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# Technology as Deterrence



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TECHNOLOGY DESCRIPTION SHEETS  
FROM THE

## AMC 1990 TECHNOLOGY EXPO

\*Original contains color plates; All DTIC reproductions will be in black and white\*

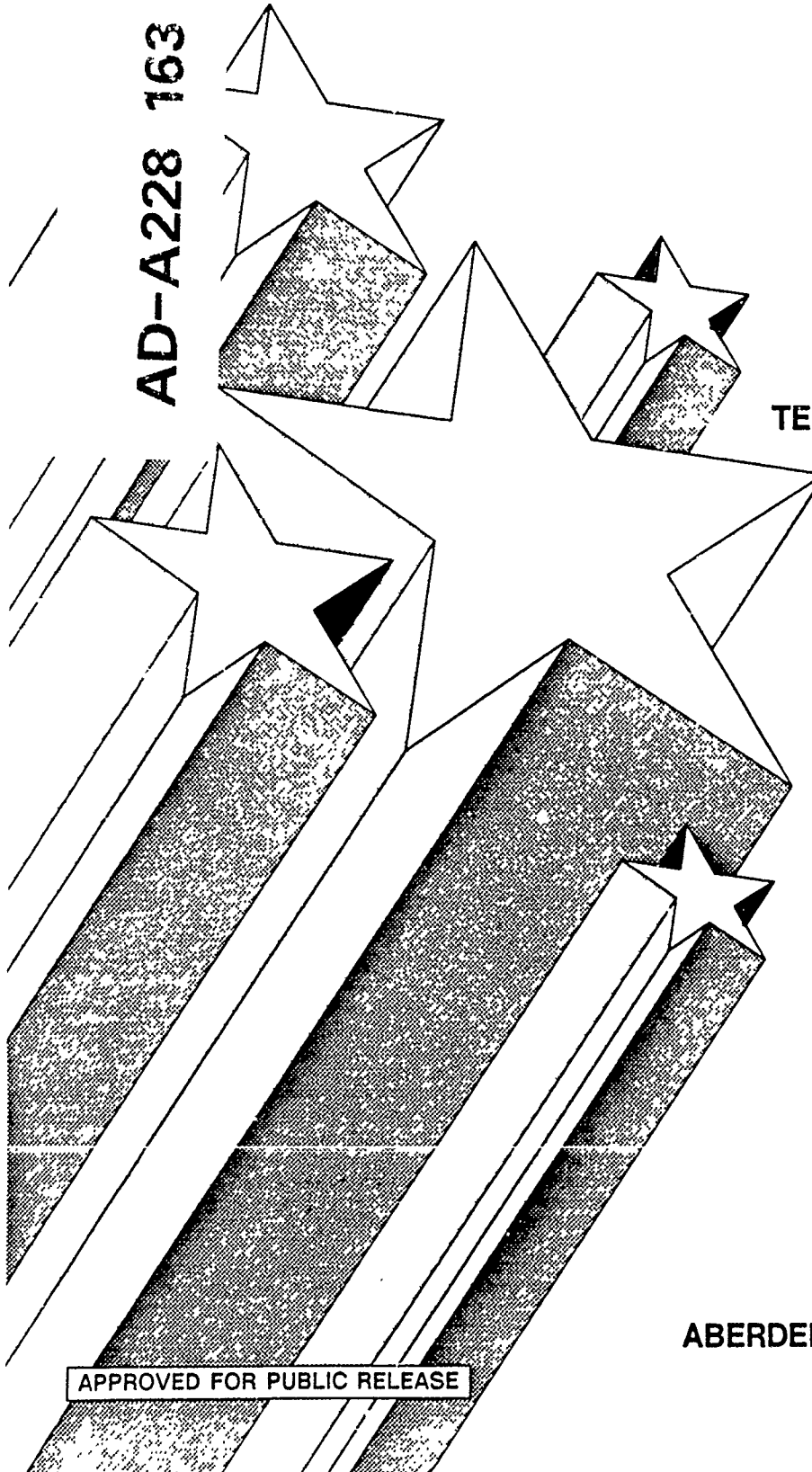
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MATERIEL COMMAND

1-4 OCTOBER 1990

ABERDEEN PROVING GROUND, MARYLAND

APPROVED FOR PUBLIC RELEASE



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13 ABSTRACT  The report describes the tech base investment strategy and contains technology description sheets representing various technologies that were exhibited and demonstrated at the U.S. Army Materiel Command's Technology Expo that was held at Aberdeen Proving Ground on 1-4 October 1990. Each sheet lists the name, phone number, and organizational affiliation of a point of contact who is able to provide additional information on each technology.			
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# INTRODUCTION

The U.S. Army Materiel Command held a technology expo on 1-4 October 1990 at Aberdeen Proving Ground, Maryland. The objectives of the AMC 1990 Technology Expo were to—

Promote an understanding of the role and importance of the Army Technology Base.

Demonstrate the products and capabilities of the laboratories, research, development, and engineering centers, and test facilities.

The Technology Description Sheets that follow represent the various technologies that were exhibited and demonstrated at the Technology Expo. They are arranged according to the four domains of the Army's tech base investment strategy:

Emerging Technologies

Systemic Issues

Supporting Capabilities

Next Generation & Future Systems, including Advanced Technology Transition Demonstrations

In addition, we have printed at the top of each sheet the functional area that was used for structuring the Technology Expo exhibits and demos. Also listed on each sheet is the name, phone number, and organizational affiliation of a point of contact from whom you may obtain additional information.



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# Technology as Deterrence

*The overriding mission of U.S. forces is to deter war.* To maintain peace for the United States and the free nations throughout the world, we must convince potential adversaries that the cost would be too high and the probability of success too low for them to risk entering into an armed conflict. The most convincing deterrent is one that clearly demonstrates our military strength and our willingness to fight and win.

As promising as the changes in the Soviet Union and the Eastern Bloc countries may be, we must maintain a sufficient level of deterrent capability. Current budget cuts and reductions in total strength of U.S. forces mean that our ability to sustain and operate forward deployed forces will be reduced. While the threat of conventional warfare appears to be declining, the possibility of nonconventional and low-intensity conflicts is on the increase. Deterrence requires capabilities that span the entire spectrum of potential conflict.

Capitalizing on technology is the first step in the critical process of ensuring a capable and modern force that will meet the strategic needs of the nation. The rapid pace of advances in technology will continue to tax our ability to absorb and to exploit the most promising innovations. Support to the Army of the future begins with careful selection and management of technology.

*The U.S. Army*, through the appropriate staff offices and major commands, carefully manages our technology base. Near-term and next-generation advancements to help counter an ever-changing threat are of primary concern. Our objective is increased performance and survivability, coupled with easier maintenance and lower support costs.

The Army's laboratories and research, development, and engineering (RD&E) centers are dedicated to ensuring that our country has the best weapons and equipment in its history. The creativity of the Army's technology base community is a national asset; it is a key force in developing new technologies to deter our adversaries and to provide for the common defense.

*The Technology Base* is the "seedcorn" from which new and innovative devices and systems will spring, leading to more powerful weapons, more flexible communications, faster and more reliable processing of battlefield information, and safer and lighter personal equipment. All this and more will emerge from the Army's technology base. And yet, as the budget shrinks, we cannot afford to invest in all the opportunities that are available. A strategy is needed to guide our investment of scarce R&D funds and to ensure that the most important and most effective technologies are supported first, without abandoning other potential capabilities for the more distant future.

Hence, the Army developed a Technology Base Investment Strategy to evaluate the potential worth of technological opportunities and assign them priorities according to a well-designed plan.

*The Technology Base Investment Strategy* (Figure 1) consists of four parts. The largest part focuses on future battlefield capabilities: we need to identify and overcome critical technology barriers associated with new and improved next-generation or future systems. The key step in such efforts is to conduct "Advanced Technology Transition Demonstrations" under realistic field conditions with actual soldiers before beginning full-scale development, procurement, and fielding.

The second largest segment of the investment strategy addresses key emerging technologies that show potential to greatly increase battlefield effectiveness, some of which are not yet ready for incorporation into specific systems. Here we are pushing back the frontiers of science and advancing the state-of-the-art in technologies that will lead us into the 21st century.

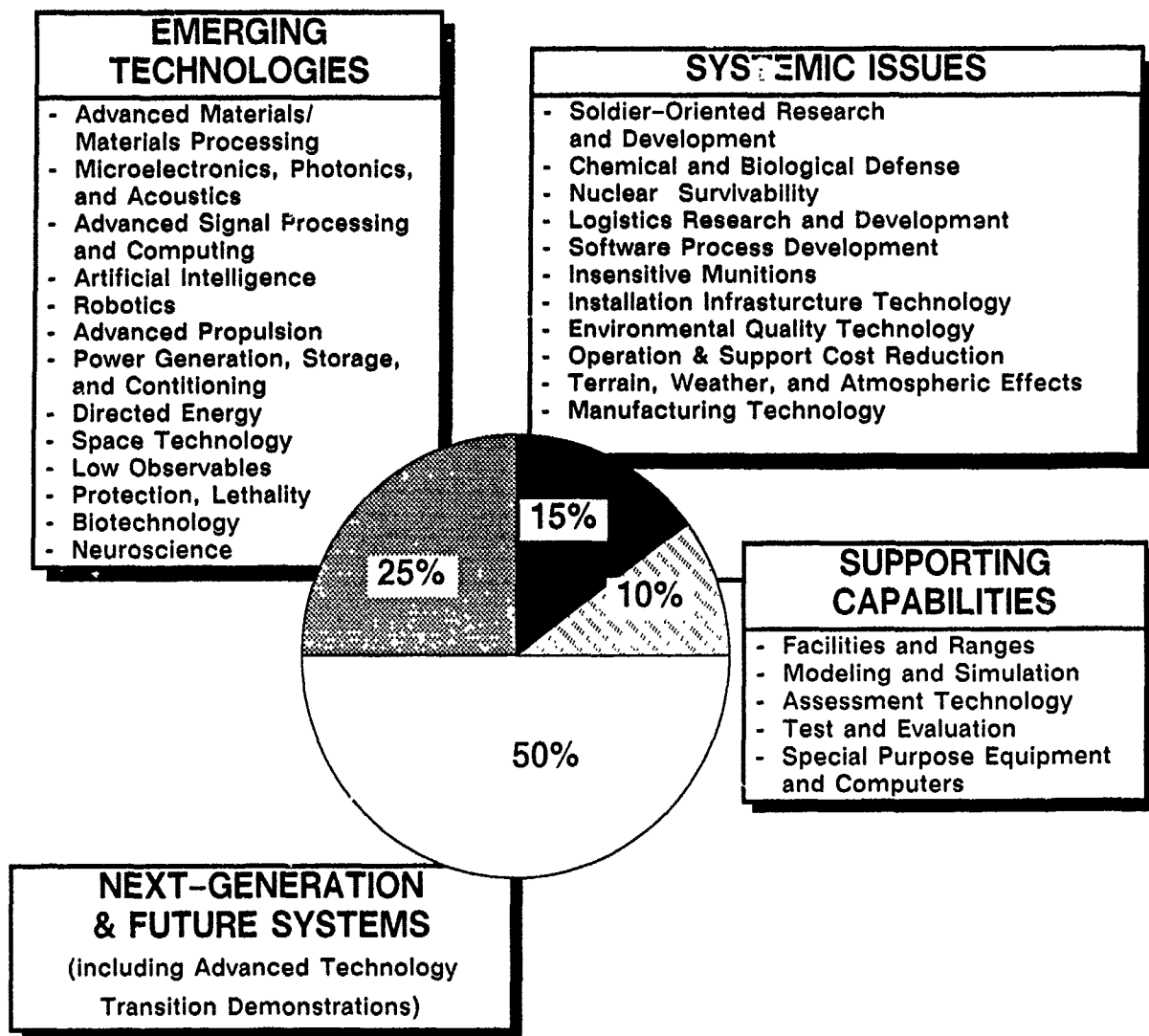


Figure 1. Tech Base Investment Strategy

The third segment deals with chronic or systemic problems that reduce battlefield effectiveness. We cannot afford to ignore such problems or to use "band-aid" solutions. Thus, part of the Army's investment strategy is to constantly improve our capabilities in these diverse areas through innovative approaches.

In the fourth segment, the Army recognizes that for the overall strategy to succeed, the R&D infrastructure must have modern facilities and test equipment.

## EMERGING TECHNOLOGIES

The Army devotes a quarter of its technology base dollar to developing key emerging technologies. Thirteen technologies have been identified which present such exceptional opportunities that they are given special emphasis and management attention. These critical technologies have a large potential to affect a variety of missions. They will be a basis for the weapons systems of the next century.

The key emerging technologies include robotics, artificial intelligence, and advanced signal processing and computing, as well as the supporting areas of microelectronics, photonics, and acoustics. Programs are also under way in advanced materials and materials processing, biotechnology, and neuroscience. Futuristic programs in low-observable, space, and directed-energy technology are already under development. Advanced concepts in power generation, propulsion, and lethality are also being explored.

The Army's goal is to exploit the most promising technological advancements in government, industry, and academia in the United States and abroad.

## **ADVANCED TECHNOLOGY TRANSITION DEMONSTRATIONS, NEXT-GENERATION & FUTURE SYSTEMS**

The Army devotes half of its technology base resources to speeding the introduction of advanced technologies into new and improved combat systems. This is done by conducting Advanced Technology Transition Demonstrations (ATTDs). These demonstrations are the link between the technology developer and the actual user, the soldier in the field. They serve as a "proof of principle" that specific operational requirements can be met and that the risk of proceeding with further development is acceptable.

The ATTDs lead to next-generation and future systems. These systems are, in reality, concepts for hardware and software that could significantly increase the Army's warfighting capability across the entire spectrum of conflict.

The ATTDs and the next-generation and future systems are coupled to the overall force modernization strategy through Army modernization plans. Each of these plans is approved by the Army Chief of Staff and describes mission or functional area needs that require advanced materiel solutions.

## **SYSTEMIC ISSUES**

It is not enough to develop new technologies. To succeed in battle, the Army must take into account how soldiers need to operate and maintain equipment under real, and often harsh, battlefield environments. Systemic problems affect every soldier and system every day.

The Army devotes fifteen percent of its technology base resources to resolving these all-pervasive issues. This investment will enhance the performance and survivability of the individual soldier, increase the capability of his/her equipment, and minimize the resources needed to sustain that equipment in peacetime and in wartime.

Systemic issues investigate ways to: enhance the soldier-machine interface; improve nuclear, biological, and chemical survivability; reduce the logistics burden; reduce operation and support costs; advance software process technology; develop better methods of safely handling lethal munitions; upgrade aging facilities; mitigate the Army's impact on the environment; broaden our understanding of the effects of weather and terrain on combat; and advance manufacturing technology so that new economies are brought to the defense industrial base.

## **SUPPORTING CAPABILITIES**

Advances in the technology base cannot be accomplished without world-class laboratories, support facilities, and advanced test equipment. Much of this infrastructure is unique and must be custom designed or adapted specifically for Army needs. Ten percent of the technology base is devoted to providing the tools and techniques needed by the Army laboratories and RD&E centers.

These supporting capabilities include the development and acquisition of new and more powerful computers, the ability to model and simulate weapon systems and subsystems under development, and the ability to assess the impact of new technology on the future battlefield. We must also develop means to test and evaluate complex systems from basic research through full-scale development, including a wide range of environmental simulators.

# INTRODUCTION

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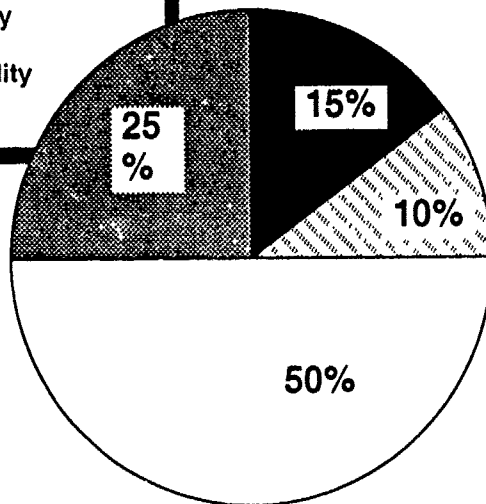
Next Generation & Future Systems, including Advanced Technology Transition Demonstrations

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## EMERGING TECHNOLOGIES

- Advanced Materials/  
Materials Processing
- Microelectronics, Photonics,  
and Acoustics
- Advanced Signal Processing  
and Computing
- Artificial Intelligence
- Robotics
- Advanced Propulsion
- Power Generation, Storage,  
and Contitioning
- Directed Energy
- Space Technology
- Low Observables
- Protection, Lethality
- Blotechnology
- Neuroscience





U.S. Army Laboratory Command

## High Performance Displays for Today's Information-Intensive Applications

The Display Devices Technology Center, located at the Electronics Technology and Devices Laboratory (ETDL), provides solutions to effectively access large, complex data bases via interactive, flat panel display devices. The Laboratory Command's sponsorship of basic development of thin film electroluminescent (TFEL) flat panel display technology within the United States impacts both military and commercial display development and production.

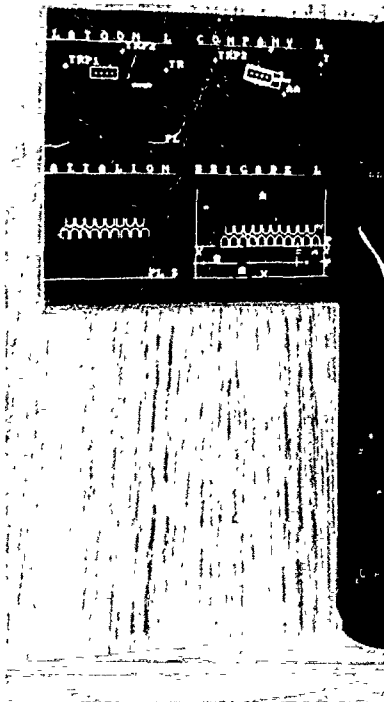
The major thrust of the display development effort has been directed toward TFEL flat panel technology because of advantages with regard to weight, power, legibility, and ruggedness. Monochrome panels under development range from 3.0x5.0 inches at 64 lines per inch up to 1.0x1.0 meters at 50.8 lines per inch, with a variety of other intermediate sizes. Advanced developments in flat panel technology include multicolor, full color, and three-dimensional stereographic panels which exist in laboratory demonstration models.

In addition, the Display Devices Technology Center participates in the development of other flat panel technologies, such as liquid crystal and plasma displays, and supports development of new display approaches by evaluating and analyzing experimental samples in conjunction with manufacturers and device developers.

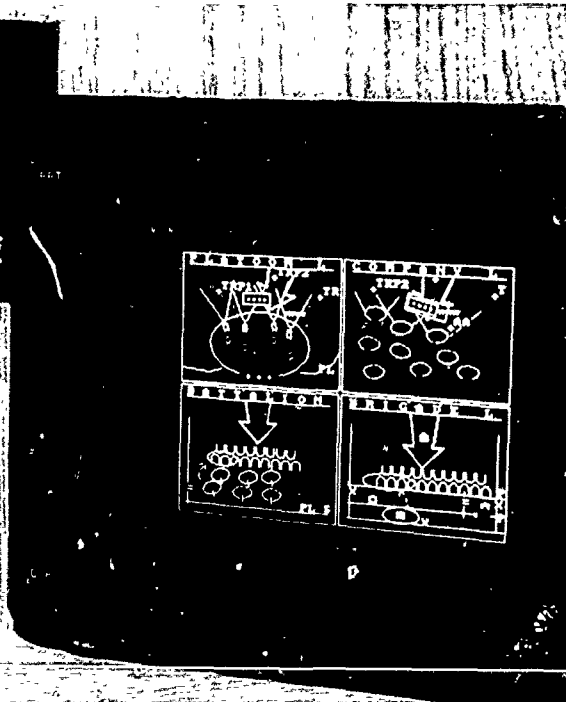
Man-portable interactive  
Commander's Intelligent Display.



Multicolor TFEL flat panel display.



Monochrome TFEL flat-panel display.



For additional information, contact:  
U.S. Army Electronics Technology and Devices  
Laboratory  
Attn: SLCET-SD-A, M. Robert Miller  
Fort Monmouth, NJ 07703-5000  
AV 995-4994 or (908) 544-4994



U. S. ARMY LABORATORY COMMAND

## Artificial Intelligence Tech Base Research

Artificial Intelligence (AI) Tech Base Research and Development at the Human Engineering Laboratory focuses applied research on complex, real-world problems for which AI technologies are appropriate and uses unique military requirements to pull AI technology development. Areas of high potential payoffs in productivity and decision quality are targeted, with a focus on problems that represent a family of applications which exhibit complexity, uncertainty, and change. Projects include AI technology demonstration efforts in the following logistics areas:

**LOGISTICS PLANNING** Knowledge-based planning techniques such as constraint directed search provide tools to deal with computationally complex problems, such as the allocation of resources, the planning and replanning of a course of action, and the configuration of facilities. One project demonstrates interactive generation of corps-level ammunition inventory, distribution and transportation plans.

**LOGISTICS SITE LAYOUT** Knowledge-based techniques are used to plan the layout of field logistics storage sites, with the goal to decrease planning time by tenfold, while significantly improving the degree to which the layout conforms to Army doctrine, safety, road, and terrain constraints. The prototype ammunition-supply point planner unified a geographic information system and terrain analysis system, an object-oriented terrain database, and AI-based tactical decision aids.

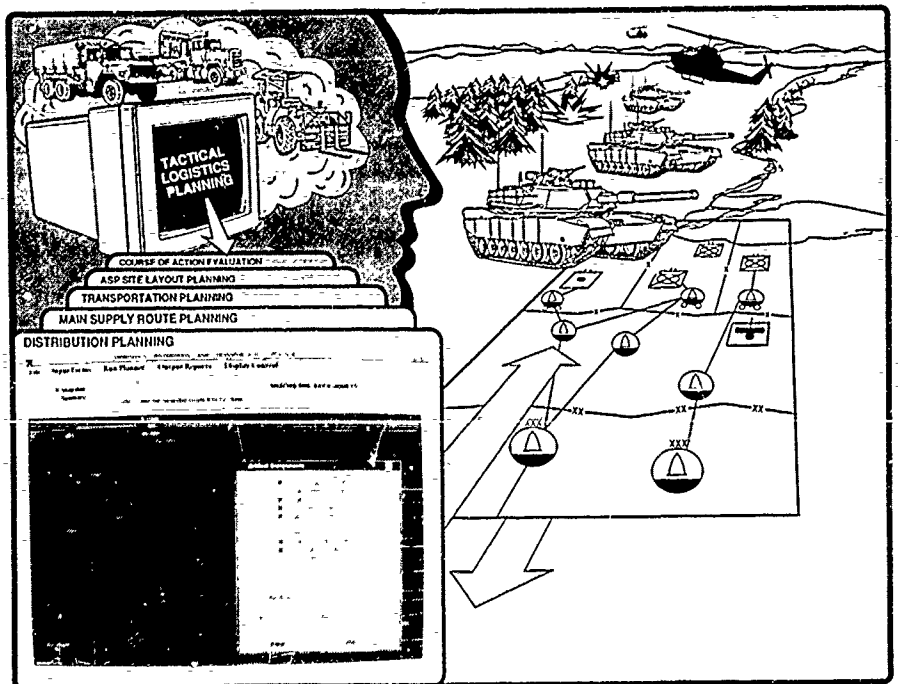
**DIAGNOSTICS** This project demonstrates an expert system for troubleshooting faults in the Hawk Pulse Acquisition Radar. It highlights the advantages of a generalized diagnostic problem-solving architecture that can be customized to different troubleshooting tasks by operating on domain-specific knowledge bases. The runtime version runs on a variety of portable computers. The knowledge base includes information on failures, tests, repairs, references to technical manuals, and graphic presentations. Near term plans include conversion to the Contact Test II and field evaluation.



HUMAN  
ENGINEERING  
LABORATORY

### For additional information contact:

Director, U.S. Army Human Engineering Laboratory  
Attn: SLCHE-CS Mr. Richard Camden  
Aberdeen Proving Ground, MD 21005-5001  
AV 298-5867 or (301) 278-5867





U.S. Army Laboratory Command

Smart Munitions

The Electronics Technology and Devices Laboratory (ETDL) is supporting the development of Smart Munitions systems and components by advancing the state-of-the-art in millimeter wave devices and circuits. ETDL has developed advanced radar components, target recognition devices, and guided munitions components for Smart Munitions as described below.

**ANTI-PERSONNEL/VEHICLE RADAR**

This radar uses smart munition components to implement a short radar for vehicle/personnel detection. This system is very simple in construction and can be easily modified to operate at any other millimeter-wave frequency for diversified applications such as tank gun aiming radar or instrumentation. This Doppler radar is excellent for short-range applications.

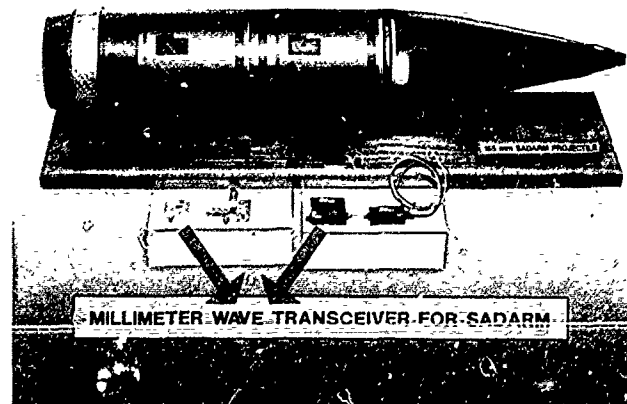
**FREQUENCY-MODULATED CONTINUOUS-WAVE (FMCW) SENSOR**

This sensor detects targets such as tanks, airplanes, and helicopters. It functions as an inexpensive seeker and-trigger for warhead firing. The front-end of the sensor contains a single chip functioning as a radar transceiver (i.e., both a transmitter and a receiver). The sensor can be packaged to fit inside a munition less than 105 millimeters in diameter such as a shell or missile. The transmitter power is about 100 milliwatts (mW).

