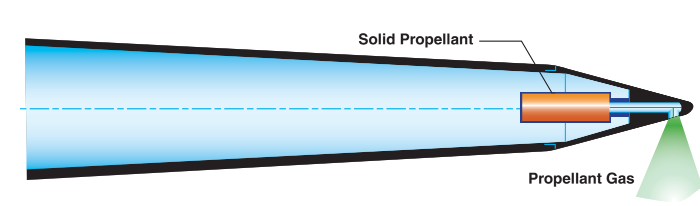
Eight-inch projectile prototype.

Eight-Inch Projectile Capability

Currently, the Range G provides the capability to launch larger projectiles (203-mm (8-inch) diameter) with weights up to 12 kg at launch velocities up to 4 km/second. Projectiles launched from two-stage light-gas guns experience acceleration loads that are typically orders of magnitude greater than that of the actual missile defense system. These acceleration loads drive design compromises in the projectiles geometry and mass-density distribution to survive the launch environment.

A "high fidelity" projectile with the proper geometry and mass-density distribution would provide a more representative simulation of the flight vehicle kinetic energy release at impact. Current upgrades under development in the Range G facility will provide for the capability to launch large-scale "higher fidelity" projectiles at higher velocities than is currently possible in ballistic ranges. In addition, AEDC is also developing a rocket motor pitch technique for providing various projectile pitch angles at the point of impact with a simulated target. These unique capabilities will make it possible to obtain more flight representative lethality data in a ballistic range."



Rocket motor pitch technique.

Scramjet Testing

Another new capability being explored is a low-cost alternative of flight-testing scramjet-integrated hypersonic vehicles by launching these vehicles in AEDC's hypervelocity gun. An axis-symmetric scramjet projectile was designed and launched at AEDC Range G Facility in 2000. Additional launches were accomplished in 2001. The ultimate program goal is to demonstrate supersonic combustion ramjet (scramjet) operation in a ballistic range and measure powered acceleration using instrumentation and measurement techniques. Performing scramjet testing in a ballistic range could greatly reduce program flight test costs.

These original tests are instrumental in developing methodologies for evaluating hypersonic flight. This capability will allow hypersonic sub-scale testing at speeds above Mach 5. Data from these shots have proven the effectiveness of using a hypervelocity ballistic range for providing low costs, free flight testing of hypersonic air breathing propulsion systems. This new test capability will give the hypersonic air breathing engine developers with another tool when transitioning from wind tunnels to expensive high risk, full scale scramjet flight-testing.

Mach 8 scramjet model

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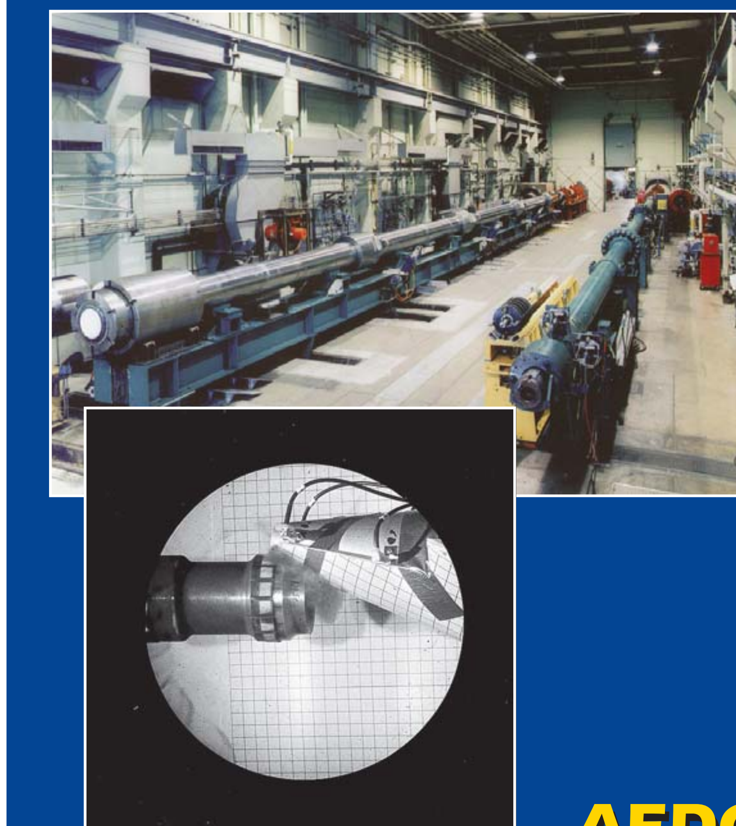
Impact and Lethality Testing



