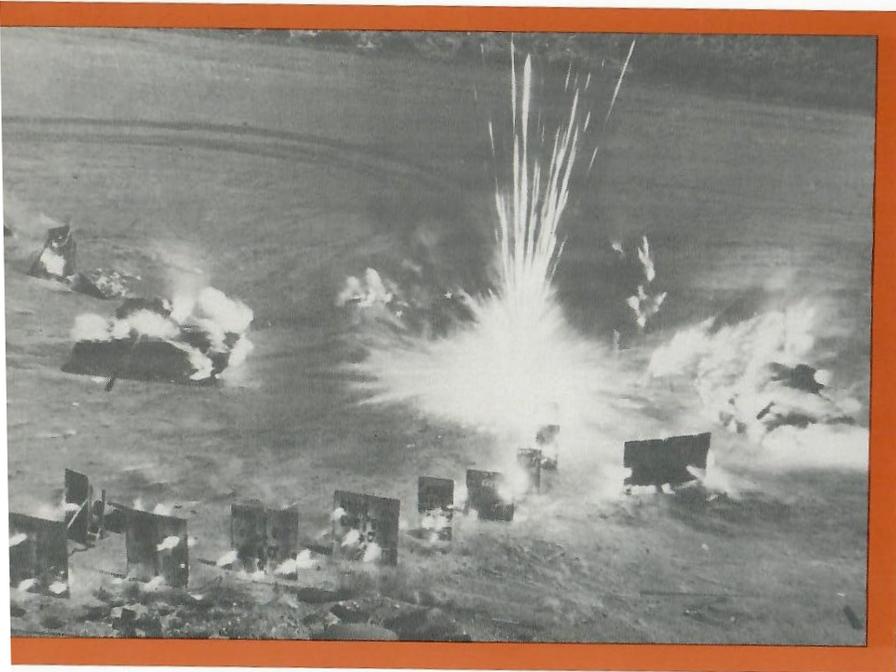


WARHEAD DEVELOPMENT PROGRAMS

TERA is best known for original work in the fields of aircraft vulnerability testing and anti-aircraft-warhead design and evaluation. Originally participating in design, test, and evaluation work for the TALOS, TARTAR, and TERRIER warhead systems, the group has been more recently active in projects with the SEASPARROW, PHOENIX, Standard Missile II, AMRAAM, CHAPARRAL, and ROLAND warhead systems. Current developmental work includes programs involving self-forging fragments and shaped-charges utilizing heavy-metals.

A number of the products of TERA's research and development efforts with anti-aircraft warheads are considered to be original concepts. These include the continuous-rod warhead, the focused-fragment controlled-motion (FFCM) warhead, and the wrap-around and other aimable warheads, to name a few.

Recent (1979-1981) development work on a High-Ballistic Coefficient (HIBAL) warhead provides an illustration of



TERA's broad capabilities in this field. Vulnerability analyses conducted by TERA on certain large threat-aircraft indicated that these targets would be susceptible to engine kills resulting from ingestion of fuel from fuel cells located in the fuselage. Such kills could result from fragments penetrating the fuselage, including the fuel cells and the liquid in them, and producing an exit hole on the far side to dump fuel into the far-side engine air duct (blast and fragment effects would also kill the near-side engine). An effort was mounted to develop a high-ballistic coefficient fragment, one that could accomplish the especially difficult task of penetrating large amounts of liquid fuel and that could be packaged efficiently in a warhead.

Liquid-penetration tests were conducted with tanks of water, and fuel-dump studies examined the nature of liquid flow from a punctured fuel cell. Prototype HIBAL fragments were defined, and work began on the design of a

warhead that would fit the delivery system and project the fragments with the required velocities and patterns. Two warhead prototypes were developed, one incorporating a unique method of "fireforming" properly sized fragments from the warhead case through a technique referred to as "opposed grooving." Once these prototype warheads were developed and proven in characterization tests, a series of lethality tests ensued in which the devices were employed against static aircraft targets, including a fuselage containing a running engine and a full fuel cell, and fragments in direct encounters with static running engines. All of this was accomplished with TERA's facilities at New Mexico Tech, on schedule, in two years, within a budget of \$1 million. The product was not just a new anti-aircraft defense capability, but also a considerable body of data on liquid penetration, fuel-dump dynamics, and fireformed-fragment engineering.