**SENSE-AND-DESTROY ARMOR (SADARM)**

Sense-and-Destroy Armor (SADARM) is a simple, low cost, fire-and-forget, target-sensing submunition with the capability to detect and destroy various armored vehicles. The SADARM 155-millimeter smart projectile employs a dual-mode millimeter-wave infrared sensor design to provide a kill rate improvement of 10:1 under all battlefield conditions and against threat countermeasures. The fire-and-forget feature of SADARM is made possible by a sensor utilizing the latest millimeter-wave technology.

SMART MUNITION COMPONENTS



For additional information, contact:  
US Army Electronics Technology and Devices Laboratory  
Attn: SLCET-MP, E. Freibergs/J. Armata/S. Dixon  
Fort Monmouth, NJ 07703-5000  
AV 995-2813 or (201) 544-2813



U.S. Army Laboratory Command

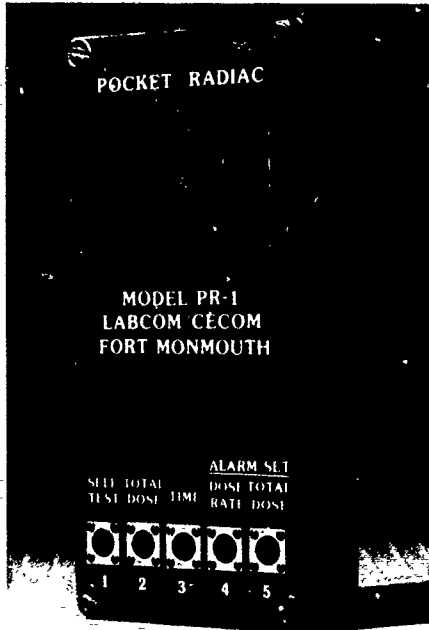
## Miniaturized Microelectronic Subsystems

Significant miniaturization of military and commercial electronic systems is made possible by the integration of advanced semiconductor sensors and computing electronics. The Class 1000 clean room is the heart of the miniaturized prototyping capability at the Electronics Technology and Devices Laboratory. This facility enables scientists and engineers to design and develop circuitry, and to assemble, package, and test the resultant prototype modules.

Innovative package designs are being developed that will provide packaged electronics with protection from radiated as well as conducted electromagnetic energy. Such designs will incorporate the use of optical interconnects for signal I/O and will isolate power leads with acoustic filters.

Under cooperative efforts with the Communications-Electronics Command (CECOM), the Atmospheric Sciences Laboratory (ASL), Harry Diamond Laboratories (HDL), and the University of Texas at El Paso, devices for radiation detection and measurement of atmospheric conditions have been miniaturized, prototyped, and transitioned for full-scale production and fielding. Two examples are the pocket-sized radiation detector (RADIAC) and a tiny meteorological data probe.

Prototype of hand-held radiation detector.



Microelectronic Miniaturization and Prototyping Facility (Class 1000 clean room)



For additional information, contact:  
 U.S. Army Electronics Technology and Devices Laboratory  
 Attn: SLGET-IB, Owen Layden  
 Fort Monmouth, NJ 07703-5000  
 AV 995-2378 or (201) 544-2378



**LIGHT FORCES**

**U.S. Army Laboratory Command**

## **Individual Soldier-Operated Personal Acoustic Detection System (ISOPADS)**

The Individual Soldier-Operated Personal Acoustic Detection System (ISOPADS) extends the soldier's useful listening range during patrols or perimeter defense operations. ISOPADS combines acoustics and fluidics to amplify sounds in the audible range.

The bandwidth of a typical fluidic amplifier is from 0 Hz (direct current) to 4 kHz. In addition this bandwidth can be adjusted through the use of fluidic signal processing and filtering. The ISOPADS has no electronics or batteries and is manually powered by air with a squeeze bulb apparatus like that used to inflate a blood-pressure cuff. An electronic microphone can be placed at the output if recording, transmission, or signal processing is desired.

The fluidic/acoustic sensor can be reconfigured to mount on load-bearing equipment, a helmet, or a weapon.

The ISOPADS offers the following attractive features:

- Highly directional detection capability
- Operation which is unaffected by moderate wind
- Passive operation (no emission signals)
- Compactness (can be hand-held).

The ISOPADS was demonstrated to troop units at the Army Training Command, Grafenwoehr, West Germany; at Schofield Barracks, Hawaii; and at the National Training Center, Fort Irwin, California. In addition, the ISOPADS is currently undergoing field evaluation in West Germany and South Korea. These demonstrations were sponsored by the AMC Field Assistance in Science and Technology (AMC-FAST) program.

ISOPADS amplifies audible sounds while not emitting any signals. Its fluidic/acoustic sensor can be mounted on load-bearing equipment, a helmet, or a weapon.



**For additional information, contact:**  
Director, U.S. Army Harry Diamond Laboratories  
Attn: SLCHD-TA-MS, Nassy Srour, Michael Scanlon  
2800 Powder Mill Road  
Adelphi, MD 20783-1197  
DSN 290-3080 or (301) 394-3080



**U.S. Army Laboratory Command**

**Global Positioning System (GPS)  
Registration Fuze Program**

The Global Positioning System (GPS) Registration Fuze program is a three-year program designed to determine if fire support effectiveness can be increased by having a method of measuring, in real-time and without external observers, the actual trajectory of artillery rounds fired in tactical situations.

The GPS Registration Fuze program is a cooperative effort supported by three Laboratory Command Organizations: the Human Engineering Laboratory (HEL), the Harry Diamond Laboratories (HDL), and the Ballistic Research Laboratory (BRL).

Work at these laboratories related to this program is oriented toward evaluating the time and accuracy requirements needed to measure round trajectories, test firing GPS translators packaged in fuzes, and determining methods of using the gathered data to increase the effectiveness of subsequent rounds.

To be successfully developed, the GPS Registration Fuze must satisfy the following requirements:

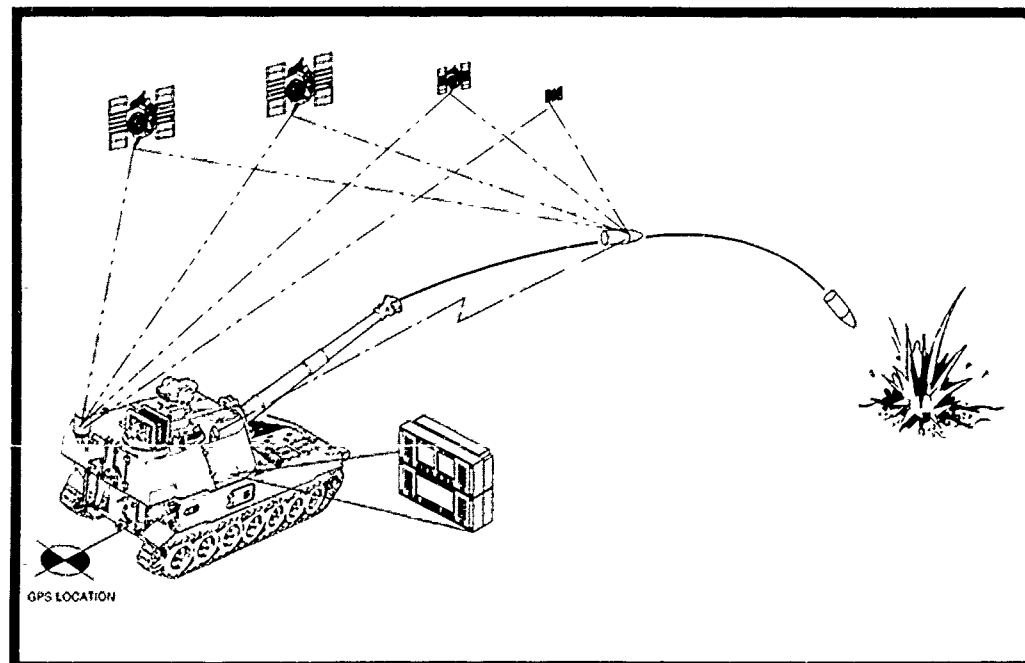
- Achieve a delivery accuracy and response time comparable to conventional transfer after registration
- Function without special projectiles or overly complex procedures
- Survive the firing shock of a gun launch
- Be completely contained in a volume of about 9.1 cubic inches (entire system to include GPS receiver/translator, antenna system, and power supply)
- Be a ballistic match to existing fuzes.

For additional information, contact:  
Director, U.S. Army Human Engineering  
Laboratory

Attn: SLCHE-FT, William Dousa  
Aberdeen Proving Ground, MD 21005-5001  
AV 298-5886 or (301) 278-5886

Director, U.S. Army Harry Diamond Laboratories  
Attn: SLCHD-TA-TS, John Miller  
2800 Powder Mill Road  
Adelphi, MD 20783-1197  
AV 290-2620 or (301) 394-2620

Director, U.S. Army Ballistic Research Laboratory  
Attn: SLCBR-LF-A, Dr. William P. D'Amico  
Aberdeen Proving Ground, MD 21005-5066  
AV 298-3405 or (301) 278-3405



**GPS TRANSLATOR ON BOARD FUZE**  
with L-Band receiving and S-Band transmitting antennas, receives L-Band GPS signals, up-converts to S-Band, adds pilot tone, and transmits to howitzer receiver.

**GPS RECEIVER/PROCESSOR BALLISTIC COMPUTER**

- Computes initial ballistic data.
- Receives and processes raw data from fuze.
- Computes fuze trajectory.
- Generates corrections based on actual trajectory data.
- Uses corrections generated by GPS system to provide accurate long-range indirect fire.



U.S. Army Laboratory Command

## Advanced Integrated Circuits

Through its research in advanced integrated circuits, the Electronics Technology and Devices Laboratory is supporting the Very High Speed Integrated Circuits (VHSIC) program. The VHSIC program is a tri-service initiative designed to exploit advanced digital microelectronics technology in order to achieve higher standards of performance for a wide range of military systems.

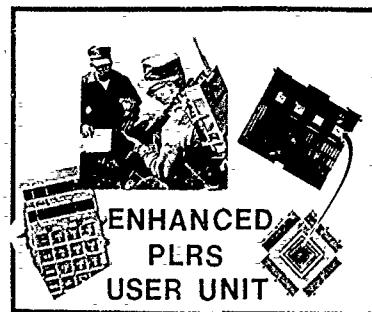
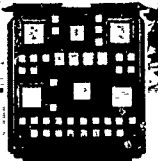
The VHSIC program has marshalled the U.S. semiconductor industries to apply advanced semiconductor technology toward improving military electronics capabilities. ETDL's partnership in the VHSIC program is resulting in widespread utilization of semiconductor technology throughout DoD, a broadening of the industrial base, and a marked improvement in products and design.

Advanced integrated circuits represent a critical step forward in defense system capabilities. The computational power of advanced integrated circuits, combined with their small size, low power needs, and high reliability, enables systems to perform as never before possible.

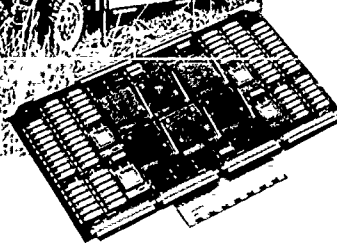
VHSIC technology can support both current and future systems. It not only meets special needs but builds long-term system capability in a variety of key military applications—communications, radar avionics, electronic warfare, and sonar.



*LHX  
COMMON MODULE*



*FIREFINDER  
SIGNAL PROCESSOR  
BRASSBOARD*



For additional information, contact:  
U.S. Army Electronics Technology and Devices  
Laboratory  
Attn: SLGET-IV, Robert H. Sproat  
Fort Monmouth, NJ 07703-5000  
AV 995-3172 or (201) 544-3172





U.S. Army Laboratory Command

## Ion Implantation to Extend Component Life

Ion implantation can be used to enhance material properties at the surface to extend the usable life of components and tools. The Materials Technology Laboratory (MTL) has already demonstrated that ion implanted tools used at the Corpus Christi Army Depot have lasted four times as long as unimplanted tools. The relatively simple, inexpensive process of bombarding the end item with an ion beam enhances hardness and toughness. It also enhances friction, wear, fatigue, and adhesion characteristics.

The ion implantation process features:

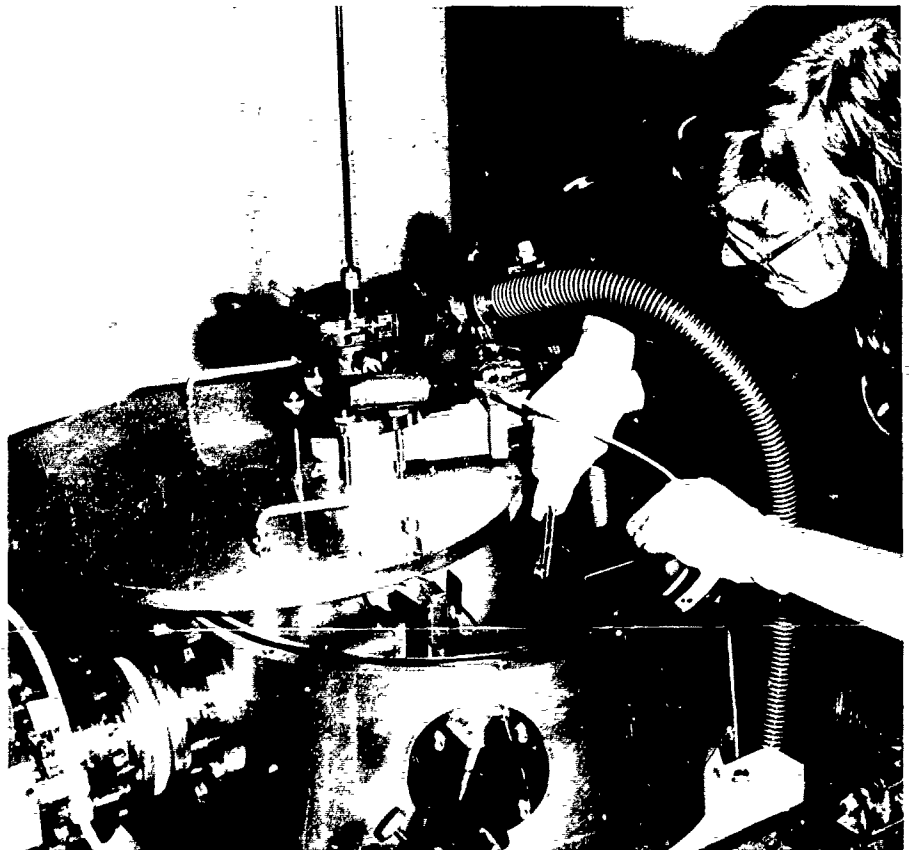
- Engineered materials—surfaces are customized while the desirable load-carrying properties of the component's interior are maintained
- Environmentally acceptable—no hazardous waste generated
- Negligible component dimensional changes—no need to redesign
- Highly controlled process, i.e., electrically monitored and calibrated
- Capability of enhancing items already in the supply system
- Diverse applications, from machining tools to aircraft components
- Improved reliability, productivity, safety, and logistics costs.

Ion implantation has effected an increase in tool life as much as 400%.



The ion implantation process is simple, inexpensive, and environmentally safe.

The incorporation of ion implantation can increase time between servicing, enhance aircraft flight safety, and increase productivity of rework facility machine shops. Ion implantation is a particularly promising technology for treatment of precision parts, such as critical aircraft components, to achieve a longer and safer service life.



For additional information, contact:  
 Director, U.S. Army Materials Technology Laboratory  
 Attn: SLCMT-EMS, Dr. Robert Culbertson  
 Watertown, MA 02172-0901  
 AV 955-5322 or (617) 923-3322



U.S. Army Laboratory Command

## Solid-State Transmitter Source for AN/PPN-20 Miniature Multiband Beacon (MMB)

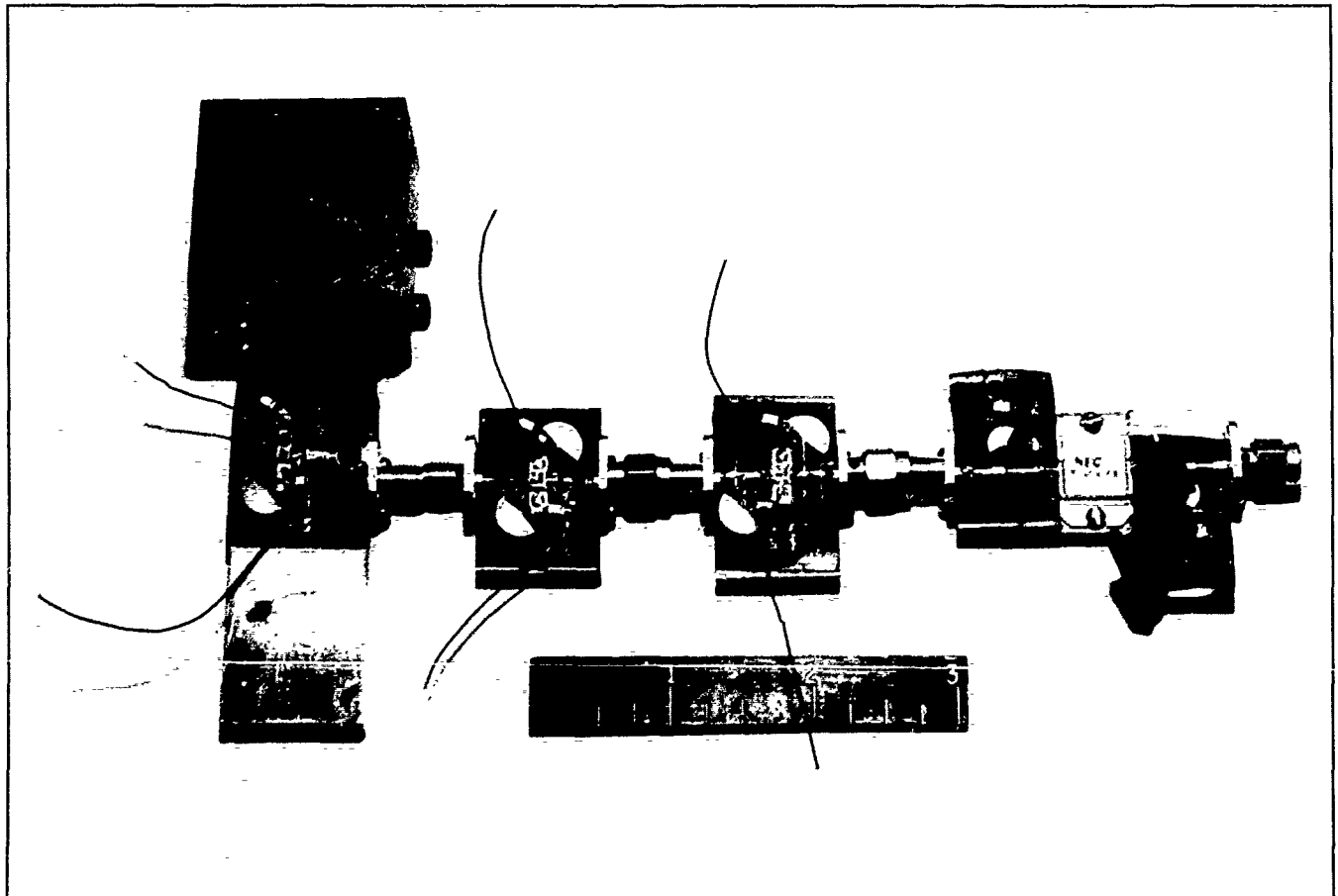


For additional information, contact:  
US Army Electronics Technology and Devices Laboratory  
Attn: SLCBT-MA-A, M Mizan/T Lukaszek  
Fort Monmouth, NJ 07703-5000  
DSN 995-4415 or (201) 544-4415

The AN/PPN-20 miniature multiband beacon (MMB) is a self-contained, lightweight, man-portable, ground-emplaced radar transponder designed for use with the Army's Special Operations Forces for enroute navigation, drop-zone location, air strip marking, and ordnance delivery. The present version of the transponder operating at X- and KU-band frequencies uses magnetron tubes as its transmitter. To achieve frequency stability, an extended warm-up period is required prior to signal transmission, expending scarce battery-supplied power.

The Electronics Technology and Devices Laboratory (ETDL) has developed an advanced solid-state transmitter for the MMB transponder with a warm-up time of less than one second. This improved capability was made possible by recent developments at ETDL of the two most critical elements of the transmitter:

- State-of-the-art, high-efficiency, high power (>10 watts) solid-state power amplifier using advanced gallium arsenide (GaAs) power field-effect transistors (FETS)
- State-of-the-art dielectric resonator oscillator with a frequency stability of less than one megahertz (MHz) over the temperature range of  $-45^{\circ}\text{C}$  to  $+50^{\circ}\text{C}$ .





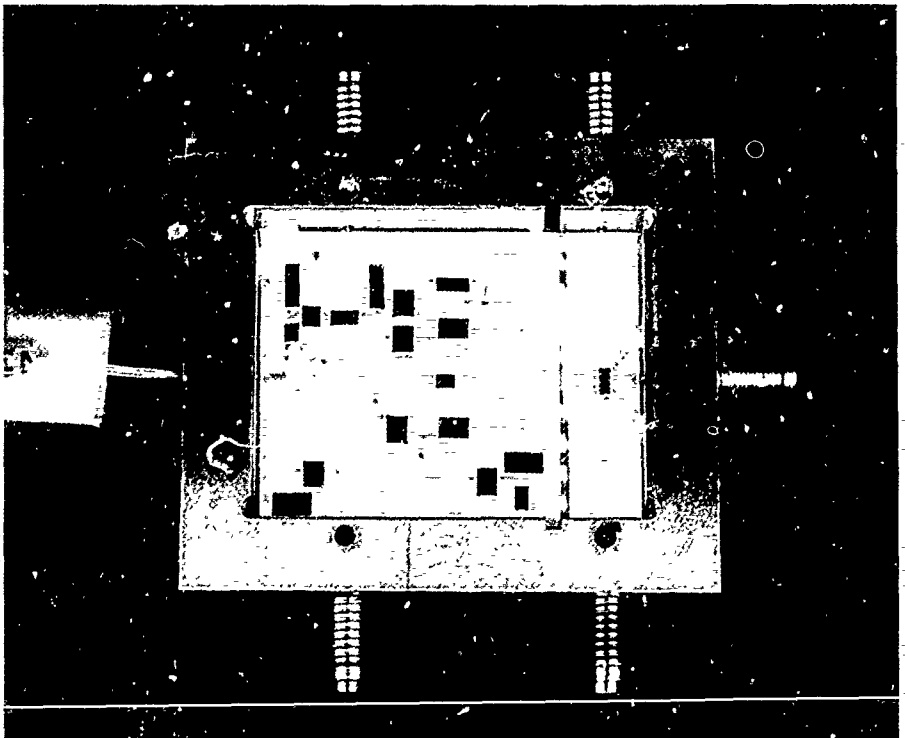
U.S. Army Laboratory Command

## Optically-Controlled Gallium Arsenide Microwave Switch

With the advent of microwave/millimeter wave monolithic integrated circuits (MIMIC) technology, increasingly complex microwave circuits and functions are being integrated into smaller areas. To be controlled, the microwave chips and modules must be interconnected with remotely located components and subsystems. Utilizing metallic cables and wires for interconnects poses problems with respect to size and weight and can cause interference from undesired electromagnetic radiation. Light waves, transmitted via optical fibers, represent an attractive alternative for the distribution of control signals to microwave chips. Fiber optics has the advantage of light weight, low loss, and immunity from electromagnetic interference (EMI) and electromagnetic propagation (EMP).

The Electronics Technology and Devices Laboratory (ETDL) has developed an optically-controlled microwave switch as a result of research in this area. For compatibility with gallium arsenide (GaAs) microwave monolithic integrated circuit technology, a GaAs photodetector is used for the switch. All the components are standard, off-the-shelf, microwave monolithic integrated circuit units assembled into a hybrid configuration.

A fiber optic link provides remote control of microwave switching functions. Fiber optics has the advantage of light weight, low loss, and immunity from EMI and EMP.



For additional information, contact:  
 Director, U.S. Army Electronics Technology  
 and Devices Laboratory  
 Attn: SLCET-MP, A. Paoletta  
 Fort Monmouth, NJ 07703-5000  
 AV 995-2825 or (201) 544-2825



U.S. Army Armament, Munitions and Chemical Command

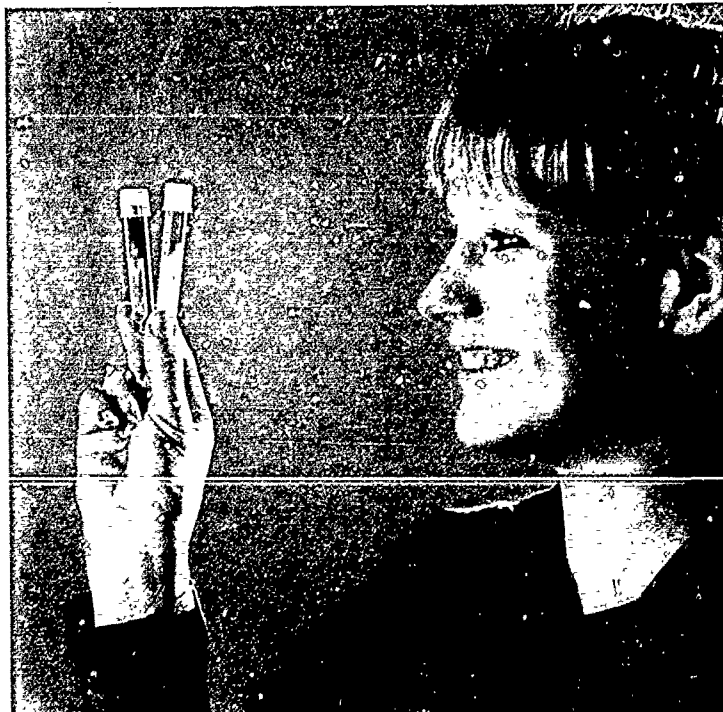
## DITAM Assay and Apparatus for the Rapid Detection of Hazardous Substances

The DITAM (Diffusion Through A Membrane) assay and apparatus will provide soldiers with a fieldable, fast, extremely easy-to-use, hand-held device that is capable of detecting several hazardous substances simultaneously. Examples of these substances are chemical warfare agents, drugs, and a variety of fungal toxins. Further modifications of the assay will enable the detection of proteinaceous substances from infectious organisms. The DITAM assay is based on antibody-antigen reactions.