AEDC Hypervelocity Range Facility

Arnold Engineering Development Center
Arnold Air Force Base, Tennessee

An Air Force Materiel Command Test Center

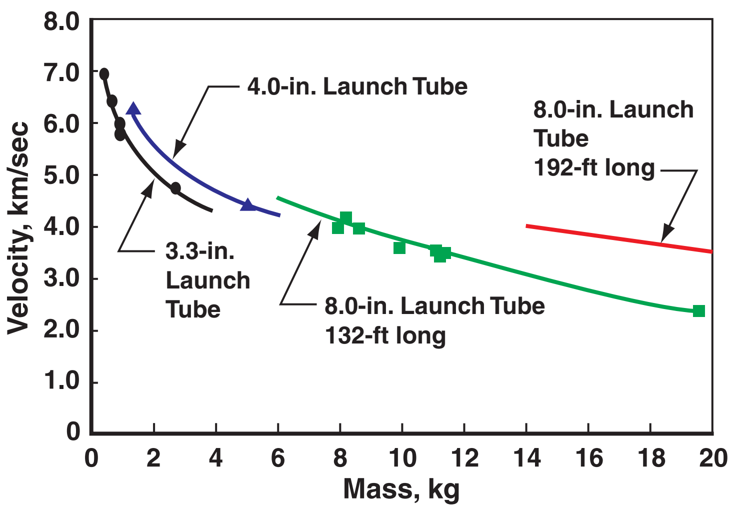
Range G Largest Two-Stage, Light-Gas Gun

The Hypervelocity Ballistic Range G at the Air Force's Arnold Engineering Development Center (AEDC) is used extensively to conduct kinetic energy lethality and impact phenomenology tests.

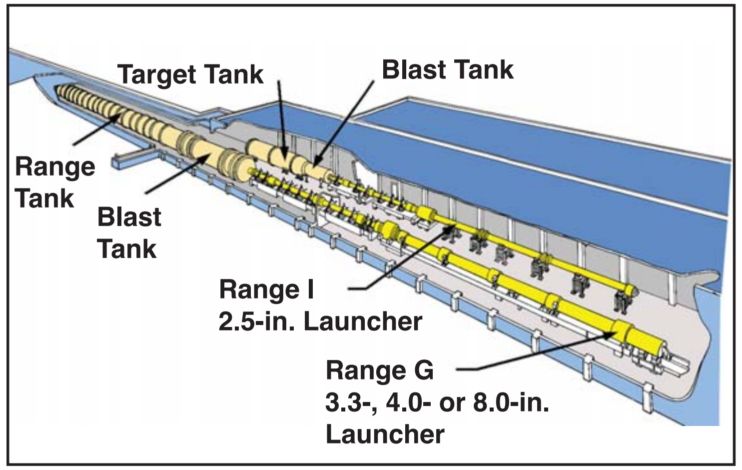
Since 1963 AEDC has conducted more than 9,000 hypervelocity ballistic range shots in the facility.

The Range G launcher is the largest routinely operated two-stage, light-gas gun system in the United States that provides unequalled "soft launch" (minimized acceleration loading) capability to launch extremely high-fidelity missile simulations at hypervelocity speeds.

Quarter-scale tests at velocities from 2- to 7-km./second (6,600 to 23,000 feet/second) have been the typical regime for Range G, but recent improvements have extended the range of capabilities to near half scale. Current upgrades under development in the Range G facility will provide for the capability to launch large-scale "higher fidelity" projectiles at higher velocities than is currently possible in ballistic ranges.