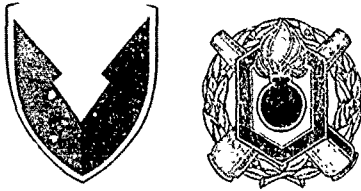
The modified DITAM apparatus is small in size; several will fit in one pocket of a soldier's battle dress uniform (BDU). The apparatus consists of a "bag" in a test tube. This "bag" is a semi-permeable membrane that is tied at both ends and contains two of the reagents needed for the test. The procedure for performing a DITAM assay is quite simple: (1) add the test sample to a fill line and shake the tube for three minutes, (2) add the premeasured enzyme substrate solutions and shake the tube for ten seconds, and (3) observe the tube for a color change. If a test sample contains a specific hazardous substance, the solution appears turquoise in color. If the substance is not present, the solution appears clear.

In addition to the military, the DITAM assay will be of use to many other U.S. Government organizations and to the private sector as well.

The DITAM assay and apparatus uses test tubes to provide rapid detection of hazardous substances.



For additional information, contact:  
Commander, U.S. Army Chemical Research,  
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Attn: SMCCR/RSB, Dr. Cynthia A. Ladouceur  
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DSN 584-4284 or (301) 671-4284



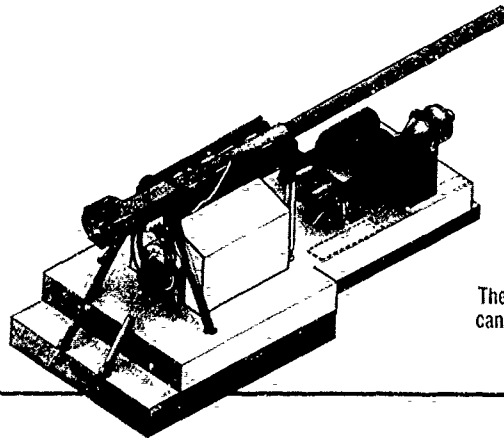
U.S. Army Armament, Munitions and Chemical Command

Electromagnetic Gun System

The gun system is a stand-alone repetitive fire compulsator-driven 9 MJ (megajoule) gun under development at the University of Texas Center for Electro-mechanics. It is an electromagnetic (EM) railgun consisting of a 9 MJ EM gun, a prime power gas turbine, a compensated pulsed alternator (compulsator), an auxiliary power turbine, a drive gearbox/clutch, a gun recoil/elevation mechanism, an autoloader, and other auxiliary equipment. The gun system required considerable advancement in the state-of-the-art of several of its critical components, including the compulsator and its 7-meter-long barrel.

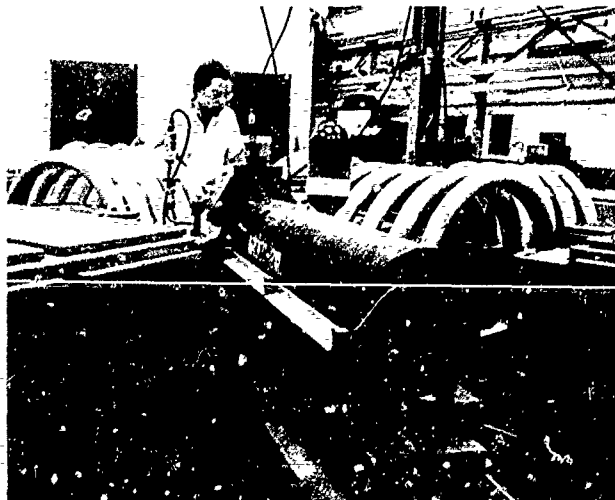
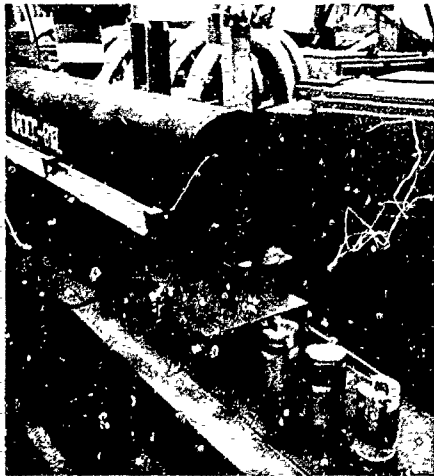
The gun will be capable of accelerating projectiles to a muzzle energy of 9 MJ, with muzzle velocities in the 2.5 to 4 kilometer per second range. It will also be capable of firing a burst of three shots per minute for a period of 3 minutes.

A weight limit of 20,000 kilograms has been imposed upon the system. The volume will eventually be consistent with armored vehicle capabilities after the gun system has been thoroughly tested.



The 9MJ Electromagnetic Gun System can fire projectiles at muzzle velocities in the 2.5-4 k/s range.

A 50mm round bore composite railgun has been developed and fabricated for ARDEC



50mm Round Bore Railgun: The 50mm round-bore, short-barrelled railgun is 1.2 meters long with copper rails backed by G11 fiberglass, and is structurally supported with a helical winding of E-glass in epoxy and a layer of longitudinal glass fibers. It is powered by 250 KJ capacitor banks, capable of producing 500 to 900 KA with variable pulse lengths. The railgun is used for testing of armatures and barrel design, and is capable of accelerating a 600 gram projectile to a velocity of 200 m/s.

For additional information, contact:  
Commander, U.S. Army Armament Research and  
Development and Engineering Center  
Attn: SMCAR-FSE/Bldg. 329, Kien Luu  
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AV 880-4348 or (201) 724-4348



**U.S. Army Laboratory Command**

**The Family of Fuzes for Mortars**

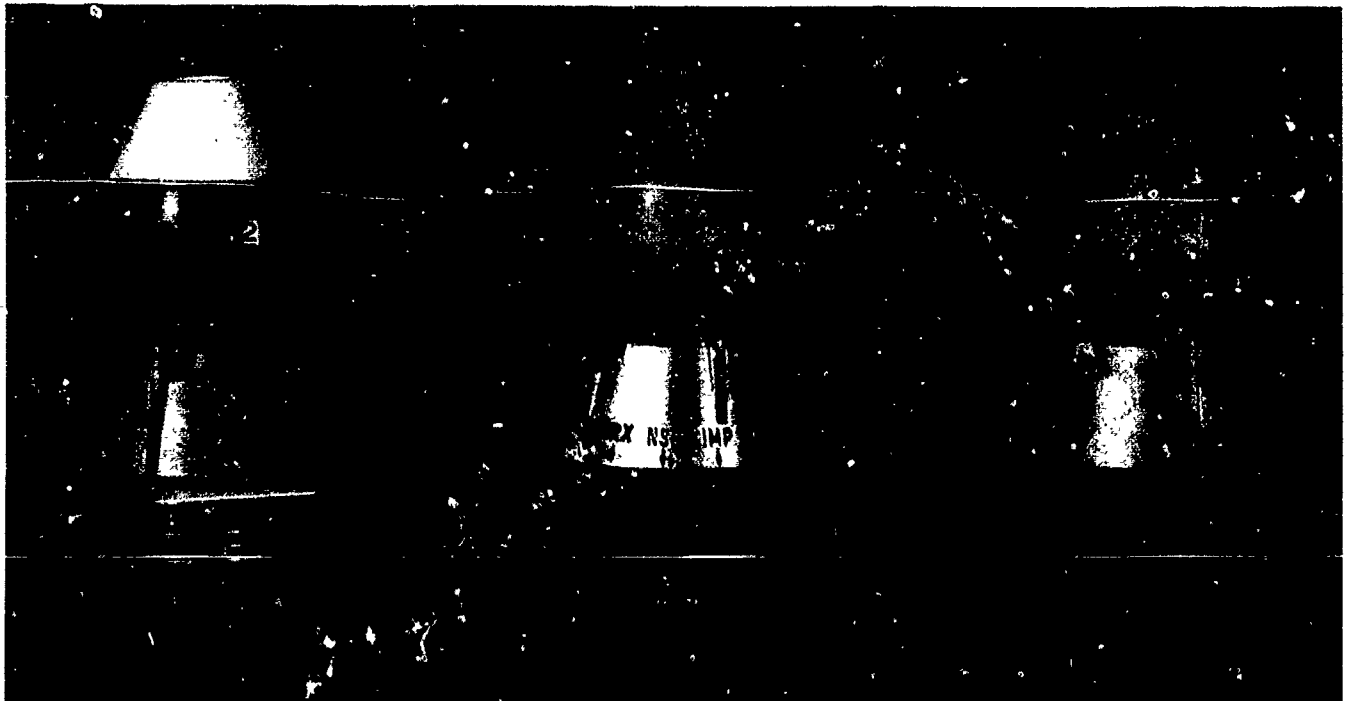
The three-fuze family for all mortars replaces some 20 fuzes in the inventory, simplifies battlefield logistics, provides dual safety arming features (required by MIL-STD-1316C), and reduces production costs through commonality of parts. All members of this mortar fuze family are identical in shape and aerodynamic characteristics, and therefore are ballistically similar. Together they form a complete family of fuzes usable with all mortar ammunition (60mm, 81mm, 120mm, and 4.2 inch). The three-fuze family is comprised of:



For additional information, contact:  
 Director, U.S. Army Laboratory Command  
 Attn: SLCHD-TA-FD, Dr. Carl J. Campagnuolo  
 2800 Powder Mill Road  
 Adelphi, Maryland 20783-1197  
 AV 290-3193 or (301) 394-3193

- **M734 Multi-Option Fuze** — The M734 is a radio-proximity fuze with options for defeating troops in open terrain, foxholes, forests, personnel carriers, and urban warfare. More than 1.5 million of these fuzes have been produced. The M734 was developed for U.S. Army Armament, Munitions and Chemical Command (AMCCOM).
- **M745 Point-Detonating Fuze** — A variant of the M734, the M745 was type-classified in 1987 on white phosphorous smoke round. At one-third the cost of the M734, the M745 serves as a low-cost training round, having eliminated the M734's electronics. This fuze marks an impact area to correct the aim of mortars using high-explosive ammunition.
- **Electronic Time Fuze** — The electronic time fuze, another variant of the M734, replaces M734 RF electronics with digital electronics. Thumbwheel switches allow hand setting under all visibility conditions. This fuze possesses an accuracy of 0.040 seconds.

The three-fuze family for mortars reduces production costs through commonality of parts. Shown from left to right, the electronic time fuze, the M734, and the M745 are usable with all mortar ammunition.



**ELECTRONIC  
TIME**

**MULTI-OPTION  
PROXIMITY**

**IMPACT  
SQ/PRACTICE**

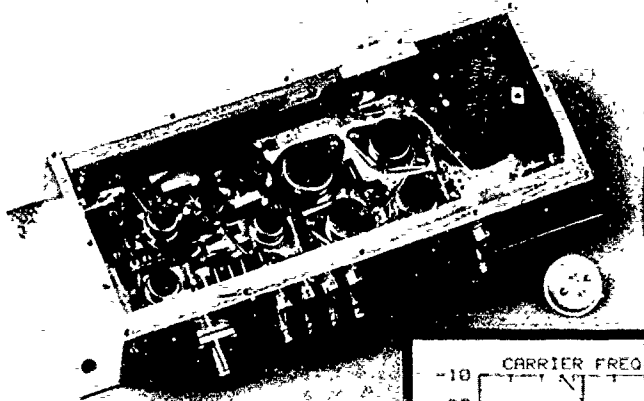


U.S. Army Laboratory Command

## Surface Acoustic Wave (SAW) Stabilized Oscillator

The Electronics Technology and Devices Laboratory (ETDL) has developed a Surface Acoustic Wave (SAW) stabilized oscillator which has the potential to improve radar and target detection sensitivity as well as range capability. Through the combination of recently designed state-of-the-art SAW resonators with advanced electronic circuit techniques, a significant reduction in oscillator phase noise performance has been achieved. SAW stabilized oscillators are capable of providing extremely low phase noise operation for close-to-the-carrier, large carrier offset, and AM frequencies. The specification for this development was directed toward a specific radar system requiring extremely low phase noise to improve radar detection sensitivity, range, and clutter suppression. SAW-based oscillators also lend themselves to multi-mode frequency capability to support not only search and track operations but also difficult target detection and recognition or positive hostile identification.

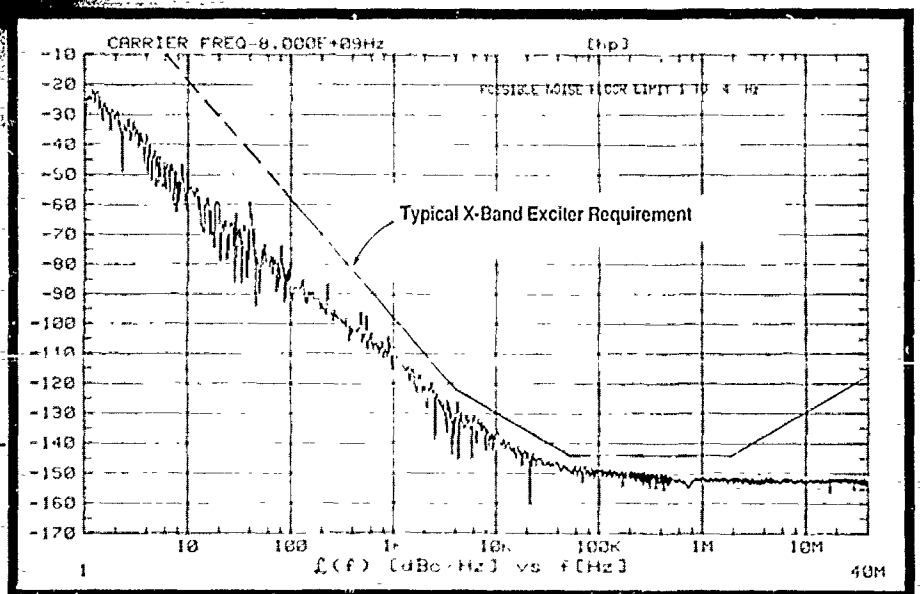
Surface Acoustic Wave  
(SAW) stabilized oscillator.



SAW oscillators are capable of providing extremely low phase noise operation for both close-to-the-carrier and large carrier offset frequencies.



For additional information, contact:  
U.S. Army Electronics Technology and  
Devices Laboratory  
Attn: SLCET-DT-MA, T. Lukaszek  
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DSN 995-2751 or (201) 544-2751

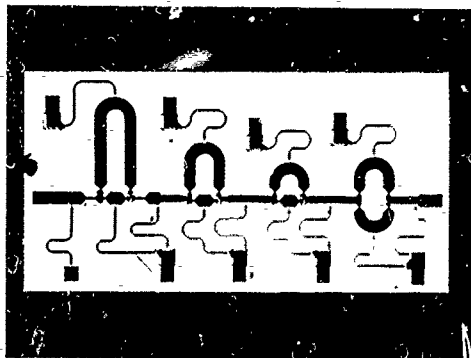




U.S. Army Laboratory Command

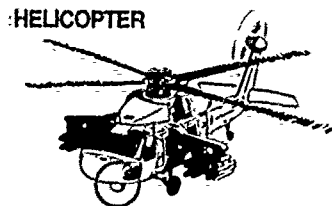
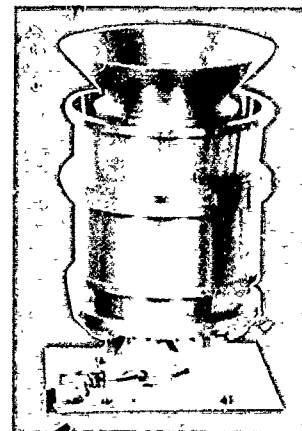
## High Power Microwave/Millimeter Wave Solid-State Array for Jammers

The development of three-terminal devices operational at Ka-band frequencies in combination with the rapid growth of Microwave Millimeter Wave Monolithic Integrated Circuits (MMIC) technology has resulted in the development of small, low-cost, and highly reliable solid-state jammer modules. Each module contains a MMIC power amplifier and a MMIC digital phase shifter resulting in an output power of 0.5 watts with digital phase control in 22.5 degree increments. These modules are integrated into a novel antenna where power combining is accomplished. Depending on the number of integrated modules, an effective radiated power level is achieved providing high power jamming. The complete jammer assembly can be installed in a wide variety of platforms (e.g., helicopter, ground vehicles, remote piloted vehicles, etc.) protecting ground and aviation assets from hostile radars.



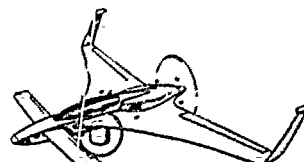
A 4-bit pin diode Ka-band switched-line phase shifter

High power MMW jamming array multi-platform use.



HELICOPTER

RPV



For additional information, contact:  
U.S. Army Electronics Technology and  
Devices Laboratory  
Attn: SLCET-MP-C, Michael Cummings  
William VanMeerbeke  
Fort Monmouth, NJ 07703  
AV 995-2887 or (201) 544-2887



## ROBOTICS



U.S. Army Laboratory Command

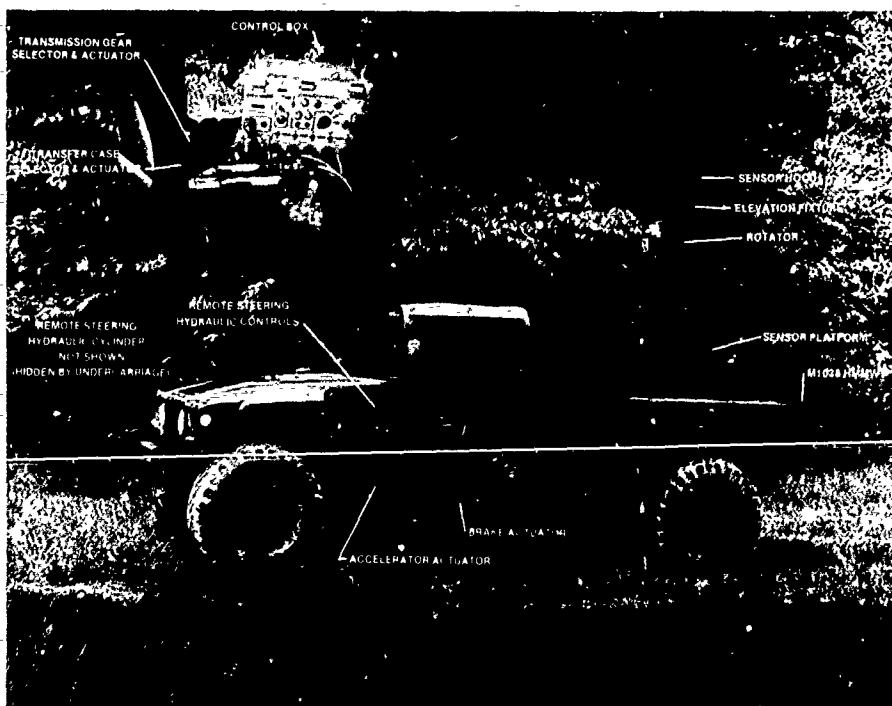
### Automatic Target Acquisition System

The Automatic Target Acquisition (ATA) System is part of an unmanned forward observer system being developed for use in situations too dangerous for soldiers, such as nuclear-contaminated areas or in support of a minefield overwatch function. The system, mounted on ground-based robotic vehicles, is part of the LABCOTM Robotic Vehicle Technology Initiative (LRI) cooperative program.

The ATA must be able to detect and track tank-sized vehicles automatically, at ranges from one-half to one and a half kilometers. It will be able to track at least seven targets simultaneously. Once a target has been detected, a high-resolution picture of it will be sent to the remote operator automatically. The operator can direct that target information, including location, speed, etc., to the laser designator control module on the vehicle, which will designate the target.

The ATA system design meets stringent requirements for high probability of detection and low probability of false alarm. To meet these requirements, the ATA system includes multiple sensors and uses sophisticated real-time algorithms for sensor correlation and tracking. Passive sensors, used to ensure the vehicle's survivability, are a TV camera, a forward-looking infrared (FLIR) sensor, a laser range-finder, and a non-imaging sensor.

Tech-base enhancement for autonomous machines (TEAM), a US Army Laboratory Command cooperative project which addresses critical telerobotic weapons platform issues, such as automated target recognition and low data rate operations.



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U.S. Army Harry Diamond Laboratories  
Attn: SLCHD-TA-AS, David Hillis  
2800 Powder Mill Road  
Adelphi, Maryland 20783-1197  
AV 290-3000 or (301) 394-3000



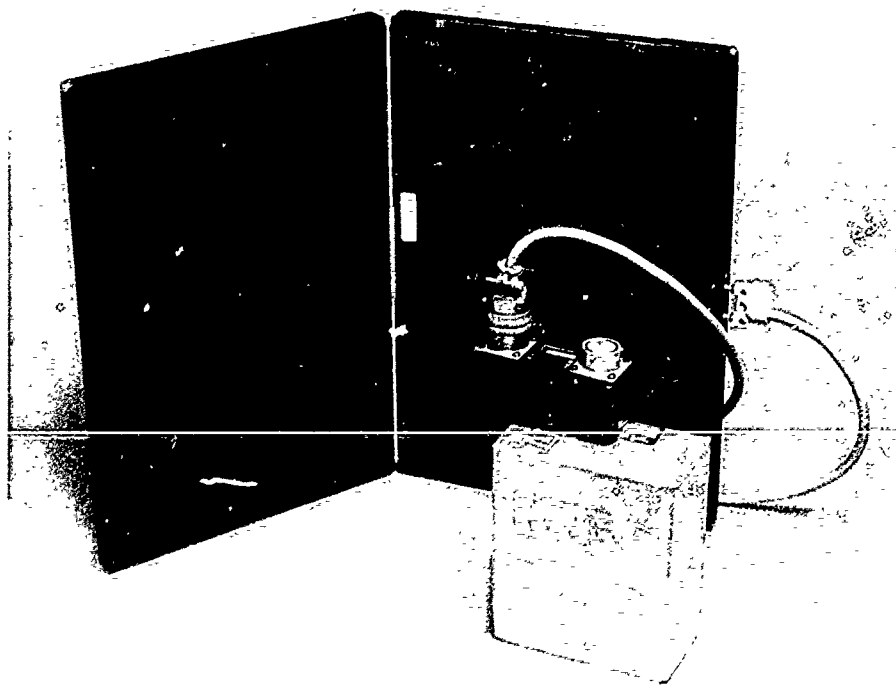
U.S. Army Laboratory Command

## Photovoltaics for Special Operations Forces (SOF)

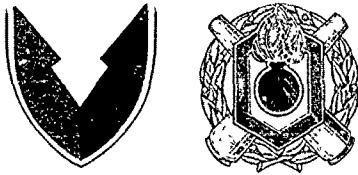
Photovoltaics research at the Electronics Technology and Devices Laboratory (ETDL) has led to development of a highly efficient, lightweight solar panel that provides a non-consumable power source especially suitable for deep reconnaissance and special operations forces (SOF) missions. The solar panel emits no noise, heat, or other characteristic signature when powering communications and electronic equipment within and from denied or targeted areas. It can recharge all SOF batteries used in hand-held radios, field computers, satellite transceivers, directional finders, night vision equipment, navigational aids, radar devices, and remotely monitored sensors. The 14-watt solar panel offers the following features:

- Compatibility with future high energy density rechargeable lithium battery types as well as nickel cadmium rechargeable batteries
- Energy density of 9 watts per pound
- Rugged, easily packaged configuration
- Cost-effective silicon cells
- Redundance to prevent complete power shutoff
- Capability of series or parallel connection with other panels.

The solar panel is an excellent and practical means of recharging SOF radio batteries in missions lasting more than a few days where resupply is not available. With rechargeable batteries, it provides significant savings in weight, volume, and cost compared to throwaway lithium batteries. When combined with the small G-67B handcranked generator, the panel can replace the large G-76A handcranked generator.



For additional information, contact:  
 U.S. Army Electronics Technology and Devices Laboratory  
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 Mr. Martin Sulkes  
 Fort Monmouth, NJ 07703-5000  
 DSN 995-4886 or (201) 544-4886  
 DSN 995-2458 or (201) 544-2458

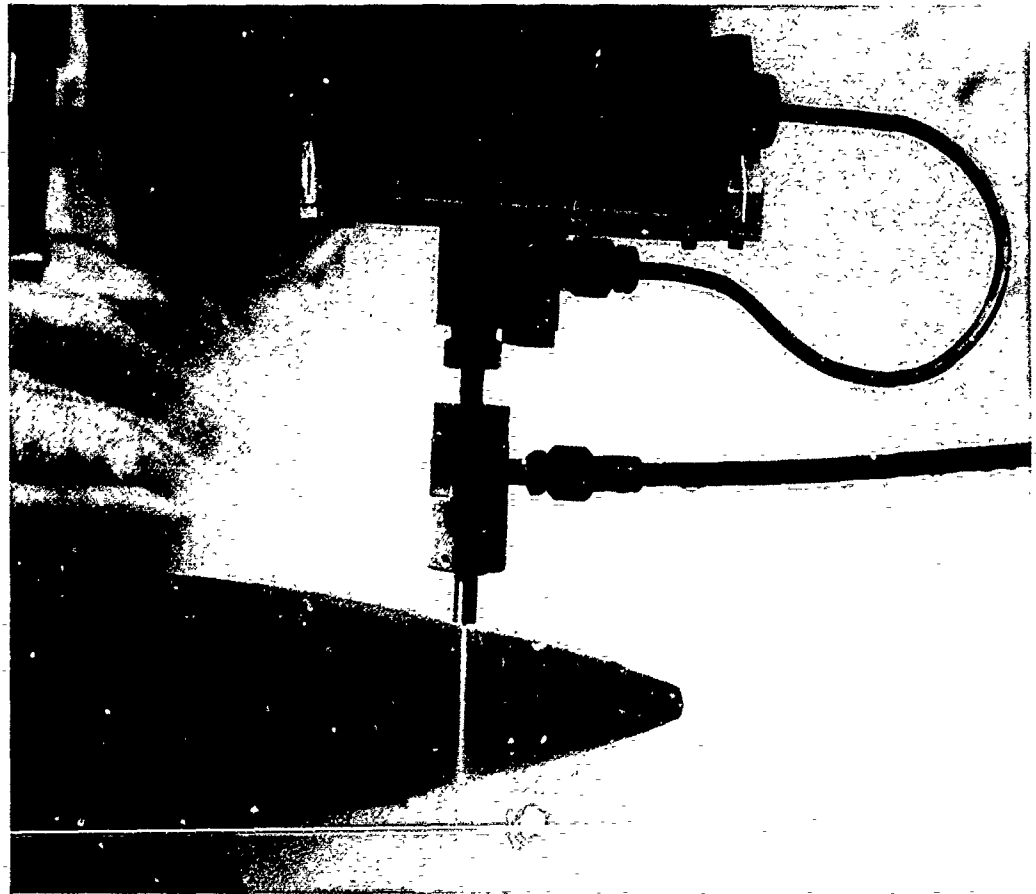


U.S. Army Armament Munitions and Chemical Command

## Explosive Ordnance Disposal Water Abrasive Jet Cutter

The Explosive Ordnance Disposal (EOD) Water Abrasive Jet Cutter is a tripod robot-mounted device that can cut through ordnance with little danger of producing a detonation. It can be operated remotely to allow a safety margin in case of an unexpected detonation. Features of the EOD Water Abrasive Jet Cutter are:

- Water stream at 30,000-50,000 pounds per square inch through a .02 orifice
- Copper oxide as the abrasive reduces the chance of sparking
- Cutter can be controlled up to 500 feet away through a visual system
- Robot tripod has a 5-to-1 weight to load ratio compared to most robots that have a 100-to-1 ratio
- Other fairly complex tools such as a drill injector may be adapted to the robot tripod



For additional information, contact:  
Project Manager, Ammunition Logistics  
Attn: AMCPM-AL, Walt Liska  
Building 455  
Picatinny Arsenal, NJ 07806-5000  
DSN 880-2188 or (201) 724-2188

The Explosive Ordnance Disposal Water Abrasive Jet Cutter can cut through ordnance with little danger of producing a detonation.



U.S. Army Armament, Munitions and Chemical Command

## UAV Passive Chemical Detection System

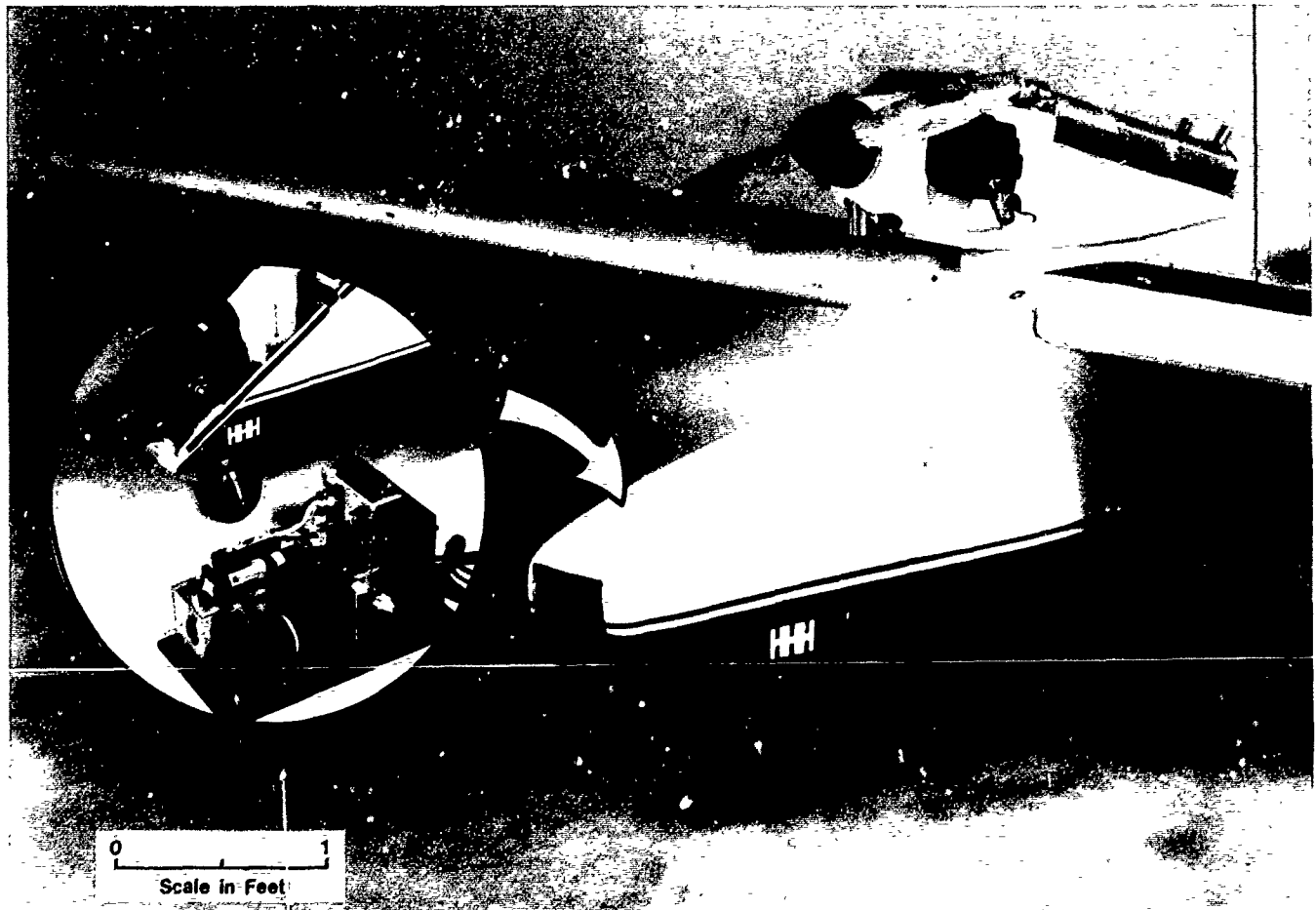


For additional information, contact:  
Commander, US Army Chemical Research, Development  
and Engineering Center  
Attn. SMCCR-DDT, Mr. William R. Loerop  
Aberdeen Proving Ground, MD 21010-5423  
DSN 584-3021 or (301) 671-3021

The Unmanned Autonomous Vehicle (UAV) is a chemical agent detection, reconnaissance, and contamination avoidance system capable of detecting lethal and toxic materials "on the move." This development will provide for the U.S. Marine Corps a first time means for critical qualification and quantification of chemical warfare agents while traversing a chemical battlefield. The UAV has a 12-foot wing span, an 11-horsepower remote control airframe, and an on-board video camera with radio frequency downlink. The UAV carries onboard a lightweight, high-speed passive infrared detection system, as well as a ground-based, real-time video/data monitoring and recording system.

Specifically, the chemical detection system consists of a high-speed, linear drive Michelson interferometer block, and high-speed, digital signal processing electronics capable of real-time data acquisition and analysis at speeds up to 50 scans per second. The detection system is capable of discerning size and weight of less than 0.3 cubic feet and 20 pounds, respectively. This achievement represents an unprecedented moving background time domain detection algorithm.

In addition, this moving detection system could be used on board a variety of aircraft platforms, to include the V-22 Osprey. This CRDEC project is expected to transition in FY91 to an Advanced Technology Demonstration Effort.





**U.S. Army Laboratory Command**

## Proximity Fuze Technology for Area Targets

Today's Army relies on proximity fuzing developed at Harry Diamond Laboratories (HDL). Described here are several technologies and applications which exemplify developments in artillery fuzing.

**HARMONIC PROCESSOR**—New technology has been developed for sophisticated proximity fuze signal processing. Harmonic processing of a frequency-modulated carrier signal provides for easily selectable heights of burst with a tight distribution of burst point. The technology is extremely resistant to countermeasures. The processor is packaged as a single integrated circuit and is therefore small and low-cost.

**RADIO FREQUENCY (RF) TECHNOLOGY**—New technology has been developed for compact, inexpensive proximity fuze applications. A wide-band capacitively coupled patch antenna, sized for the operating frequency, occupies the tip of the fuze. Mounted directly behind the antenna is a gallium arsenide monolithic microwave integrated circuit (MMIC) that constitutes the rest of the RF system. The MMIC provides the circulator function so that no magnetic components are required and a single antenna may be used.

**ELECTRONIC SAFE-AND-ARM TECHNOLOGY**—HDL conducts the Army's research program in Electronic Safe-and-Arm (ESA) technology. ESA technology promises many benefits over the traditional mechanical safe-and-arm technology, including higher reliability, enhanced safety, precise timing for multiple and directed warheads, and more flexible operating modes.

HDL is also a strong supporter of various project managers (PMs), providing parallel ESA designs for program risk reduction, review of contractor designs, and consulting. Current efforts include developing new circuit architectures using low-cost-micro-controllers and safety-enhanced application-specific integrated circuits (ASICs), developing lower energy detonators, and advancing component technology. Prototype efforts include a small generic ESA, development of a qualified explosive foil initiator (EFI), and brassboard systems in support of various PMs.



For additional information, contact:  
 Director, U.S. Army Harry Diamond Laboratories  
 Attn: SLCHD-TA-ES, Bob Goodman  
 2800 Powder Mill Road  
 Adelphi, MD 20783-1197  
 DSN 290-3710 or (301) 394-3710

The Multiple Launch Rocket System (MLRS) delivers submunitions using the M445 time fuze and the XM445 medium altitude proximity fuze.



Electronic fuzes: the XM450, the M445, and the M732A2 (left to right).



### **MULTI-OPTION FUZE FOR ARTILLERY (XM773 MOFA)—MOFA**

operates in four functional modes: proximity, time, impact, and delay. A single fuze for all current and developmental artillery weapons and bursting projectiles, it can replace all current inventory. It permits pre-fuzing/wooden rounds and reduces the logistics burden.

It can be set automatically by the inductive setting scheme adopted as standard by the Army. This permits direct, automatic, error-free fuze setting by the fire control system. MOFA can also be hand-set without tools or setters.

It is uniquely able to satisfy the high rates of fire required for the developmental Advanced Field Artillery System (AFAS) for bursting rounds.

MOFA and the M762 (used for ICM [Improved Conventional Munitions] rounds) can form a two-fuze family for all Army artillery.

**M732A2 ARTILLERY PROXIMITY FUZE**—The M732A2 was developed to provide the Army with a proximity fuze qualified for use with modern extended-range munitions, including rocket-assisted and base-bleed projectiles and high-performance propelling charges.

The short intrusion proximity fuze provides airburst fuzing for artillery-delivered fragmenting munitions to defeat enemy personnel and soft targets. It is used on burster-type projectiles for the 4.2 inch mortar and 105-mm, 155-mm and 8-inch artillery.

The M732A2 is hand-settable without tools to function either by proximity action (with impact backup) or on target impact. Frequency modulation of the continuous-wave, radio Doppler target sensor provides improved height-of-burst control and enhances countermeasures immunity.

**MULTIPLE LAUNCH ROCKET SYSTEM FUZING**—The Multiple Launch Rocket System (MLRS) fuze represents the latest in Army fuzing technology. Each MLRS rocket launcher is capable of delivering up to twelve rockets; each containing either M77 submunitions, Sense-and-Destroy armor (SADARM) (anti-tank) submunitions, or AT-2 (anti-tank) submunitions.

To accurately deliver these submunitions, HDL has developed two fuzes, the M445 time fuze and the XM450 medium-altitude proximity and time fuze.

Both fuzes are set by the MLRS fire control system just prior to launch. In addition to the setting, the fuzes also perform a self test to ensure that the fuze is functioning properly. In the time mode, both fuzes can be set from 5 to 199.9 seconds in 0.1 second increments. In addition to the time mode, the XM450 fuze also contains a precision radar proximity fuze that has three function heights (75, 150 and 300 meters). The optimum height for a mission is selected through the MLRS fire control system just prior to launch.



The M732A2 functions by proximity action or on target impact.



New technology enables sophisticated proximity fuze signal processing.



U.S. Army Laboratory Command

## Tank Gun Accuracy

The Ballistic Research Laboratory has developed an integrated experimental diagnostic technique to aid in the optimization of ammunition performance. State-of-the-art instrumentation is utilized to determine the contributions of gun dynamics, projectile disengagement, and sabot discard disturbances to ammunition jump and dispersion, thus permitting the engineer to identify the principal sources of disturbance to the projectile during launch and initial stages of free flight. Using information obtained with this tool, the designer can focus on modifications to the projectile design which will optimize performance. The technique has been successfully utilized during the development of 25-mm, 105-mm and 120-mm ammunition.

This photo shows the launch diagnostics experimental test stand used for the analysis of 120-mm ammunition. To the left is an M1A1 tank, instrumented to measure gun dynamics. On the right side of the photo are six orthogonal X-ray stations used to measure the trajectory and yawing motion of projectiles as they are launched.



For additional information, contact:  
Director, U.S. Army Ballistic Research Laboratory  
Attn: SLCBR-LF, Dr. J. Bornstein  
Aberdeen Proving Ground, MD 21005-5066  
AV 298-3737 or (301) 278-3737





## U.S. Army Troop Support Command

### M1A1 Decoy



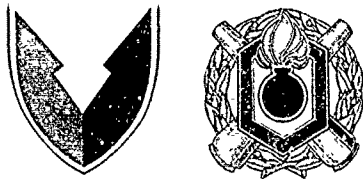
A two-dimensional replica of an M1A1 tank consists of a fabric skin with a visual image, and an embedded thermal signature system mounted on a collapsible support frame. A portable generator supplies power for the thermal signature. An audio simulation device can be used with the decoy to portray battlefield sounds. Two types of devices are being investigated: a vehicle-mounted device to portray the acoustic presence of large tactical troop units and assemblages of equipment; and a man-portable device to portray the acoustic presence of individual weapons/squad-sized troop units. Both systems will use a hardened tape recording, mixing and mastering console to produce scenario tapes.



For additional information, contact:  
Commander, US Army Belvoir RD&E Center  
Attn: STRBE-J, G.A. Orlicki  
Ft. Belvoir, VA 22060-5606  
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The M1A1 tank decoy system replicates the thermal signature and visual image of the Abrams Tank.





## U.S. Army Armament Munitions and Chemical Command

### Battlefield Rearm

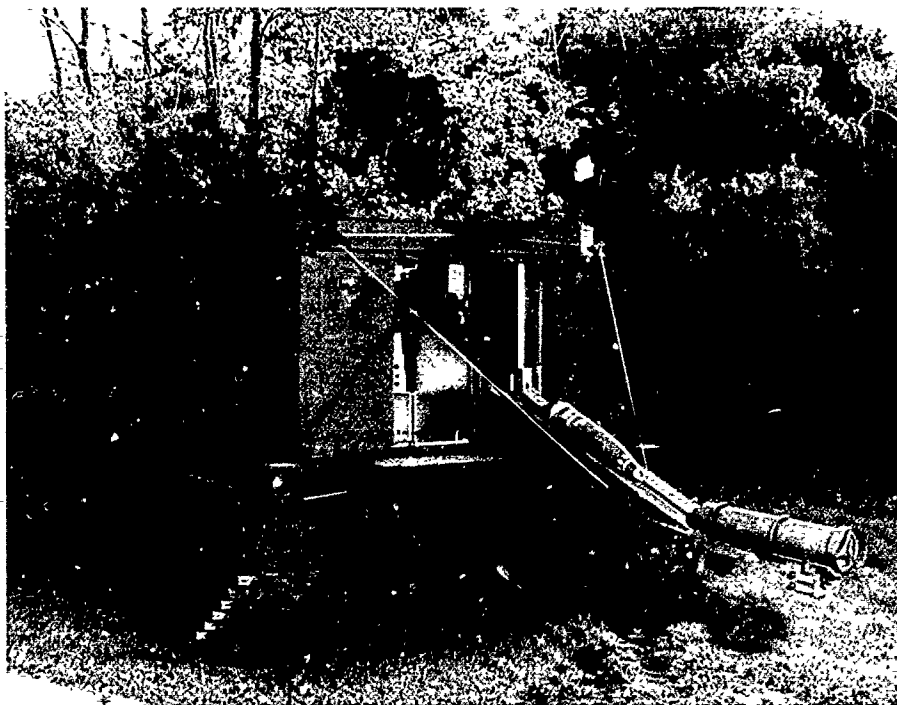
Rearming our major ground combat weapons systems on the battlefield is a labor intensive and time consuming task. Combat systems must be withdrawn from the line and the crews must unbutton to rearm, leaving them exposed and vulnerable. Our challenge is to improve this process. We are developing automated rearm technologies that will be reliable, fast, robust, user friendly and affordable. Our soldiers will then be able to rearm rapidly and well forward in the battle area protected from direct fire and NBC contamination. The rearm program is addressing specific and unique problems in each of the field artillery, armor, infantry, and aviation mission areas.

The Field Artillery, Armor, and Infantry programs are supporting the Armored Systems Modernization program and are synchronized with the Advanced Field Artillery System (AFAS), Block III Tank and the Future Infantry Fighting Vehicle (FIFV). These programs will culminate in technical demonstrations of system capabilities and then transition as candidate technologies to the Project Manager for the Future Armored Rearm Vehicle-Ammunition.

Artillery is stored in the Artillery Rearm Module, and passed to awaiting howitzers by the conveyer on the front of the vehicle



For additional information, contact:  
Project Manager, Ammunition Logistics  
Attn: AMCPM-AL  
Duane Scarborough (Field Artillery)  
Nelson Gravenstede (Armor)  
Al Galonski (Infantry and Aviation)  
Building 455  
Picatinny Arsenal, NJ 07806-5000  
DSN 880 2262 or (201) 724 2349





## U.S. Army Laboratory Command

### Armor/Anti-Armor Technology

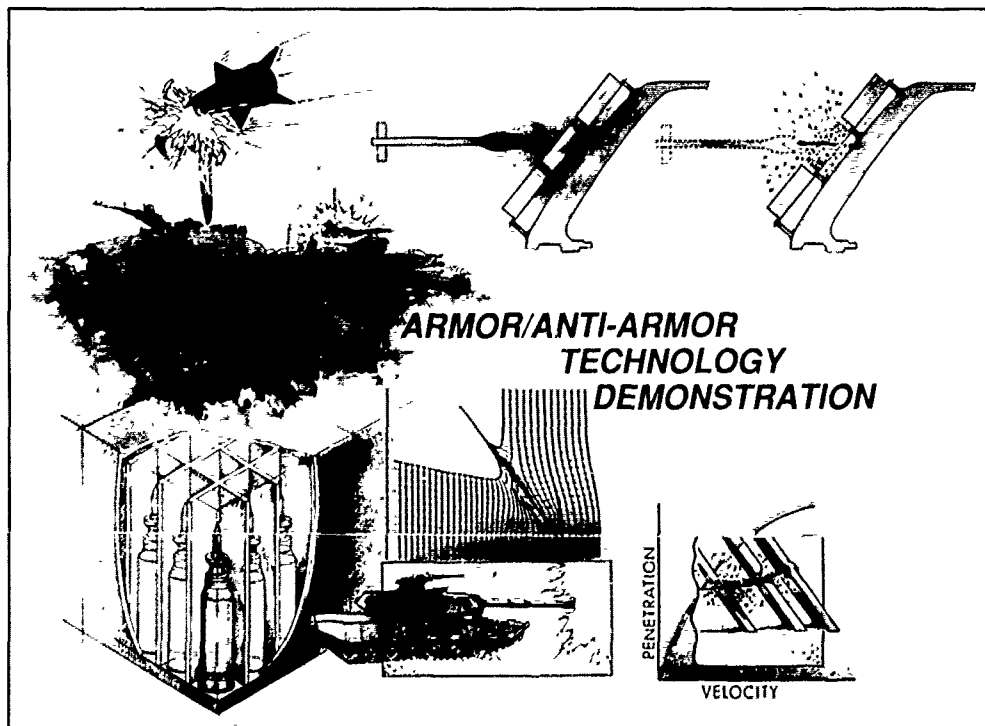
Armor/anti-armor technology is primarily concerned with the interaction of a warhead or penetrator with the armor which protects a weapon system. The Ballistic Research Laboratory (BRL) investigates the full-range of armor/anti-armor technology including the following areas:

- **Armor Technology** — various aspects of armor technology are researched, such as passive and reactive armor, combat vehicle armor design, and fabrication of low-cost ceramic armor.
- **Anti-Armor Technology** — some of the aspects of anti-armor technology being researched are tungsten and depleted uranium (DU) penetrators, shaped-charge warheads, and new liner materials and explosives.
- **Ammunition Survivability** — ammunition compartmentation technology is investigated to increase survivability in combat vehicles.



For additional information, contact:  
Director, U.S. Army Ballistic Research Laboratory  
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Aberdeen Proving Ground, MD 21005  
AV 298-6002 or (301) 278-6002

BRL employs computer-aided design and engineering to maximize performance of prototype kinetic energy hardware. Experimental tests of armor materials, warheads and penetrators, including live fire tests, are performed to aid the design and evaluation process. BRL also uses supercomputers as a complement to experimental tests.



# ARMORED SYSTEMS

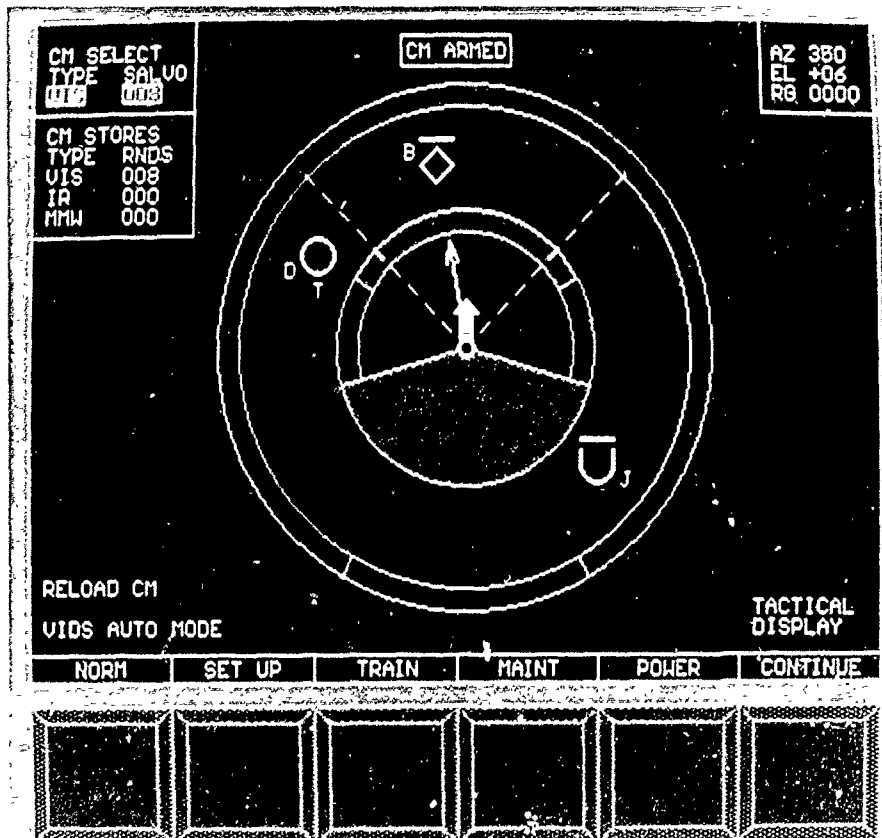


U.S. Army Tank-Automotive Command

## Vehicle Integrated Defense System

Enhanced combat vehicle survivability via non-armor oriented technology provides a low weight alternative to a conventionally armored vehicle. The Vehicle Integrated Defense System (VIDS) concept incorporates a suite of selected threat sensors to detect, classify, and locate hostile threats, coupled to a data management processor to inform the crew of threat location and classification information. The VIDS can initiate appropriate responses and select/initiate appropriate countermeasure reactions. Advanced countermeasure reactions such as multi-salvo smoke, integrated automatic weapon aiming, and active protection provide effective countermeasures to weapons of the 2000 time frame. This technology automates threat detection and provides a quick response.

The Vehicle Integrated Defense System (VIDS) automates threat detection and provides a quick response.