Demonstrated capabilities of launch tubes.

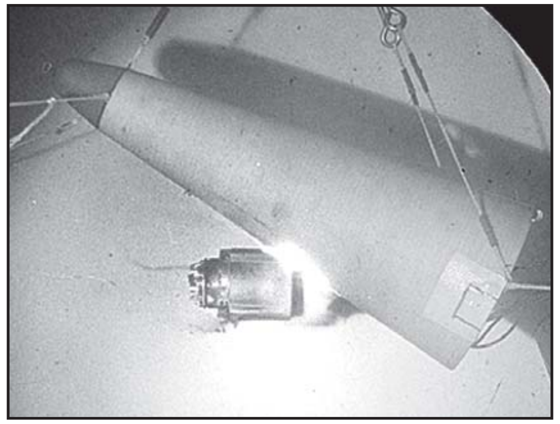


Range G facility.

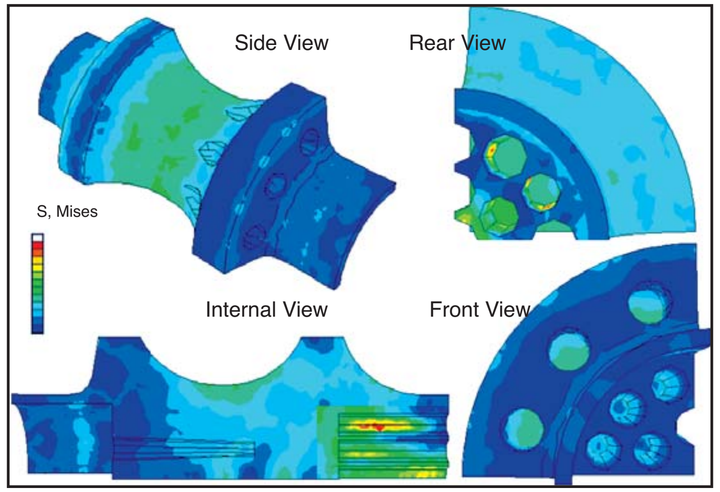
Range G Capability

The Range G launcher is a two-stage, light-gas gun that is capable of launching various types of projectiles at velocities up to 7 km./second (23,000 feet/second). Projectiles up to 203-mm (8.0-inch) diameter are launched into a 3-m (10-feet) diameter, 283.5-m (930-feet) long instrumented tank that can be maintained at pressures from 0.2 torr to 1.7 atmospheres. Three sizes of interchangeable barrels (84 mm (3.3 inch), 102 mm (4 inch), 203 mm (8 inch)) are available for use on the Range G launcher. A four-rail guidance system can be mated to the barrel in order to guide the projectile close to the target and provide increased hit-point accuracy.

Impact against simulated warhead.



The 84-mm (3.3-inch) diameter launch tube is typically used to support one-fourth scale testing (projectile and target one-fourth size of full-scale system), but in order to meet the lethality test requirements of missile defense programs, AEDC has developed the capability to launch larger-scale projectiles (up to 203 mm (8 inch)) at higher velocities than was previously achievable at any ground test facility. With this capability, AEDC is able to provide a greater level of projectile and target fidelity for test conducted with two-stage light-gas guns.



Stress distribution in GMD projectile.

The primary challenge in designing projectiles for gun range lethality testing is to develop a geometrically-scaled projectile that matches the axial and radial mass distribution of the actual missile and is also able to withstand the acceleration loads experienced during gun launch. The use of 3-D finite element analysis software (ABAQUS) coupled with the AEDC light-gas gun code, provide a seamless design path that permits engineers to analyze proposed projectile designs in a simulation of the dynamic environment of launch. This capability not only allows for the design of higher fidelity projectiles, but also minimizes the expense of developing these complex projectiles.

High fidelity prototype projectile being loaded.

The G Range facility has an extensive assortment of unique test instrumentation that can be located as required for a particular test.

New instrumentation capabilities are also being developed to aid in kill assessment using multi-spectral/infrared signature measurements. A high-speed x-ray imaging system also being developed will provide a method for understanding post impact debris dispersion.