For additional information, contact:  
Commander, U.S. Army Tank-Automotive Command  
Attn: AMSTA-RSC, S. Caito  
Warren, MI 48397-5000  
AV 786 5788 or (313) 574-5788



U.S. Army Laboratory Command

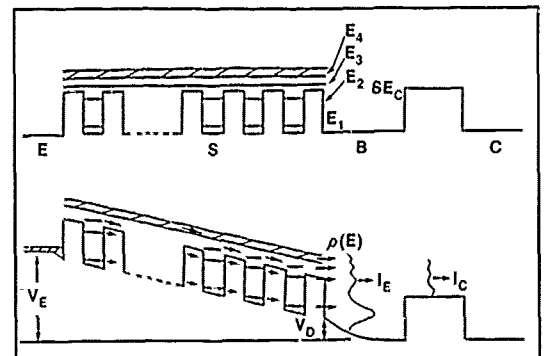
## Multiple Quantum Well Infrared Sensors

New photodetector concepts utilizing gallium arsenide (GaAs) and aluminum gallium arsenide (AlGaAs) for the detection of 5- to 100-micron infrared (IR) radiation have been invented and are being further developed at the Electronics Technology and Devices Laboratory (ETDL). These new detectors, when fully developed, should provide an attractive alternative to mercury cadmium tellurium (HgCdTe) technology for IR detection, owing to their lower cost, improved stability and more controllable fabrication/processing requirements. High quantum efficiencies and good responsivities have been achieved for 10-micron sources in GaAs/AlGaAs structures designed for impact ionization and avalanche gain at low voltages.

Development of multiple quantum well IR sensors is made possible by ETDL's Compound Semiconductor Research Center, a facility designed to support the fabrication and testing of next generation III-V semiconductor devices.

These photodetectors offer possibilities for multiple applications, such as IR viewing systems, tracking and surveillance systems, medical diagnostics, and SDI systems.

Fabrication and testing of next generation III-V semiconductor devices, such as novel infrared sensors, is supported by ETDL's Compound Semiconductor Research Center which features such unique devices as the Molecular Beam Epitaxy (MBE) machine pictured above.



These energy band diagrams illustrate the operation of a multiple quantum well infrared sensor. The top diagram corresponds to no applied voltage, while the bottom diagram shows current flow with applied voltage.

The Target Acquisition Designation Site (TADS) Pilot Night Vision Sensor (PNVS) for the AH-64 Apache helicopter is one of many potential applications of multiple quantum well infrared sensors.



For additional information, contact:  
 US Army Electronics Technology and  
 Devices Laboratory  
 Attn: SLCE/ED, Dr. Kwong-Kit Choi  
 AV 995-3806 or (201) 544-3806



**U.S. Army Laboratory Command**

## Millimeter Wave Radar

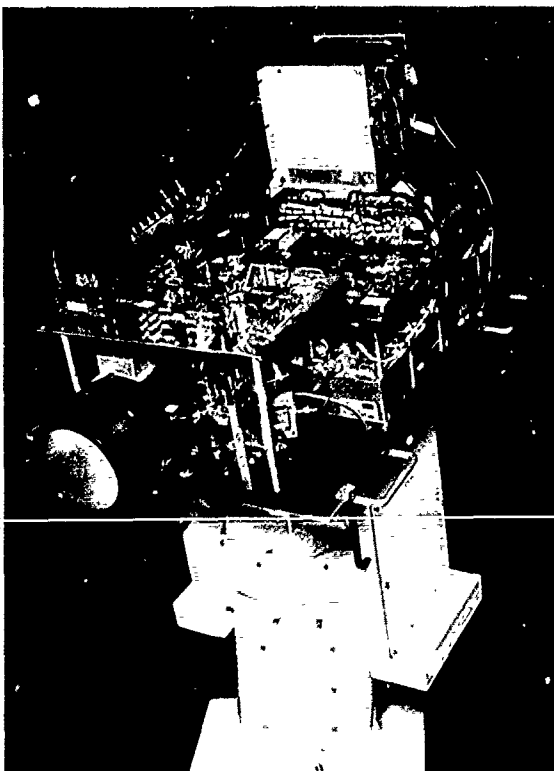
Rapid advances in tank armor technology will require future smart munitions to incorporate a proximity fuze with minimum modifications to the existing system. Harry Diamond Laboratories (HDL) is developing the technology needed to design and build a prototype millimeter wave (MMW) guidance-integrated fuze (GIF) sensor. The prototype GIF will provide the basis for a low-cost product improvement for smart munitions that have a MMW guidance sensor, such as the Multiple Launch Rocket System-Terminally Guided Warhead (MLRS-TGW).

The HDL program includes the measurement of radar signatures for Soviet tanks and other tactical vehicles and the use of these signatures to develop validated computer models of MMW GIF sensors.

The HDL-advanced 95-Gigahertz monopulse instrumentation radar used for the target signature measurements, shown here, is all solid state, coherent, wideband, and fully polarimetric. Signatures for Soviet tank targets have been obtained with the radar from the Missile Command's new 300-foot tower and test facility. High-resolution radar cross-section images of these targets have been generated from the measurements, and these images are being used to aid the development of computer models of MMW radar backscatter from tank targets. Data obtained with the radar are also being used to calculate the end-game tracking of the tank target by a smart munition guidance sensor.

The 95-GHz monopulse radar signature measurements program is providing essential data for the development and validation of a GIF sensor system model. The resulting model will allow the evaluation of various 95-GHz GIF sensor systems designs without the necessity for extensive and costly field testing.

The HDL 95-GHz monopulse instrumentation radar is used for target signature measurements. It is all solid-state, coherent, wideband, and fully polarimetric.



For additional information, contact:  
Director, U.S. Army Harry Diamond Laboratories  
Attn: SLCHD-ST-SP, Dr. Joseph Nemarich  
2800 Powder Mill Road  
Adelphi, MD 20783-1197  
DSN 290-3130 or (301) 394-3130



## U.S. Army Troop Support Command

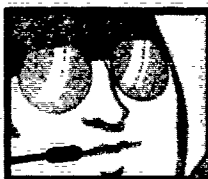
# Soldier Integrated Protective Ensemble

The Soldier Integrated Protective Ensemble (SIPE)—a modular, head-to-toe individual fighting ensemble for the Soldier System—is being developed at the Natick Research, Development, and Engineering Center and at other AMC Centers. Expected to be fielded by the year 2000, SIPE will include:

- integrated helmet (individual communication system)
- interface with weapons
- ballistic and laser eye protection
- respiratory and aural protection
- microclimate conditioning and power unit
- advanced clothing system (to include uniform, body armor, handwear, footwear, and load bearing).

In practical terms, SIPE will enable the soldier to communicate when out of earshot, aim and fire his/her weapon effectively with a "shoot from the hip" capability, and encapsulate himself/herself with auxiliary cooling for nuclear, biological, and chemical (NBC) operations. SIPE will provide protection from multiple battlefield hazards, including ballistic, flame, directed energy, and biological/chemical threats. The modular approach will allow flexibility in tailoring the Soldier System to meet mission requirements.

**ENHANCED VIEWING DEVICE**  
will integrate night vision capabilities as well as output of visual information to the visor



**HELMET**  
made of high impact advanced materials, it will provide ballistic respiratory and aural protection as well as short range communications

**VISOR**  
will provide laser and ballistic protection to the eyes and face

**COMMUNICATIONS**  
integrated radio communications will provide effective soldier-to-soldier communications capabilities

**MICROCLIMATE CONDITIONING**  
man portable cooling/power system will maintain soldiers thermal equilibrium and power electronic components

**NAVIGATION**  
a global positioning system will eventually be incorporated to enable the soldier to know his/her exact location.

**WEAPON**  
will be integrated with a remote viewing device (thermal imager) which will output onto the enhanced viewing device

**MATERIALS**  
material systems are being developed which integrate chemical, flame, thermal and directed energy protection

**GLOVES/BOOTS**  
gloves and boots will integrate chemical and flame protection

**COMPUTER**  
a personal soldier computer will eventually enable the soldier to transmit and receive images and information integrated with the enhanced viewing device

**For additional information, contact:**  
U.S. Army Natick Research, Development  
and Engineering Center  
Attn: STRNC-TTE, Ms. Carol J. Fitzgerald  
Natick, MA 01760-5000  
DSN 256-5311 or (508) 651-5311

**SOLDIER INTEGRATED PROTECTIVE ENSEMBLE  
(SIPE)**



**U.S. Army Armament, Munitions and Chemical Command**

**Family of Military Technologies**

- Energetic Materials
- Structural Materials
- Fuzing Safing/Arming
- Warhead Mechanics
- Aeromechanics/Aeroballistics
- Gun Propulsion
- Weapon/Ammo Packaging

The Armament Engineering Directorate of AMCCOM's Armament Research, Development and Engineering Center (ARDEC) is engaged in advancing the state-of-the-art in the technological areas listed below. These areas make up a Family of Military Technologies and represent a broad spectrum of disciplines and expertise. The application of these technologies by ARDEC and other materiel developers contributes to the development of more effective munitions for our soldiers.

**Trinitroazetidine (TNAZ)**

The Process Demonstration Module (PDM) manufactures Trinitroazetidine (TNAZ), a powerful new explosive developed by ARDEC. TNAZ is the first super-energetic strained ring explosive and releases more energy than OCTOL, the Army's most powerful castable explosive. The PDM will make sufficient quantities of TNAZ for developing formulations, testing (e.g., characterization and sensitivity testing), and will provide necessary information to evaluate and streamline production.

**Long Rod Penetrator**

The 25mm XM919 APFSDS-T cartridge utilizes the latest long rod penetrator. ARDEC has optimized this design and core metallurgy, which improves terminal ballistics. It utilizes an aluminum windscreen for aeroballistic efficiency and a fin assembly for stabilization. The projectile has a discarding, three-piece aluminum sabot that carries the assembled projectile through the gun tube. The projectile is decoupled from the full spin effects of the rifled tube by a free rotating slip ring which also serves as the obturating seal. The cartridge will be used in the Bradley Fighting Vehicle.

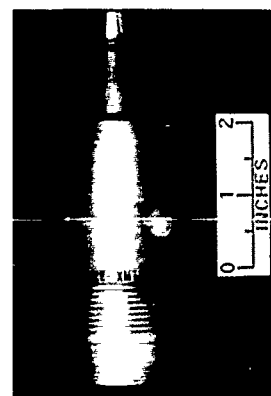
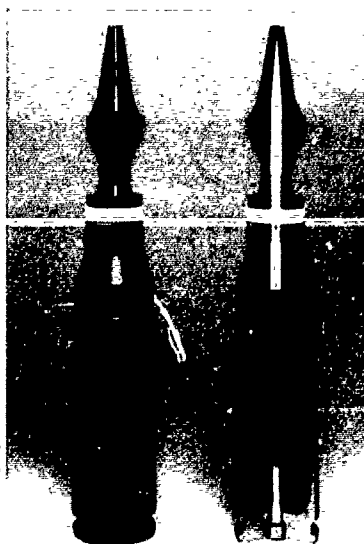
**M762 ET Fuze**

The M762 ET is an accurate, reliable, and mass producible electronic time fuze which can be set manually or automatically. The fuze will interface with all 105mm, 155mm, and 8-inch projectiles. Auto setting provides the capability for a direct, automatic data link between the fuze and the fire control system. It will permit the incorporation of rapid automated projectile handling techniques in future artillery weapon systems. The M762 is used for cargo-carrying projectiles, and a variant fuze that has a booster (the M767) is used for explosive projectiles. It will replace mechanical time fuzes presently in the field.

The Process Demonstration Module (PDM) manufactures Trinitroazetidine (TNAZ), a powerful new explosive developed by ARDEC.



Latest long rod penetrator is used in the 25mm XM919 APFSDS-T cartridge, which will be placed in the Bradley Fighting Vehicle.



The M762 ET Fuze is accurate, reliable, and can be set manually or automatically. It will replace mechanical time fuzes presently in the field.

**Hybrid Warhead Concept**

A new warhead is being developed in the ARDEC technical base program that utilizes the detonation mach stem phenomena generated by a core (lower energy)/jacket (higher energy) explosive configuration. The warhead is being developed in the ARDEC technical base program, and offers better anti-materiel performance than conventional Explosively Formed Projectiles (EFP) warheads.

**Samara Type Decelerator**

The Samara Type Decelerator drives a submunition in a lunar motion while it descends vertically over a battlefield, scanning for armored targets. It is a one-fin device which consists of a sheet of 3-oz. per square yard nylon cloth with a tip weight, evolved from an ARDEC exploratory development program. The idea of using a single flexible fin with a tip weight to generate a lunar scan motion was derived from the flight of maple seeds (samaras). Multi-degree-of-freedom flight simulation and the modeling of fin deployment from a rapidly spinning artillery shell were used as design tools.

**UNICHARGE**

UNICHARGE is a single increment universal propelling charge that meets full zoning requirements of 155mm artillery by using multiples of the increment. It will be compatible with advanced automatic-load howitzers and existing systems. The unit is a rigid charge suitable for use with either an automatic system for charge selection and loading, or manual handling. UNICHARGE uses a combustile core and high energy insensitive propellant. It provides less packaged volume per charge fired, reduces crew size, and increases stowage in current self-propelled weapons.

**Metal Container for 120mm Tank Ammunition**

A lightweight metal container for 120mm tank ammunition is used for both kinetic energy and HEAT ammunition. The container is waterproof, has an opening on the end, and has interlocks to form a rigid pallet load of 30 rounds. Internal cushioning and sleeves are used to support the round. Advantages over the old fiber tube/wood box are reduced rearm time, reduced weight, and reduced cost.



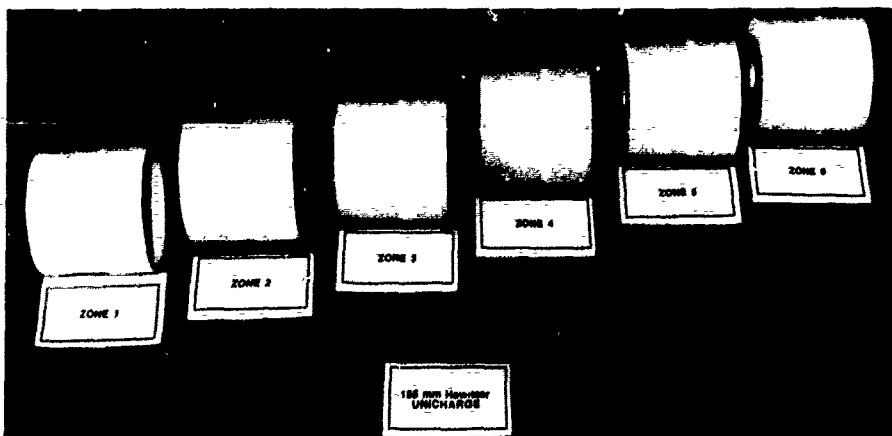
▲ An ARDEC laboratory fixture, which is being used to develop a new warhead. The warhead will offer better anti-materiel performance than conventional EFP warheads.

This 120mm tank ammunition container can be used for kinetic and HEAT ammunition. It is made of metal, and is lighter and less expensive than the fiber tube/wood box. ▼

The Samara Type Decelerator ► drives a submunition in a lunar motion while it descends vertically over a battlefield, scanning for armored targets.



◀ UNICHARGE propellant will be compatible with advanced automatic-load howitzers and existing artillery systems.



For additional information, contact:  
 Commander, ARDEC  
 Attn: SMCAR-AEB, Fred Cotton  
 Picatinny Arsenal, NJ 07806-5000



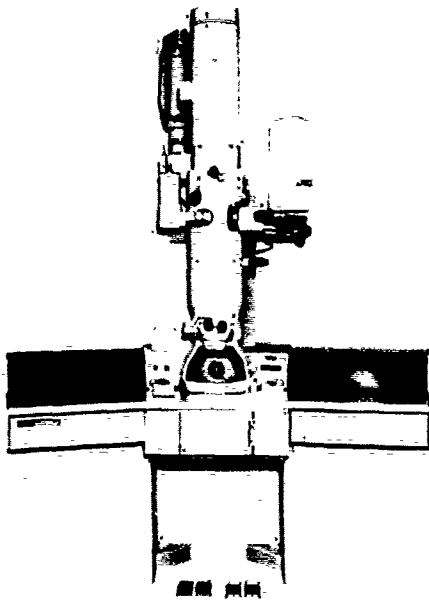


## U.S. Army Laboratory Command

### Nanoelectronics

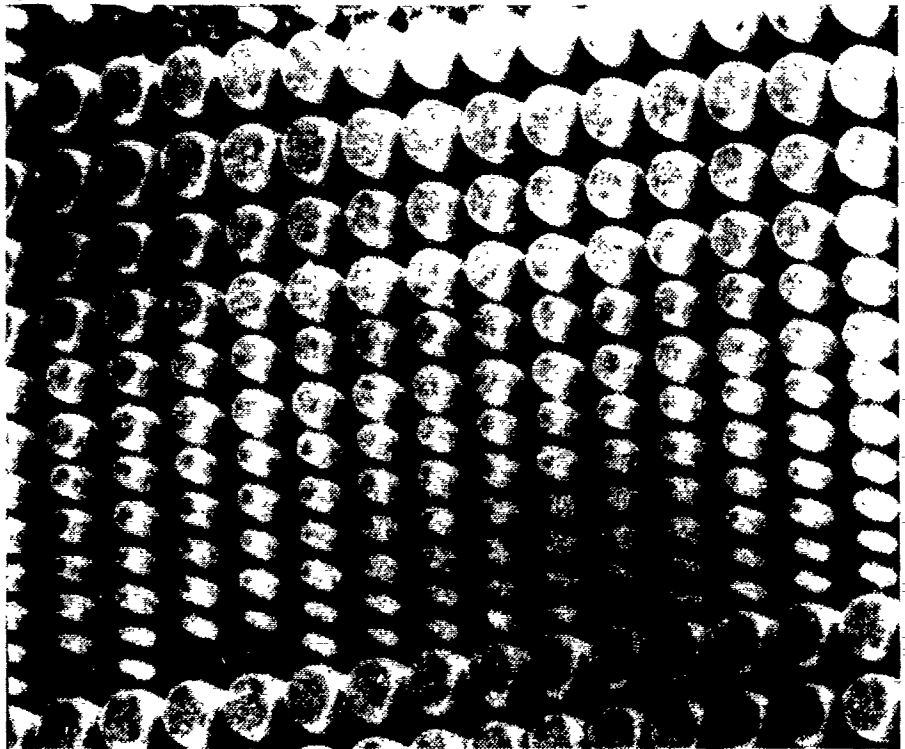
Nanoelectronics is the multi-dimensional integration of molecular-size electronics with photonics and acoustics to provide pre-processed sensing, information throughput, and decision-making abilities orders of magnitude greater than those presently attainable using microelectronics. Successful development of nanoelectronics will improve capabilities such as machine vision, autonomous and brilliant real-time decision-making, and automatic scene recognition, with advantages of compactness, reduced cost, lighter weight, and reduced power usage.

The Electronics Technology and Devices Laboratory (ETDL) is advancing the development of nanoelectronics technology through the generation of concepts, integration of design, and establishment of fabrication processes on the nanometer feature scale. Laboratory facilities featuring molecular-level thin-film epitaxy, nanolithography, device nano-analysis techniques, and high resolution electrical characterization methods are utilized to advance the future technology of nanoelectronics.



200 KeV Transmission Electron Microscope with nanometer resolution. This state-of-the-art microscope is utilized in the atomic analysis of crystalline lattice structures grown at ETDL's Compound Semiconductor Research Center.

High resolution images of nanoelectronics.



→ ← 10 μm



For additional information, contact:  
U.S. Army Electronics Technology  
and Devices Laboratory  
Attn: SLCE-E, Dr. Joel Shappirio  
Ft. Monmouth, NJ 07703  
AV 995-2452 or (908) 544-2452



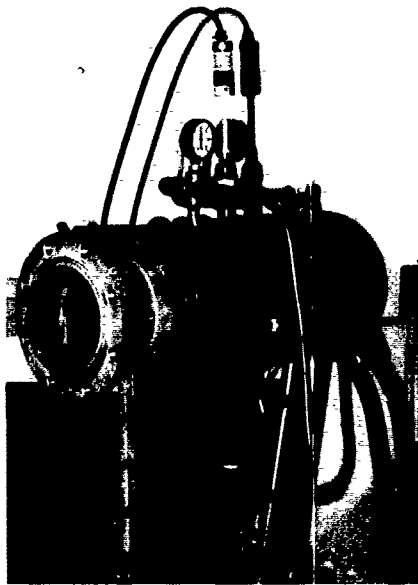
U.S. Army Laboratory Command

## Manufacture of High-Temperature (1-2-3) Superconductors by Self-Propagating High-Temperature Synthesis (SHS)

The global objective of superconductor research is to discover materials that will be electrically superconducting at higher than supercold temperatures; ideally room temperature. The materials technology aspect of the research includes synthesis and processing. Self-Propagating High-Temperature Synthesis (SHS) is a most promising process for production of powder and bulk ceramic materials for high-temperature superconductors of the 1-2-3 class.

The current process for manufacturing these ceramics is costly in terms of labor, time, and power, requiring closely-monitored heating/annealing of powders in a furnace at 950° C for 4 to 5 days, with interruptions for grinding the powder. The SHS process could allow production of a pure, stable ceramic with superior electro-magnetic properties in a one-step process taking only seconds, at about 1/50,000 of the current cost.

Earlier pioneering work on SHS at the Materials Technology Laboratory (MTL) won an Army R&D Achievement Award. This work laid the foundation for MTL to pursue this revolutionary process for inexpensive production of superconductor materials. Because of its obvious potential to the critical technology of superconducting materials, the Soviets and Japanese are focusing intensely on refining SHS technology.



The SHS process provides a one-step method of producing ceramic materials for 1-2-3 class superconductors. SHS can yield superior properties at about 1/50,000 the cost of current ceramic production techniques.



For additional information, contact:  
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Attn: SLCMT-EMS, Dr. Lou Carreiro  
Watertown, MA 02172-0001  
AV 955-5030 or (617)-923-5030

## ROBOTICS



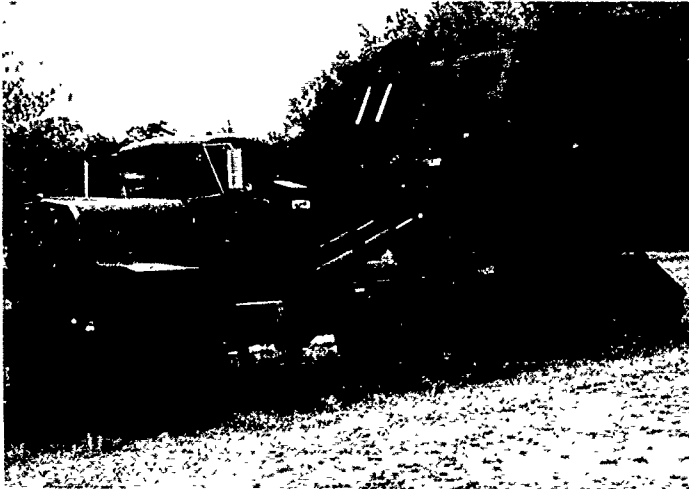
U.S. Army Laboratory Command

### Field Material Handling Robot Technology (FMR-T) and the Palletized Loading System (PLS)

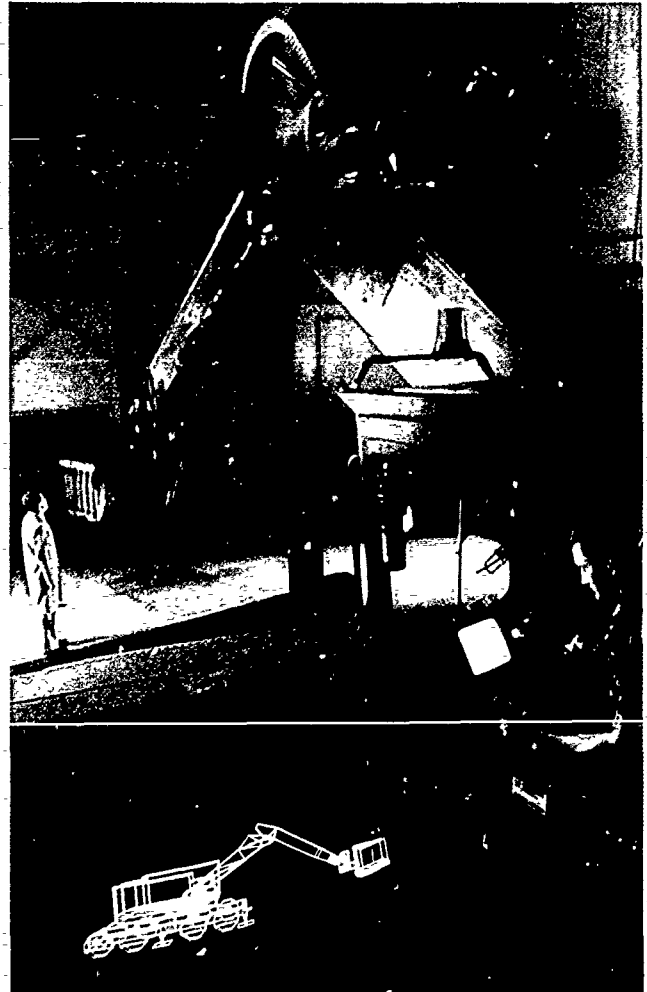
The Field Material Handling Robot Technology (FMR-T) project examines the application of successful industrial innovations in material handling to the Army field environment. FMR-T is compatible with the emerging ammunition distribution system, the maneuver-oriented ammunition distribution system (MOADS), and the palletized loading system (PLS). It places special emphasis on human factors analysis, performance evaluation, and technology transfer.

The PLS is a logistics vehicle designed to provide a more efficient means of delivering ammunition or other supplies to field locations. The Human Engineering Laboratory (HEL) and the Program Manager for Ammunition Logistics (PM-AMMOLOG), have developed and conducted field trials on three enhancements—the Hooklift Interface Kit (HIK), the inter-modal Ammunition Container (AM-CON), and an air-lift compatible pallet.

The PLS provides a more efficient means of delivering ammunition or other supplies to field locations.



Field material handling robot technology incorporates successful industrial innovations.



For additional information, contact:  
Director, U.S. Army Human Engineering Laboratory  
Attn: SLCHE-CS  
Maj. Harry McClellan (FMR-T)  
AV 298-5895 or (301) 278-5895  
Mr. John Salser (PLS)  
AV 298-5861 or (301) 278-5861  
Aberdeen Proving Ground, MD 21005-5001





U.S. Army Laboratory Command

Advanced Ceramics: Engine, Armor, and Gun Applications

Ceramic materials are uniquely able to perform and survive in many extreme environments. Current research seeks better processing techniques to improve and control the properties of ceramics that make them resistant to intense heat, high ballistic impact, extreme wear, corrosion, and erosion. Applications for advanced ceramic materials include:

- Ceramic Engine Components—zirconia and silicon nitride
- Advanced Ceramic Armor—titanium diboride and silicon carbide
- Ceramic Gun Tube Liners—silicon carbide, sialon, and silicon nitride
- New Glass Technology—oxynitride glass, fiber and bulk.

For heat engine components, work focuses on quasi-static properties at room and elevated temperatures. For ballistic applications, the focus is high-strain-rate mechanics of ceramics. Relating performance to materials microstructure and processing will enable improvement of performance and cost.

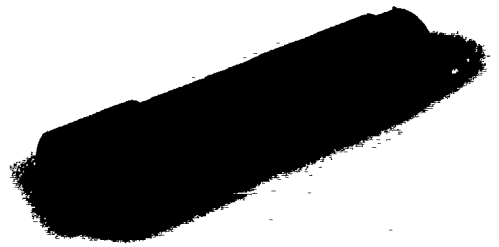
While one of the advantages of ceramics is the wide availability of raw materials, many of the applications for high-performance ceramics are unique to defense, with no immediate commercial market to inspire cost reduction. The Materials Technology Laboratory (MTL) has worked closely with the private sector to encourage and leverage interest in new processing technologies to lower the cost of such materials.



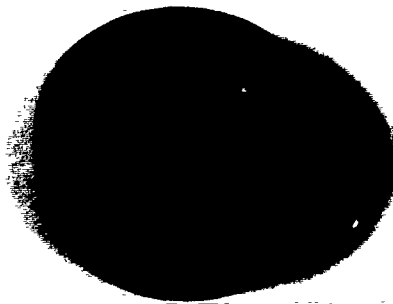
For additional information, contact:  
Director, U.S. Army Materials Technology Laboratory  
Attn: SLCMT-EMC, Mr. Phillip Wong  
Watertown, MA 02172-0001  
AV 955-5324 or (617) 923-5324



ZIRCONIA (T T) HEAD PLATE



0.50 CALIBER RIFLED SILICON CARBIDE TEST MODULE



HOT PRESSED SILICON NITRIDE ADIABATIC DIESEL PISTON CAP



SINTERED SILICON NITRIDE TURBOCHARGER



ZIRCONIA (TT) VALVE SEAT



ZIRCONIA (TT) VALVE GUIDE



U.S. Army Laboratory Command

## Man-Packed Binocular Radio Components

The Man-packed Binocular Radio is a two-way fast-deployable line-of-sight secure voice communications system. It is capable of operating under all-weather conditions over a range of 1 kilometer. The radio uses millimeter-wave integrated circuits which make it very inexpensive. All electronic circuitry is tightly packaged in the binocular housing, replacing one optical lens. The binocular radio can be hand held or mounted on a tripod. The communicating parties are generally in sight of each other with the optical half which then guarantees millimeter wave communication capability. The narrow beam width and the low power usage reduces the probability of detecting the operation of the binocular radio.



For additional information, contact:  
U.S. Army Electronics Technology and Devices  
Laboratory  
Attn: SLCET-DT, E. Freibergs  
Fort Monmouth, NJ 07703-5000  
AV 995-2813 or (201) 544-2813



U.S. Army Laboratory Command

## Composite Infantry Fighting Vehicle

The Materials Technology Laboratory's (MTL) Composite Hull Technology Demonstration is proving the feasibility of molding a hull of advanced thick composite material which can be used in an armored combat system that meets severe ballistic and structural performance requirements. An Infantry Fighting Vehicle (IFV) has been fully outfitted with a composite hull as an operational vehicle and has been road tested. With respect to metal hulls, benefits of the composite hull are: 25% weight reduction, enhanced crew survivability, noise and vibration reduction in the crew compartment, reduced manufacturing costs, and reduced life cycle costs.



For additional information, contact:  
Director, U.S. Army Material Technology Laboratory  
Attn: SLCMT-MEC, Mr. William Haskell  
Watertown, MA 02172-0001  
AV 995-5172 or (617) 923-5172

An infantry Fighting Vehicle with a composite hull offers the benefits of light weight, superior structural performance, and reduced manufacturing and maintenance costs





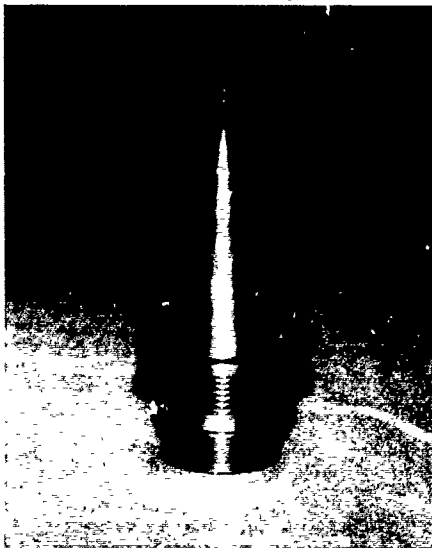
**U.S. Army Laboratory Command**

## Yawsonde Technology

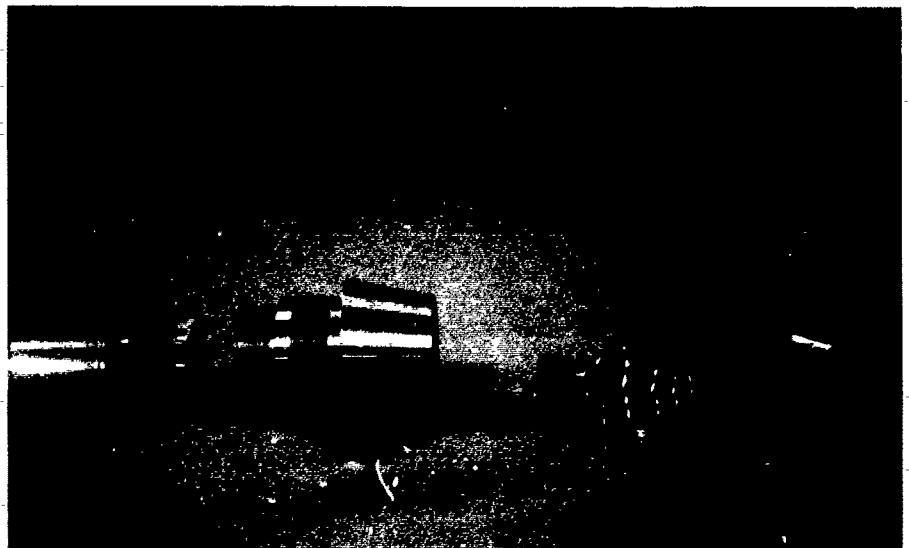


**For additional information, contact:**  
 Director, U.S. Army Ballistic Research Laboratory  
 Attn: SLCBR-LF-A, Mr. Wallace Clay  
 Aberdeen Proving Ground, MD 21005-5066  
 AV 298-2533 or (301) 278-2533

During the development cycle of projectiles, a detailed knowledge of the yawing motion and the spin history are required to assure flight stability and precision. A relatively inexpensive instrumentation/telemetry system has been developed to provide such data. A standard artillery fuze can be replaced by a fuze-configured yawsonde. The yawsonde has optical sensors that determine the orientation of the projectile with respect to the sun. Engineers can then relate the solar angle data into yaw and spin histories along the entire trajectory. The Ballistic Research Laboratory (BRL) has developed the yawsonde into an engineering tool that has been used to aid in the type classification of essentially all artillery projectiles in the inventory and those under development. Yawsonde systems have also been built for non-standard systems such as the M712 Copperhead projectile and Sense-and-Destroy Armor (SADARM) submunitions. BRL also builds custom instrumentation/telemetry systems for inflight measurements. A recent example involved the measurement of motor temperature and pressure for the 155-mm M864 base-burn projectile.



Assembled fuze-configured yawsonde for use on 155-mm and 105-mm artillery projectiles.



Exploded view of major components of a yawsonde: battery and connector, metal body with optical sensors, hybrid electronics, and antenna with plastic windscreen.



U.S. Army Laboratory Command

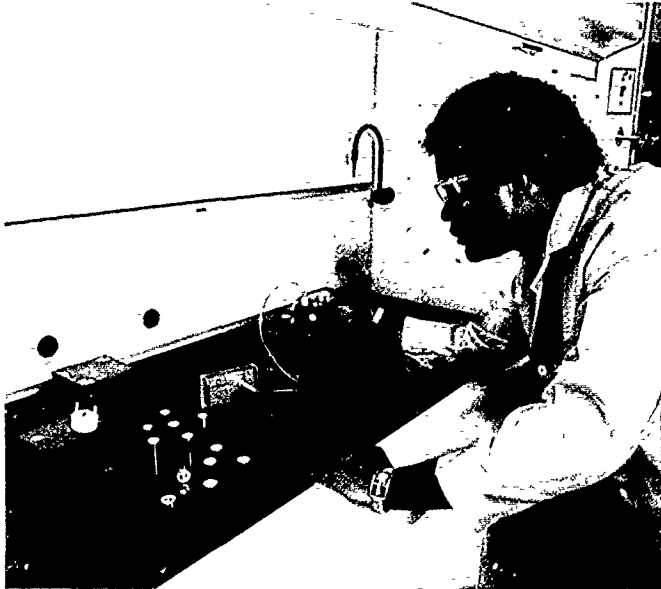
## Lithium Battery Indicator and Safe Disposal Discharge Device



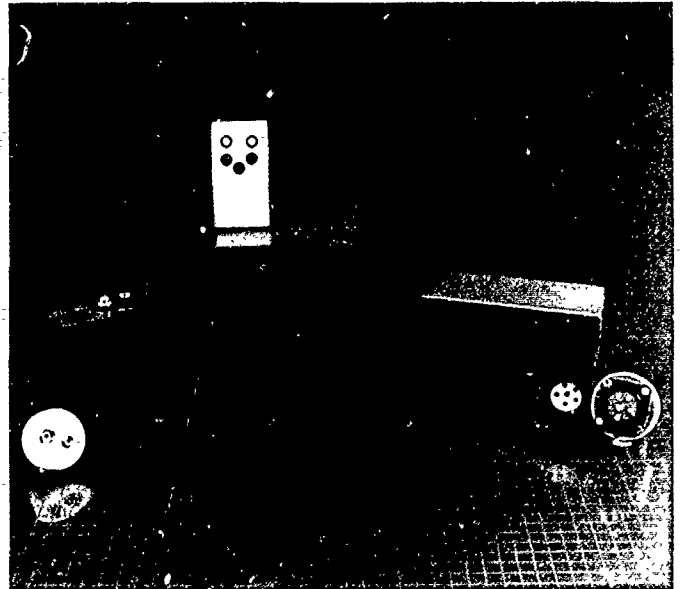
For additional information, contact:  
US Army Electronics Technology and Devices Laboratory  
Attn: SLCET-DT  
Fort Monmouth, NJ 07703-5000  
DSN 995-4886 or (201) 544-4886  
DSN 995-2458 or (201) 544-2458

The Bench Model Battery Status Indicator (BSI) is a small self-contained cable-based unit that can be used continuously to test batteries at a rate of approximately four per minute. The purpose of the battery status indicator is two-fold. First it indicates if the internal battery fuse has been blown. This is important in deciding whether or not an External Discharge Device (EDD) can be utilized to ensure elimination of all lithium reactivity by completely discharging the battery. Partially used lithium batteries must be treated as hazardous waste due to their residual lithium content. However, a completely discharged lithium battery is non-reactive, and does not require costly hazardous waste disposal. The status indicator also tells if the battery is too weak to power equipment. This feature can be exploited in the field with a smaller portable model and has been designed for intermittent use.

The use of these battery status meters to prevent discarding live usable batteries and the use of the discharge devices to eliminate any residual reactivity in used batteries can save the government millions of dollars in lithium battery procurement and disposal costs.



The Bench Model Battery Status Indicator, shown here testing the charge of a lithium battery, can contribute to significant savings in lithium battery and procurement costs.



External Discharge Device for BA-5588 and BA-5598.



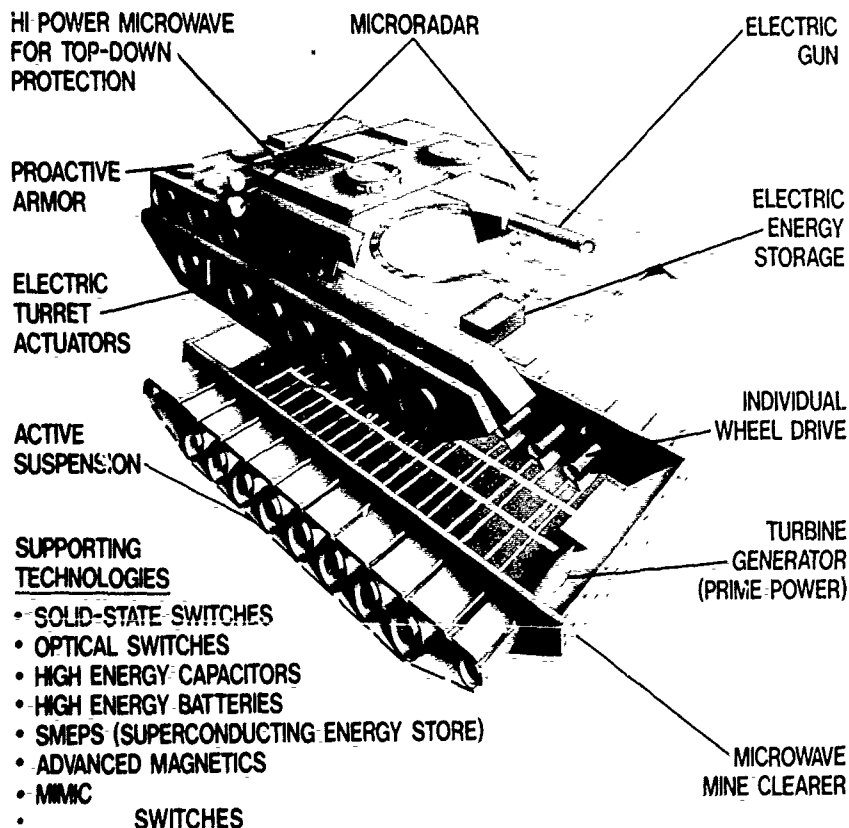


U.S. Army Laboratory Command

## Megawatt Electronic Components for Army Vehicles

Electronic components with power capabilities in the megawatt range can find tremendous application in Army vehicle systems. The Electronics Technology and Devices Laboratory (ETDL) has recently collaborated with the Tank-Automotive Command (TACOM) to identify the particular vehicle systems which can be impacted by megawatt electronics technology developments. These include electric drive, electric guns, countermeasures, and other vehicle systems. The components include solid-state and gaseous switches (which will be included in motor drives), high density energy storage systems, high-power microwave systems, and electric actuators. High energy density batteries and capacitors are essential for the development of electric guns and proactive armor, a countermeasure in which plates are launched from the vehicle to defeat incoming enemy fire. Superconductive inductive energy storage also may be applied here, in conjunction with high-power opening switches. Such components will play a role in a variety of vehicle systems, such as the All-Electric Tank Concept illustrated below, as well as such other vehicles as armored personnel carriers, weapons platforms, and transport vehicles.

### ALL ELECTRIC TANK CONCEPT



For additional information, contact:  
U.S. Army Electronics Technology and Devices  
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Attn: SLGET-ML, T. Podlesak  
Fort Monmouth, NJ 07703-5000  
DSN 992-0276



**U.S. Army Laboratory Command**

**Computer-Aided Design, Modeling,  
and Simulation**

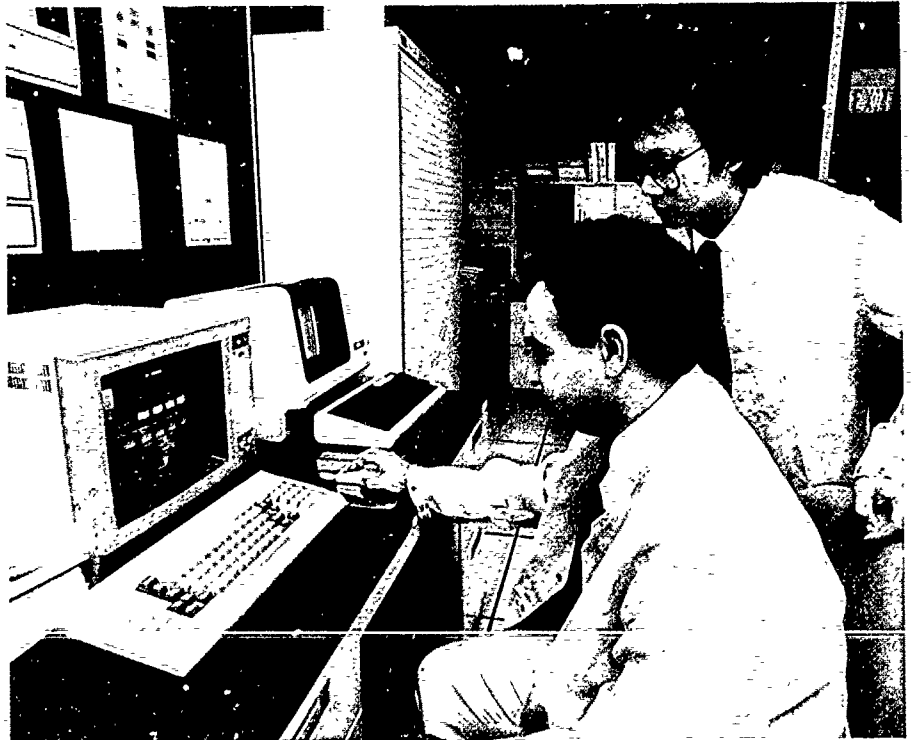
The Electronics Technology and Devices Laboratory (ETDL) has entered into partnerships with American industry and academia to help leverage diminishing research and development (R&D) budgets.

Consortia and cooperatives allow industry, academia, and the government to share resources without the exchange of funds. Two examples of this are the System Design Methodology Consortium and the Rapid Emulation of Non-Available Parts Cooperative.

Small Business Innovative Research (SBIR) contracts allow small businesses to solve important Army technical problems. An SBIR program participant developed a PC-based Very High Speed Integrated Circuit (VHSIC) Hardware Description Language (VHDL). The VHDL is a software package which designs, builds, and manipulates prototypes of hardware systems, saving both time and money in the process.

U.S. Army cooperation with universities allows sharing of unique Army technology with university innovation. The Summer University Program is part of the Army Research Center and brings in university faculty and students to participate in Army research. A similar program is conducted with the U.S. Military Academy at West Point.

Universities and private industry participate in the Electronics Technology and Devices Laboratory (ETDL) researching and developing of computer-aided design.



For additional information, contact:  
Director, U.S. Army Electronics Technology & Devices  
Laboratory  
Attn. SLCE-IC, Charles Bosco  
Fort Monmouth, NJ 07703-5000  
AV 995-2613 or (201) 544-2613

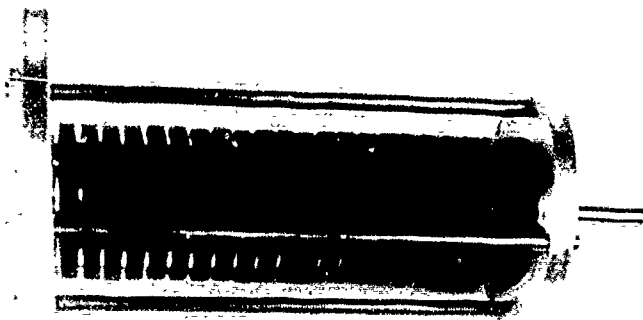


U.S. Army Laboratory Command

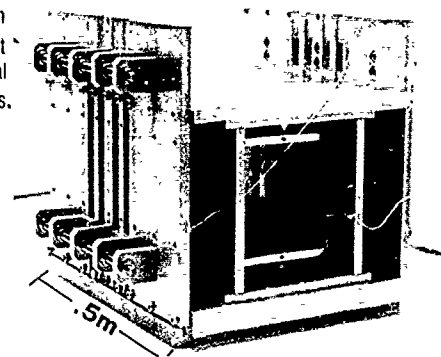
## High Energy Magnets for Army Systems

High energy product permanent magnets offer the utility of powerful magnetically rigid, thermally stable, light-weight magnetic circuit configurations for millimeter-wave magnetic focusing structures used in radar and communications devices. An outgrowth of ETDL's work with novel magnetic circuit designs has been a Cooperative Research and Development Agreement (CRDA) with Martin Marietta where ETDL has been funded to design a permanent-magnet biasing structure to meet Martin Marietta's requirements. ETDL is also developing permanent magnet cavities which are expected to replace conventional superconducting magnet-based magnetic resonance imaging instrumentation.

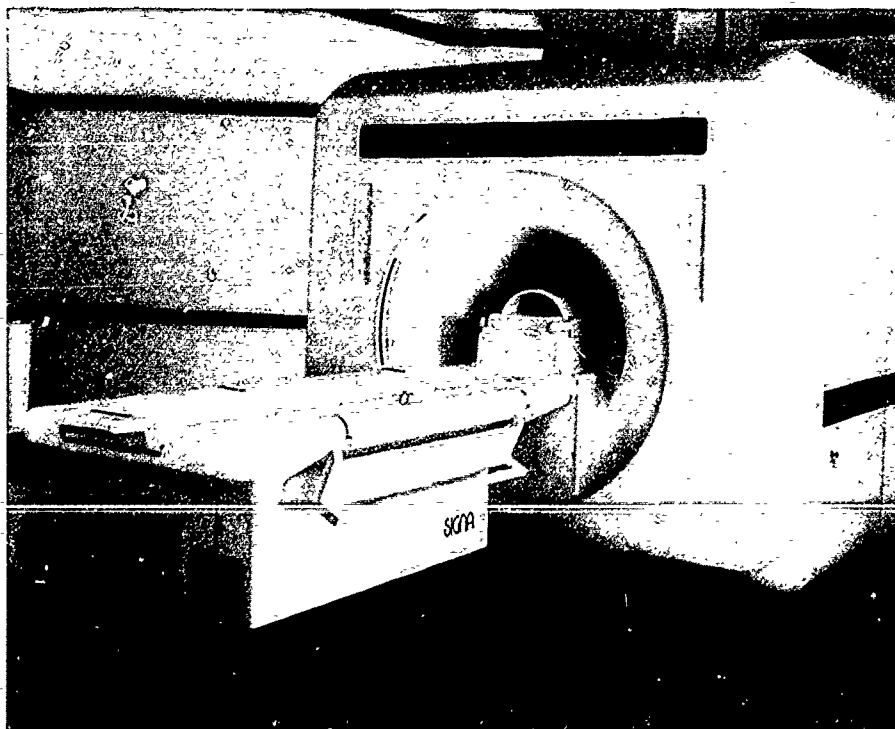
Hughes 982H 95GHz Periodic Permanent Magnet—an electron-beam focusing magnet stack made from high energy-product materials.



Second generation permanent magnet source for medical diagnostics.



Presently used conventional superconducting magnet for magnetic resonance imaging medical diagnostics. Bulky energy consumptive cryogen dependent conventional superconducting magnet sources will be replaced by a much more compact, energy-independent permanent magnet source.



For additional information, contact:  
 Director, U.S. Army Electronic Technology  
 and Devices Laboratory  
 Attn: SLCEFS, Dr. Herbert Leupold  
 Fort Monmouth, NJ 07703-5000  
 DSN 995 4300 or (908) 544-4300

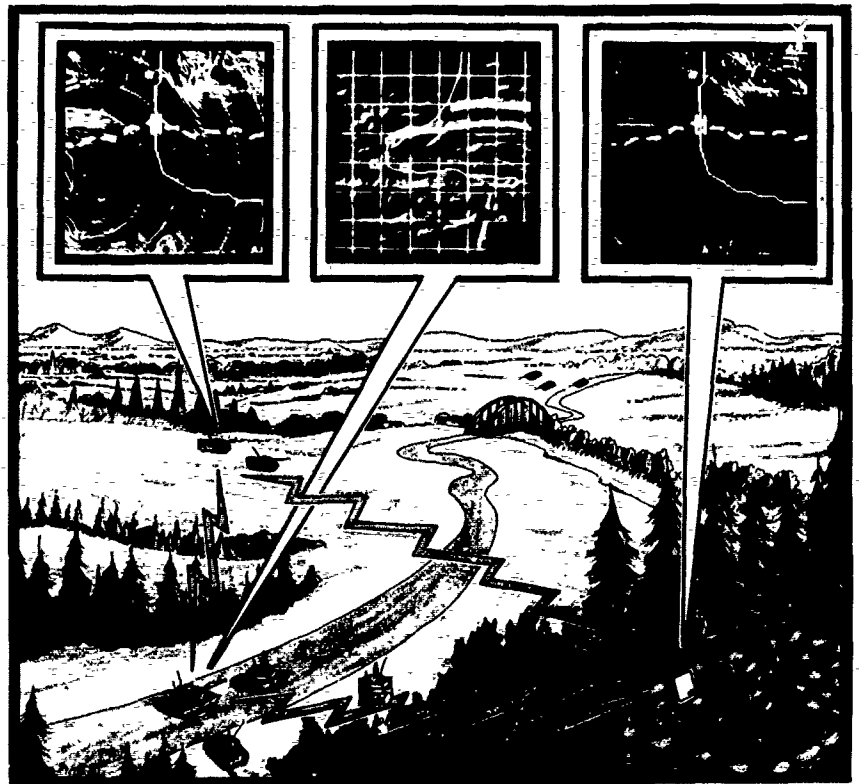


**U.S. Army Tank-Automotive Command**

## **Combat Vehicle Command and Control Concept**

The Combat Vehicle Command and Control (CVC2) concept is designed to provide a real-time data linked tactical situation to all commanders at battalion level and below (i.e., battalion, company, and platoon). The tactical display will provide map information, enemy and friendly locations, and operational graphics which will, in effect, provide commanders a simultaneous bird's-eye view of the battlefield tailored to their area of interest. This will enable synchronization and efficient use of combat power. The results should be a dramatic improvement in combat effectiveness of the battlefield force, a true force modifier.

In contrast, command and control at battalion level and below is currently done with paper maps, plastic overlays, a grease pencil, physically getting commanders together, and voice radio communication. These practices make command and control very difficult and inefficient on a dynamic battlefield.



The Combat Vehicle Command and Control concept is aimed at providing battalion, company, and platoon commanders with a bird's-eye view of the battlefield tailored to their area of interest.

For additional information, contact:  
Commander, U.S. Army Tank-Automotive Command  
Attn: AMSTA-RV, Mr. D. Sarna  
Fort Eustis, VA 23604-5577  
AV 786-6160 or (313) 574-6160



U.S. Army Missile Command

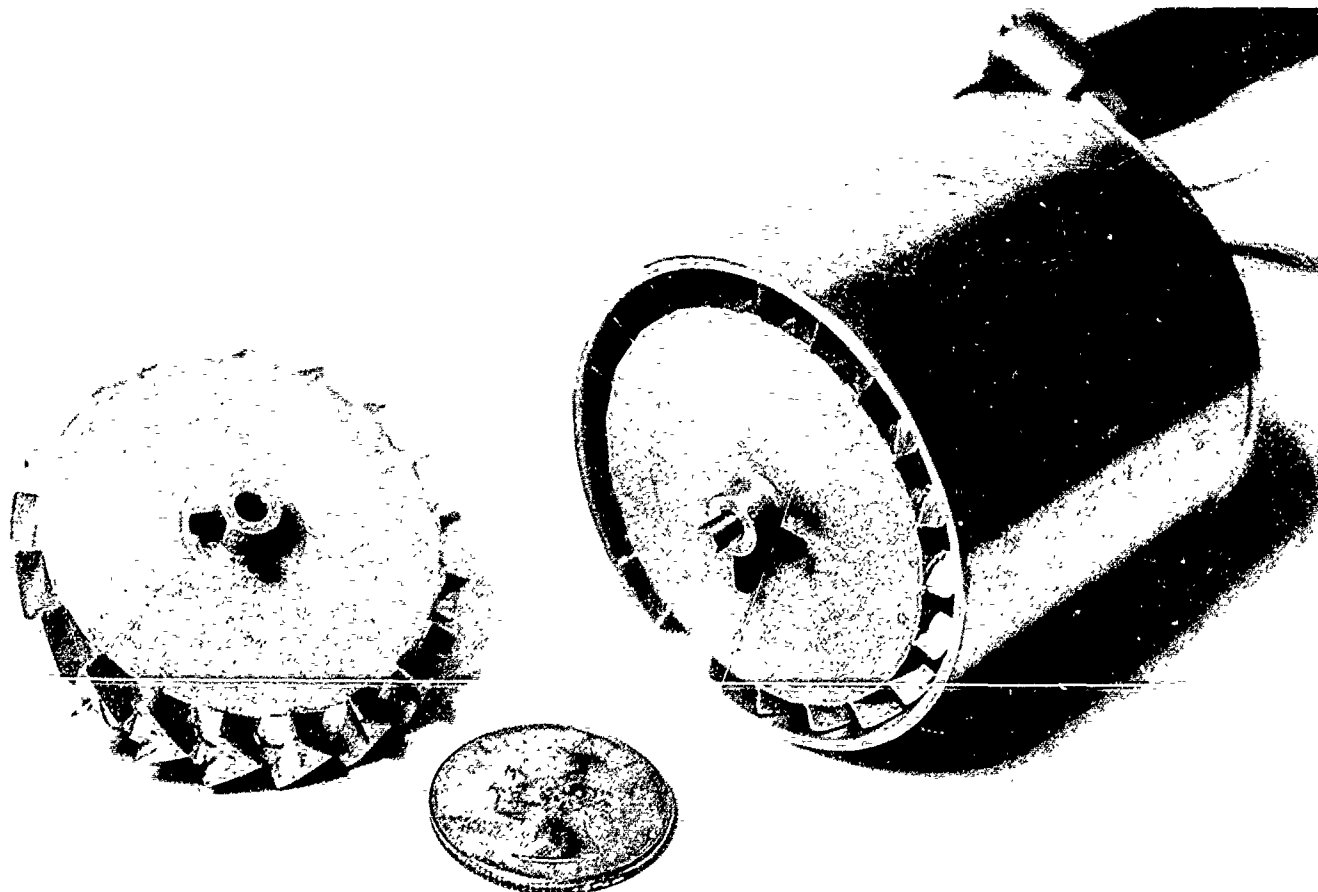
## Compact Air-to-Electrical Power Conversion Unit

A power converter which transforms air power to electrical power is being developed at the Army Missile Command (MICOM) to energize a telemetry package which monitors the reaction of missile systems to Electromagnetic Interference (EMI). Air power is delivered to the sensitive test environment (missile) by a rubber air hose. The pneumatic energy is converted to electricity by a miniature turbo-alternator. The use of a nonconducting hose to deliver power is essential to preserve the electromagnetic test environment.

The Air-to-Electrical Power Conversion Unit was developed as an alternative solution to the remote power problem which was also addressed by the Compact Optical-to-Electrical Power Conversion Unit. The air powered unit proved to be a more cost-effective method.

For additional information, contact:  
Commander, U.S. Army Missile Command  
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Redstone Arsenal, AL 35898-5245  
AV 746-7457 or (205) 746-7457

The compact Air-to-Electrical Power Conversion Unit contains a two inch diameter cylinder housing an eight watt alternator driven by the turbine wheel. A major consideration of the converter design was that the unit run properly with a small, inexpensive, portable air compressor. Limited air availability means the turbine and nozzle assembly must be highly efficient.





## U.S. Army Troop Support Command

### Biotechnology

Work at the Natick Research, Development, and Engineering Center in the area of biotechnology has spawned developments of materials which will enhance the Soldier System. New materials and technologies will provide more protection with less weight and bulk, nutritious foods from as yet untapped sources, and less waste for disposal.

#### Spider Silk

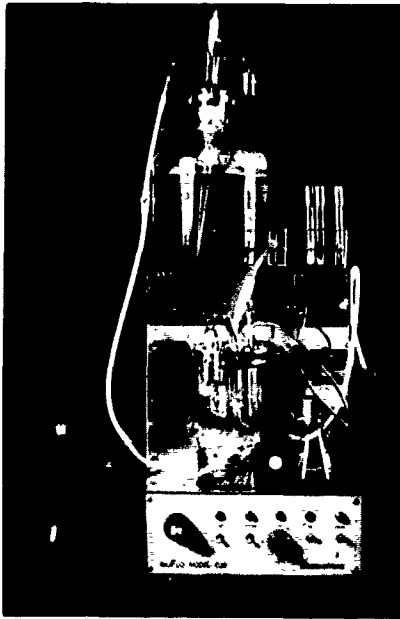
Scientists at Natick are cloning spider silk to produce a natural fiber that may someday be used to increase the ballistic protection of helmets and vests. Spider silk may also be used to enhance the strength of parachute cords and reduce the weight of clothing.

#### Pigments

New camouflage pigments with chameleon-like properties can be produced from bacterial, algal, and fungal sources. These pigments may be integrated into uniforms to reduce the soldier's signature and actually give him the ability to blend into his environment.

#### Packaging

New packaging fibers with low-oxygen permeability and a high ratio of degradation are being produced to reduce the logistics burden while protecting the environment from waste. Some of these natural fibers are edible and will possibly be used as a source of food.



New camouflage pigments with chameleon-like properties can be produced from bacterial, algal, and fungal sources.



Lightweight and biodegradable packaging fibers are being produced.



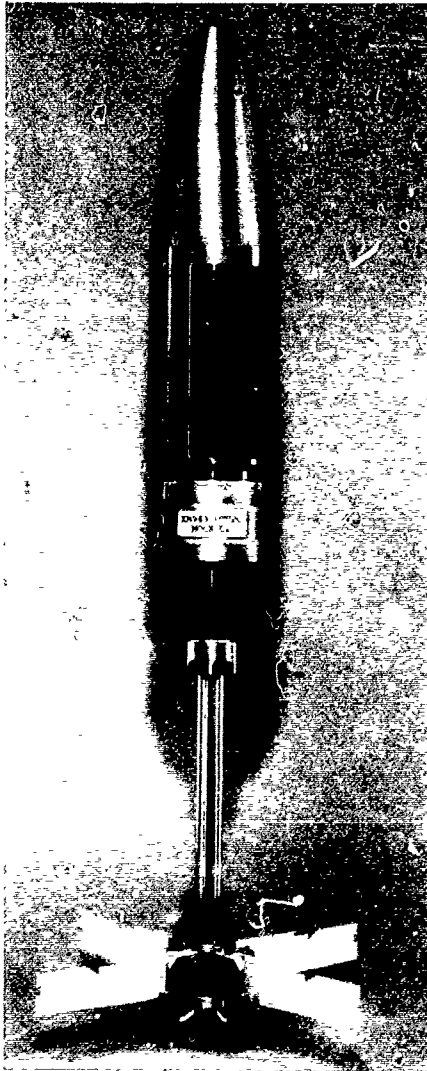
Scientists are cloning spider silk to produce a natural fiber that may increase the ballistic protection of helmets and vests.

For additional information, contact  
U.S. Army Natick Research, Development and  
Engineering Center  
Attn: STRNC-YM, Dr. David Kaplan  
Natick, MA 01760-5000  
DSN 256-5530 or (508) 651-5530



## U.S. Army Armament, Munitions and Chemical Command

### Smart Munitions



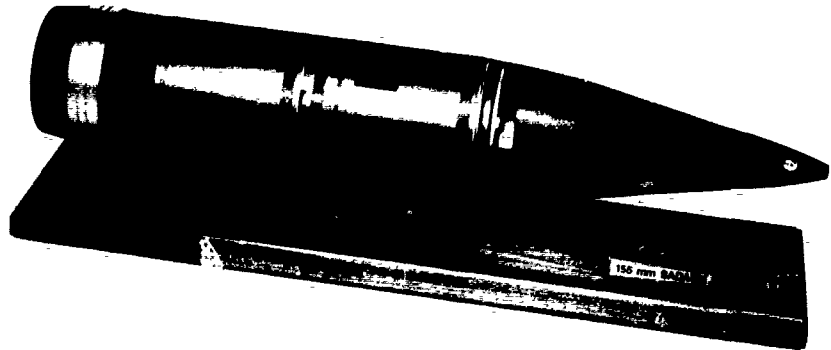
Above, the XM 943 detects a target and then fires an explosively-formed penetrator (EFP) through its lightly armored top.

#### XM 943 STAFF Projectile

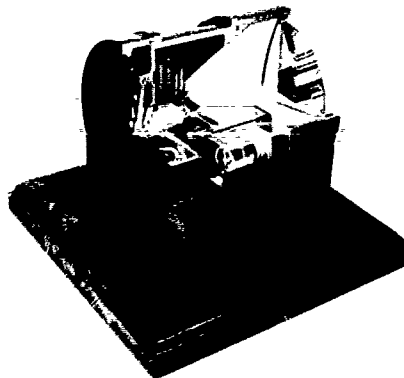
The XM 943 Smart Target Activated Fire-and-Forget (STAFF) Projectile is being developed for direct-fire weapons. The STAFF projectile employs a sensor to detect a target and fire an explosively-formed penetrator (EFP). The projectile follows a ballistic path and is roll-controlled through the use of fluidic-controlled jet nozzles located in the rear fin assembly. This projectile takes advantage of the extremely large lethal zone that serves as an aiming basket for the gunner. The STAFF program offers true "leap-ahead" technology to the Army, and its development continues to follow a sound technical track.

#### XM 898 155-mm Projectile and Submunition

The XM 898 Sense-and-Destroy Armor (SADARM) Projectile carries target-sensing submunitions which are expelled into the air over a target area, then enter a controlled descent at a constant spin and rate-of-fall. Dual sensors (millimeter and infrared wavelengths) scan a decreasing spiral footprint on the ground, locate the target, trigger a fire pulse, and launch an explosively-formed penetrator (EFP) to impact the top of the target. SADARM will be operable in both benign and countermeasure environments in all weather conditions, and during both daytime and nighttime, up to the system maximum range.



Above, an XM 898 155-mm SADARM projectile carries and expels target-sensing submunitions which locate a target and then launch EFPs to impact its top. Left, an XM 898 155-mm SADARM submunition.



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Commander, US Army Armament, Research,  
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Attn: SMCAR-FSP-A, Dr. Floyd Ribe  
Picatinny Arsenal, NJ 07806-5000  
AV 880-2937 or (201) 724-2937

**For additional information, contact:**  
Commander, US Army Armament, Research,  
Development, and Engineering Center  
Attn: SMCAR-FSP-I, Peter Burke  
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### Wide Area Mine (WAM)

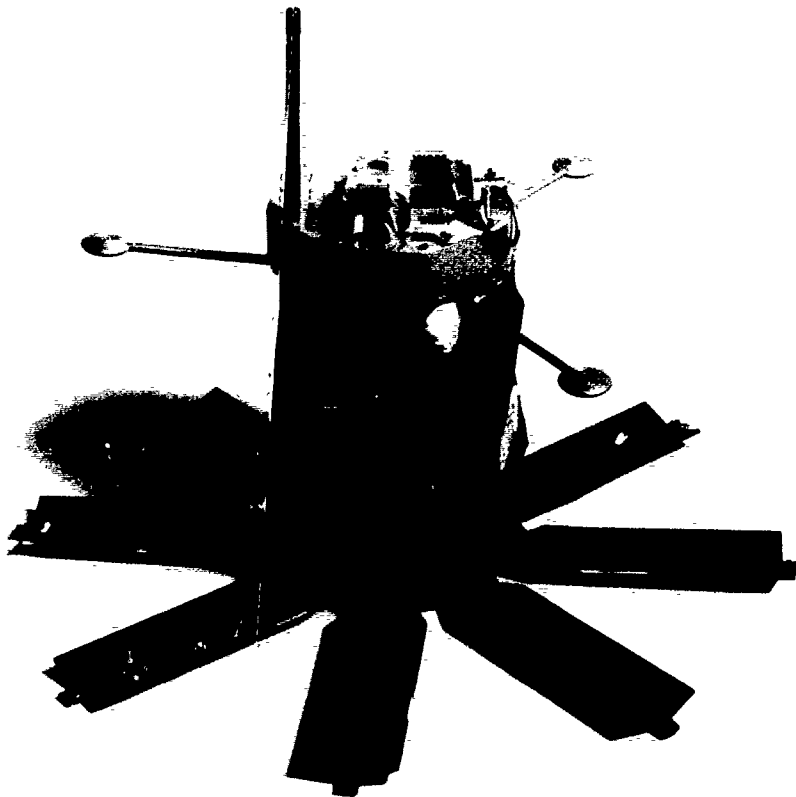
The Wide Area Mine (WAM) is a one-man portable Anti-Tank/Anti-Vehicle mine designed to detect and defeat a target vehicle at a distance. It is deployed by hand, and could potentially be deployed by such systems as Volcano, the Army Tactical Missile System (ATACMS), and the Multiple-Launch Rocket System (MLRS). The WAM can be commanded to "turn on" and "self-destruct" via interface and commands from the M71 Remote Control Unit (RCU).

After deployment on the ground, the WAM comes to rest, rights itself automatically, autonomously searches for target vehicles, and then launches a smart submunition (sublet) towards target vehicles which have a Closest Point-of-Approach (CPA) to the mine of 100 meters or less. The sublet is launched so that it flies toward the target vehicle and attacks the top of the target with an explosively-formed penetrator (EFP) lethal mechanism.

The WAM consists of three major subsystems: a communications module, a ground platform module, and the sublet module. The communications module receives information from the M71 RCU in regard to command arming and command destruct. The ground platform module contains electro-mechanical components and the necessary electronics for controlling ground erection, detection, classification, aiming, and launching of the sublet module. The sublet module has components capable of target detection, determining target aimpoint, and the firing direction of a lethal mechanism at the target vehicle.



The Wide Area Mine (WAM) is designed to detect and defeat a target vehicle at a distance. Above, the WAM prior to deployment. Left, after deployment, the WAM rights itself and autonomously searches for target vehicles.



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For additional information, contact:  
Commander, US Army Armament Research,  
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Attn: SMCAR-FSM-S, Mr. George Lutz  
Picatinny Arsenal, NJ 07806-5000  
AV: 880-7848 or (201) 724-7848





U.S. Army Laboratory Command

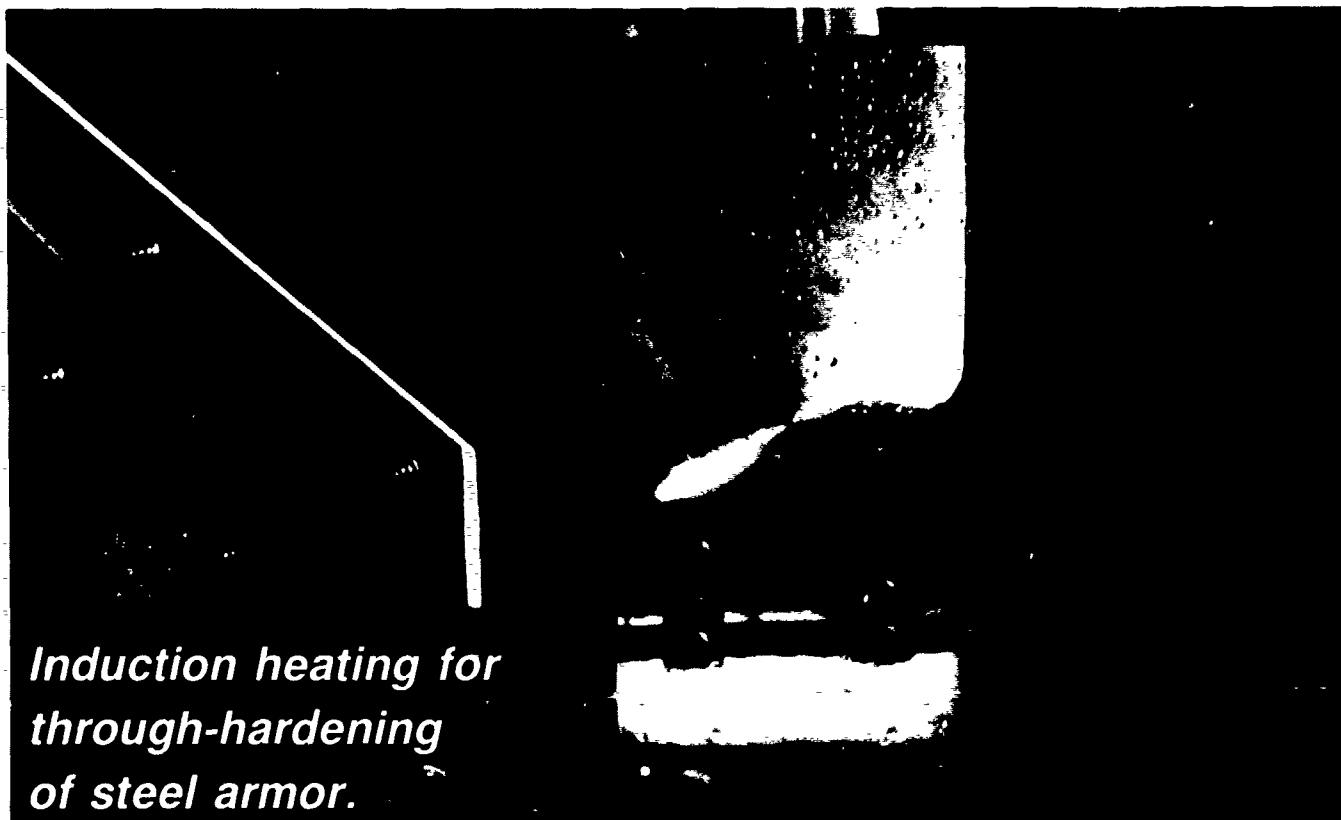
## Directions in Advanced Metals Research

**Tungsten:** The density of tungsten and depleted uranium (DU) make them uniquely suitable for armor penetrators. Although tungsten is more expensive than DU, depleted uranium production difficulties (lack of plant capacity and increased problems and cost of waste disposal) are shifting interest to tungsten. The Materials Technology Laboratory's (MTL) in-house and contract research teams (funded by the Defense Advanced Research Projects Agency—DARPA) are focusing on improving tungsten properties and processing; as the cost/performance gap narrows between the two materials, tungsten will become the material of choice for penetrators.



For additional information, contact:  
Director, US Army Materials Technology Laboratory  
Attn: SLCMT-MRM, Mr. Roger Gagne  
Watertown, MA 02172-0001  
AV 955-5467 or (617) 923-5467

**Steel:** Despite the advent of new composite and polymeric materials, steel remains the workhorse of Army systems. A continuing critical decline in the U.S. steel industry has seen a corresponding decrease in related steel research. MTL has sought to minimize the effect of a shrinking industrial base on the Army's need for armor steels by actively participating in a university/industry/government R&D consortium. Current investigations are directed at improved RHA (rolled homogeneous armor) performance by better chemistry and higher hardness levels. Companion programs are seeking improvements by selective hardening of armor steels using novel induction techniques.



*Induction heating for  
through-hardening  
of steel armor.*



U.S. Army Laboratory Command

AirLand Battle Management Program (ALBM)

The AirLand Battle Management Program (ALBM) is a joint effort between the U.S. Army and the Defense Advanced Research Projects Agency (DARPA), applying artificial intelligence to problems of corps- and division-level planning. ALBM integrates prototype expert systems written for maneuver, fire support, and intelligence elements to produce cooperatively derived courses of action. These prototypes use the U.S. Army Training and Doctrine Command's Common Teaching Scenario as a baseline model, with expertise provided by personnel from Forts Leavenworth, Sill, and Huachuca.

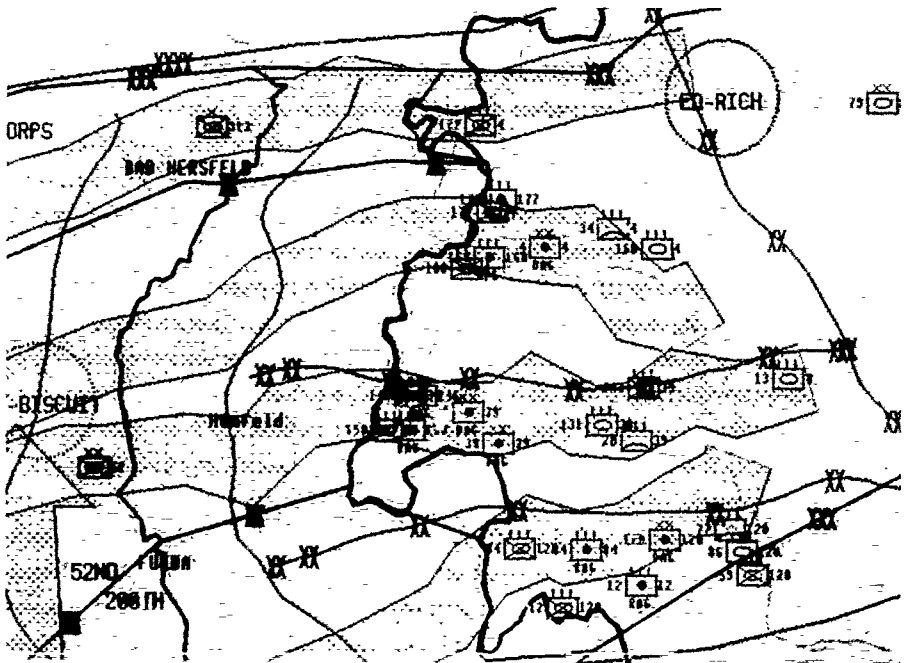
ALBM is capable of producing multiple courses of action, playing them for combat effects, producing an operations order, and determining if the proposed plan deviates from the operations order. The program uses state-of-the-art graphics interfaces and allows the user a wide choice of control. A number of aids are used to assist in the comparison of courses of action. A tool suite is provided that allows for both modification of existing nodes and addition of new nodes. An adversarial planner has also been produced and successfully demonstrated.

ALBM brings together artificial intelligence, map graphics, soldier-machine interfacing, and natural language to provide a state-of-the-art tactical planning aid.



(Above) AirLand Battle Management (ALBM) workstation

(Right) ALBM is co-sponsored by the Defense Advanced Research Projects Agency (DARPA) and the US Army, and demonstrates that advanced computer processing and machine intelligence can provide useful support to tactical planning.



For additional information contact: Director, U.S. Army Ballistic Research Laboratory Attn: SLCBR-SE, Mr. Morton Hirschberg Aberdeen Proving Ground, MD 21005-5066 AV 298-6661 or (301) 278-6661



**U.S. Army Laboratory Command**

## **Bradley Fighting Vehicle System Muffler**

In response to complaints about noise from Bradley Fighting Vehicle System (BFVS) training ranges located in Germany, the Army generated an Operational Needs Statement for a muffler capable of being used with all training rounds for the BFVS 25mm chain gun. The muffler was needed to reduce noise by at least 10 dB, and not interfere with training.

A prototype general purpose muffler was developed to be used with all types of rounds, reduce the impulse noise by more than 10 dB, and meet all the Army's requirements. 405 of these mufflers are currently in use at three training ranges, with a fourth training range under construction.

A Bradley Fighting Vehicle System (BFVS) muffler installed on a BFVS 25mm chain gun reduces noise and does not interfere with training.



**For additional information, contact:**  
Director, U.S. Army Ballistic Research Laboratory  
Attn: SLCBR-LF, Dr. Kevin Fansler  
Aberdeen Proving Ground, MD 21005-5066  
AV 298-3773 or (301) 278-3816



## U.S. Army Missile Command

### FOG-M IOE Fire Unit and Missile

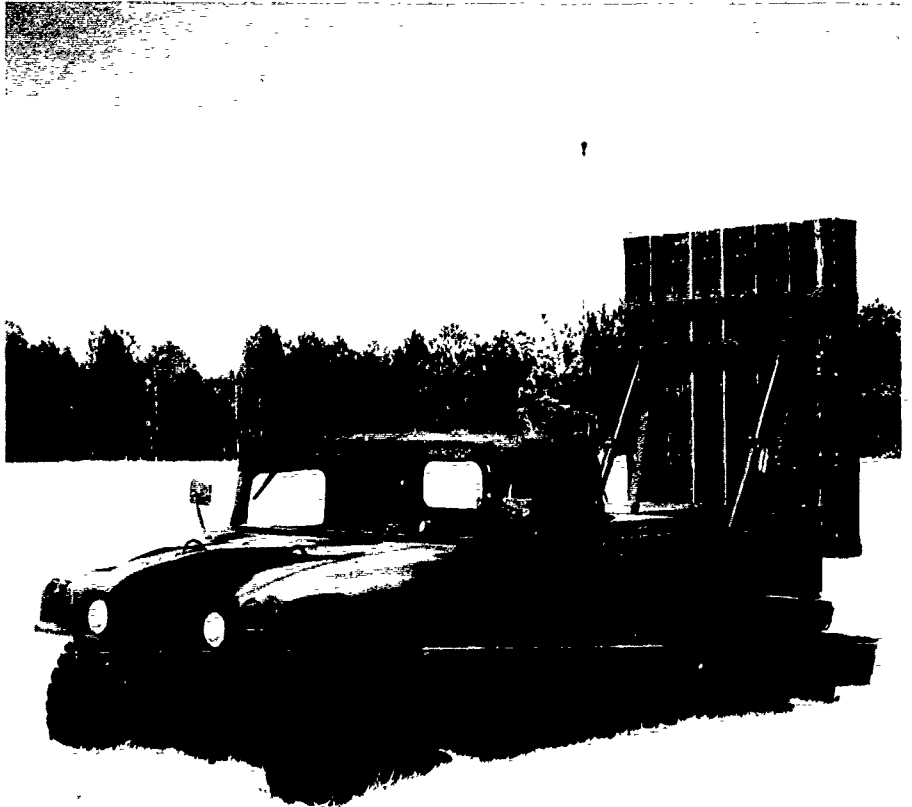
The Fiber Optic Guided-Missile (FOG-M) display and fire unit demonstrates how MICOM's Research, Development, and Engineering Center (RDEC) took an emerging technological capability and implemented a near-term tactical system that will give the Army a tremendous force multiplier in the tactical ground and air defense battle. By the use of a payoutable fiber optic cable, a gunner can remain safely hidden in his fire unit in defilade many kilometers from the direct fire battle, and yet be able to fire missiles and successfully engage targets in the battle, including second echelon targets that have not yet reached the battle. An imaging sensor in the nose of the missile brings the battlefield picture to the gunner directly through the fiber optic cable, allowing him to acquire and engage targets at will.

One of the FOG-M Initial Operational Evaluation (IOE) fire units and an inert missile demonstrate the RDEC development of a fully integrated weapon system. This system recently underwent both a Force Development Test and Evaluation (FDT&E) and an OTEA-conducted operational test at White Sands Missile Range, using soldiers from the Air Defense School to operate the system. The system is fully functional, and is able to conduct actual simulated firings using the embedded training mode. Operators will be able to "fly" a missile just as the soldiers do, by using a digital scene image generator that is part of the system.

This system is now in full scale development as the Non-Line-of-Sight (NLOS) Forward Area Air Defense System.



FOG-M IOE missile and fire unit enable remote operation of a fully integrated weapon system via fiber optic cable and imaging sensors.



For additional information, contact:  
Commander, U.S. Army Missile Command  
Attn: AMSMI-RD-GCT, Paul Jacobs  
Redstone Arsenal, AL 35898  
AV 746-2520 or (205) 876-2520



U.S. Army Laboratory Command

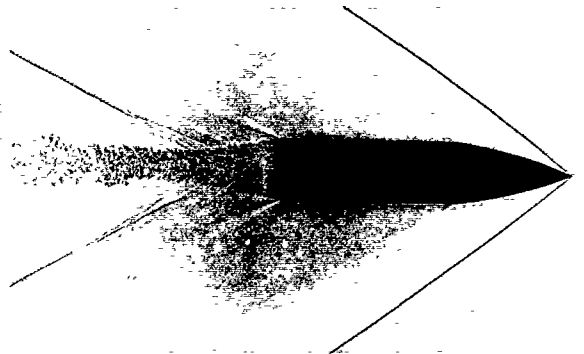
## Determining Aerodynamic Data Using a Spark Range

The aerodynamic characteristics of flight vehicles are determined in a spark range under controlled conditions. All projectiles for which aiming data are required are tested in the Ballistic Research Laboratory (BRL) Transonic Range Facility, which utilizes spark shadow graph stations.

Aerodynamic data from wind tunnels is often not at realistic flight conditions due to small models, limited test sections, and sting mounts for holding the model in the air stream. However, spark ranges obtain shadow graphs of the vehicle in free flight, and the shadow graph data determines the trajectory, and the angular and spin motion of the projectile. The aerodynamic coefficients, such as "drag," are obtained by analyzing the trajectory motion of the vehicle at various Mach numbers and yaw levels. In addition, other photographic data are gathered to display detailed features of the flow around the vehicle.



The Ballistic Research Laboratory Transonic Range Facility uses spark shadow graph stations to analyze the free flight, trajectory, and angular and spin motions of a projectile.



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AV 298-4987 or (301) 278-4987



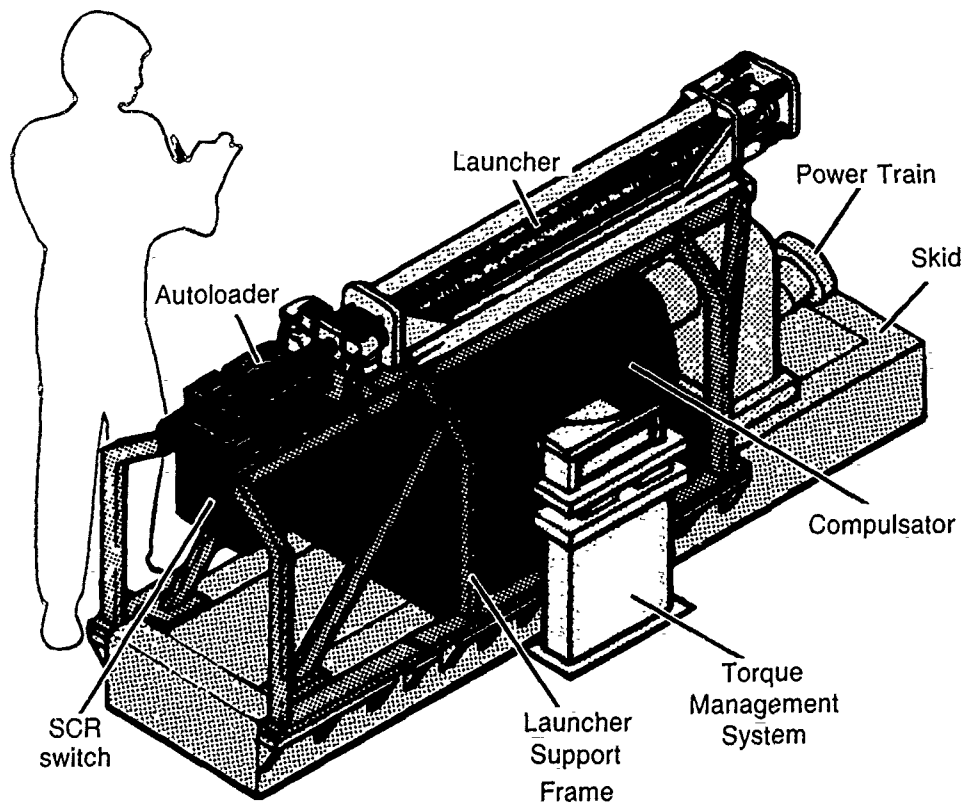
U.S. Army Armament Munitions and Chemical Command

## Small Caliber Electromagnetic Launch

The advanced fighting system of the future will utilize a new weapon system characterized by a significant improvement in performance. Illustrated is a laboratory test bed for just such a system—the Small Caliber Electromagnetic Launcher. Here the electromagnetic launcher is mounted on a skid with the electrical power supply, a two pole air-core compulsator. Electromagnetic forces accelerate the integrated armature/penetrator through the launcher to dramatically increase muzzle velocities which yield significant increases in performance. The launcher does not rely on cryogenics and can be used at field temperatures. It has ceramic bearings and shaft, and is the first integrated armature/penetrator projectile—launched salvo fire system. It is the highest power density machine in existence. This effort represents an example of technology push, resulting in drastic reductions in projected weight and volume, and opening electromagnetic launch for a portable application to infantry weapons.

### PERFORMANCE PARAMETERS

projectile energy	64 kJ
projectile velocity	2,000 ms
launcher bore diameter	15.2 mm
launcher length	16 m
launcher L'	1.25 $\mu$ H/m
compulsator energy	9 MJ
compulsator mass	740 kg
rotor angular velocity	25,115 rpm
firing repetition rate	10 Hz



4101.0059

For additional information, contact:  
Commander, U.S. Army Armament Research,  
Development and Engineering Center  
Attn: SMCAR-CCL-FA, Harry L. Moore, Jr.  
Picatinny Arsenal, NJ 07806-5000  
AV 880-7932 or (201) 724-7932



U.S. Army Laboratory Command

Information Processor (IP)

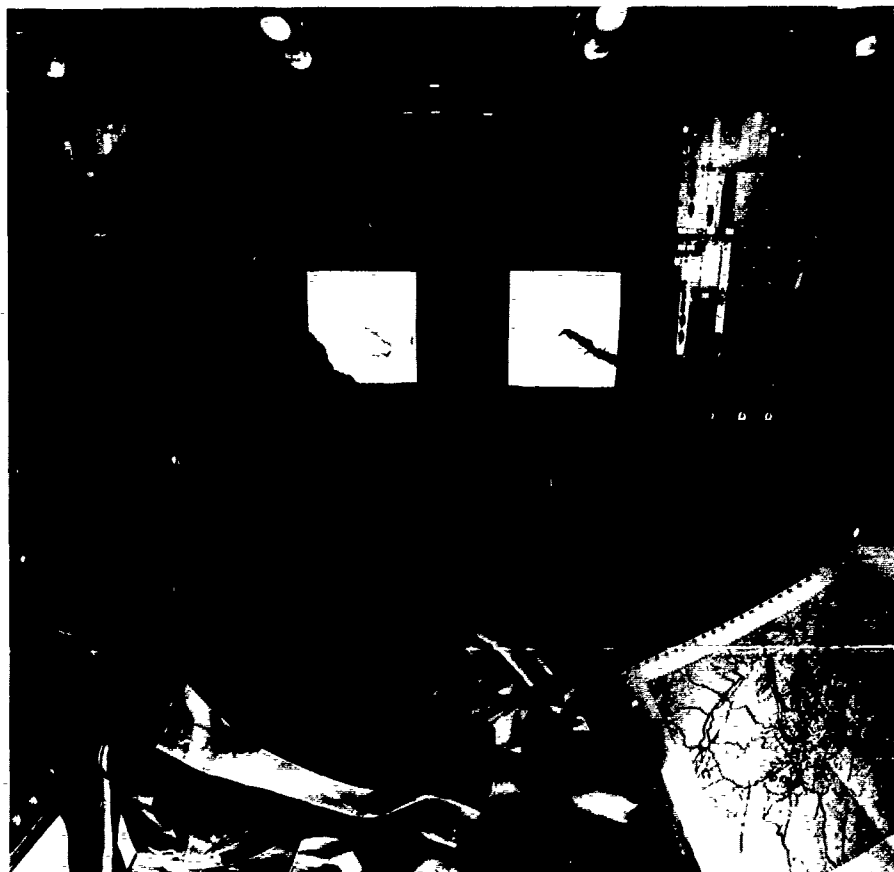
The Information Processor (IP) test bed collects, processes, and disseminates real-time combat information on the battlefield. It integrates information from automated and manually-operated sensors and communications systems via standard Army radios using MISMART and TACFIRE protocols. It also uses real-time track data from an unmanned aerial vehicle (UAV)-based radar, integrating information to provide a total picture of terrain, weather, map features, and friendly and enemy locations.

IP software functions are based on a modular, multi-layered software design approach which provides the operator with the ability to program the system to track multiple tactical situations as they develop.

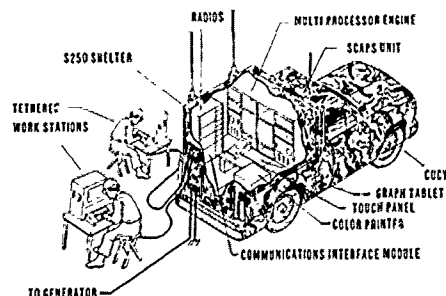
The IP gives the battlefield commander the advantage, providing the capability of prediction early in the decision-making process so that costly mistakes may be avoided.



For additional information, contact:  
 Director, U.S. Army Harry Diamond Laboratories  
 Attn: SLCHD-TA-AS, Larry Tokarcik  
 2800 Powder Mill Road  
 Adelphi, Maryland 20783-1197  
 AV 290-3000 or (301) 394-3000



The Information Processor test bed provides the battlefield commander with entity location and prediction capability early in the military decision cycle.





DISSEMINATION STATEMENT

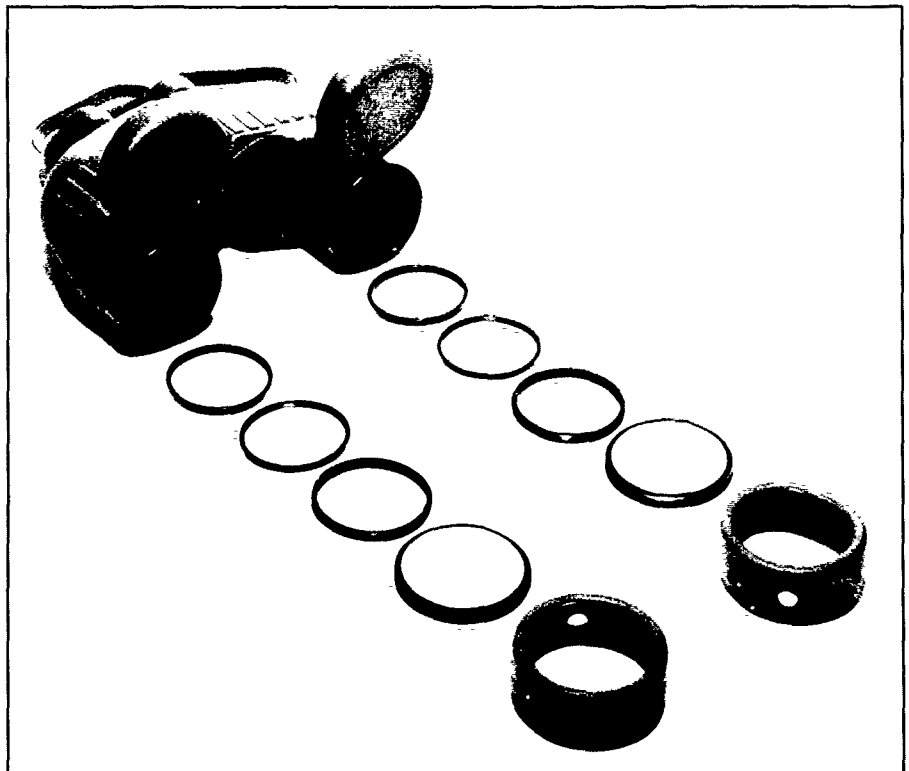
**U.S. Army Armament Munitions and Chemical Command**

## **Laser Protection for Magnified Optical Sight Devices**

In response to the proliferation of friendly and enemy lasers on the battlefield, the Armament Research, Development, and Engineering Center (ARDEC) has developed eye protection for use in magnified optical devices. M22 binoculars have been fitted with laser protection filter assemblies. Filters have also been or are being installed in the magnified optical sights of a number of critical weapons systems.

The filters employ thin film technology and do not significantly reduce image clarity. ARDEC is currently investigating laser protection technologies capable of countering the projected frequency-agile lasers of the 1990s.

Laser protection filter assembly:  
Optical filters which use thin film technology provide protection against hazard and threat lasers with minimal impact on performance.



**For additional information, contact:**  
Armament Research, Development and  
Engineering Center  
Fire Support Armaments Center  
Research and Development Branch  
Attn: SMCAR-FSF-RO, Robert Volz  
Bldg. 95N  
Picatinny Arsenal, NJ 07806-5000  
DSN 880-6257 or (201) 724-6257

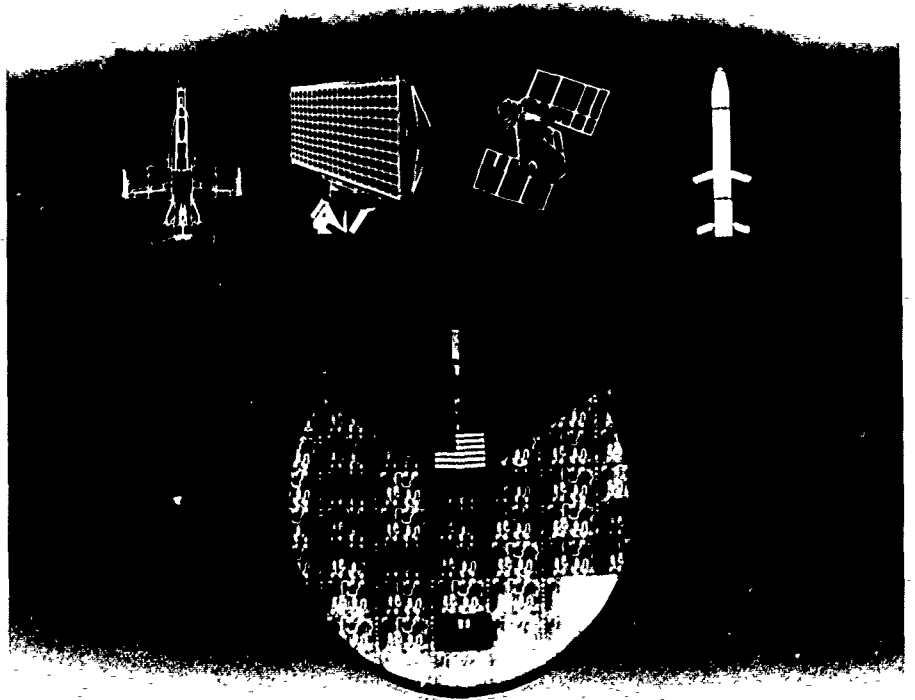




**U.S. Army Laboratory Command**

## **MIMIC-Microwave/Millimeter Wave Monolithic Integrated Circuits**

Research in the area of microwave/millimeter wave monolithic integrated circuits (MIMIC) is designed to meet exploding requirements for radio frequency signal processing functions in military systems for 1990 and beyond. The MIMIC program is a tri-service initiative to develop affordable and producible MIMIC components for insertion into numerous military systems. Postulated on the need for a strategic U.S. military advantage in microwave and millimeter wave systems, the MIMIC initiative is being used to create a broad base of American leading-edge technology in this area. The MIMIC program is organized to provide proof-of-affordability and applicability by direct demonstration and insertion of its technology into various military communications, electronic warfare, radar, and smart munitions systems.



**For additional information, contact:**  
Director, U.S. Army Electronics Technology and  
Devices Laboratory  
Attn: SLCET-MH, Lee Ross  
Fort Monmouth, NJ 07703-5000  
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## AMC Field Assistance in Science and Technology

### Quick Erect Antenna Mast (QUEAM)

In response to a request by the Commander-in-Chief of the U.S. Army-Europe (USAREUR), the AMC Field Assistance in Science and Technology Office (AMC-FAST) has provided a quick-erect antenna mast (QUEAM) to assist USAREUR in addressing the requirement to reduce emplacement and displacement times for tactical operations centers.

The QUEAM consists of an antenna mast composed of extruded aluminum alloy sections and lacquered in infrared-resistant paint (CARC). The telescoping action of the progressively smaller sections of the mast is assisted by plastic guides. The mast is secured by Kevlar guy wires which are wound on stretch winders equipped with special locking tension devices. The mast can handle gale-force winds and can operate reliably in all climatic conditions. The mast is normally installed by two persons, but it can be set up by one person in emergencies.

The Communication-Electronics Command (CECOM), with assistance from ACM-FAST, demonstrated the QUEAM in Europe and participated in the evaluation of its use. The advantages associated with the increased mobility of tactical operations centers through the use of these masts were clearly shown through the demonstrations. As a result, USAREUR has initiated procurement procedures to provide QUEAMs to its tactical operations centers. The antenna to be provided is the 9-meter, TM-128.

The QUEAM increases tactical operations center mobility.



For additional information, contact:  
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Electronics Command  
Attn: AMSEL-P-L-O, MS Rose Marie Greene  
Fort Monmouth, NJ 07703-5013  
AV 992-3103 or (201) 532-3103

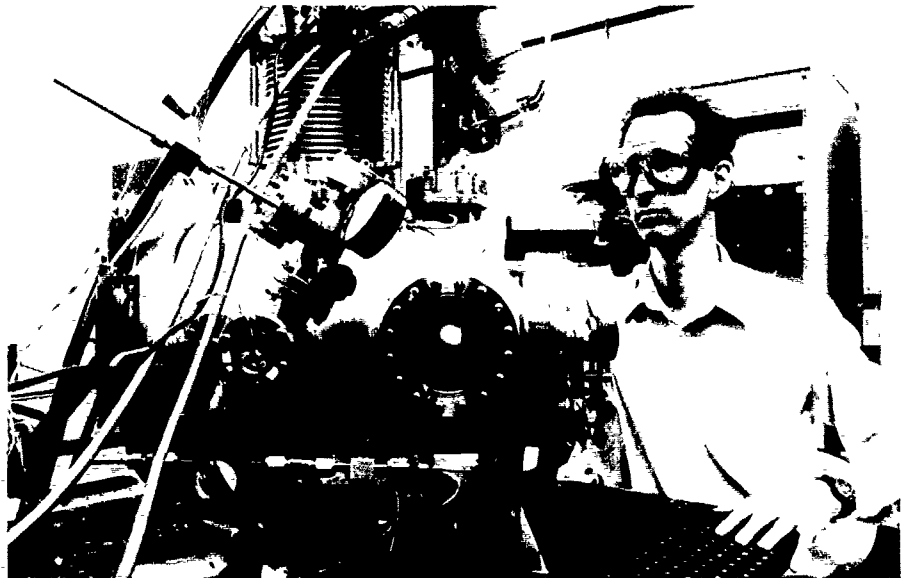


**U.S. Army Laboratory Command**

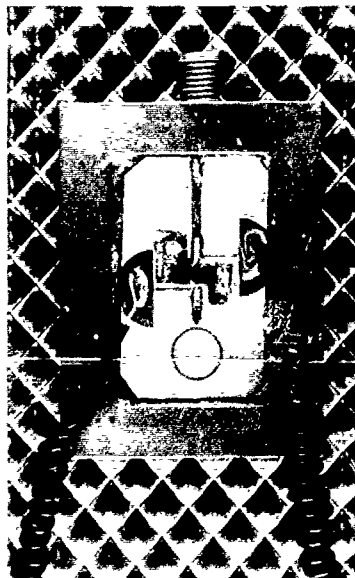
## High-Temperature Superconductivity

High-temperature superconducting films have demonstrated a significant improvement in the performance of microwave resonators and filters. The high performance factor of superconducting resonators results in lower noise oscillators, which produce radars with better resolution and allows them to see smaller and fainter signals. Superconducting microwave microstrip filters are light-weight with a high sensitivity and a high signal-to-noise ratio.

The excimer laser ablation facility is used to produce yttrium-based high-temperature superconducting thin films for use in high-efficiency, low-loss microwave devices such as resonators, delay lines, mixers, etc



High-temperature superconductors (HTSC) are most advantageous in millimeter-wave devices where high quality, low insertion loss and small size are very important. Shown is a HTSC ring resonator which was designed, patterned, assembled, and evaluated by ETDL personnel. The device exhibits a quality factor 10 times better than a comparable unit fabricated from gold at 83 GHz and 77 Kelvin.



The high-temperature superconducting ring resonator and related devices that are currently being fabricated and evaluated such as HTSC delay-lines and multipole filters will find extensive use in ground, air and satellite receiver and radar front ends where size, weight, and efficiency are of prime importance.



**For additional information, contact:**  
U.S. Army Electronics Technology and Devices Laboratory  
Attn: SLGET-EA, Dr. E. Potenziani  
DSN 995-3628 or (908) 544-3628  
SLGET-MP-W, A. Rachlin/R. Babbitt  
DSN 995-2377 or (908) 544-2377  
Fort Monmouth, NJ 07703-5000



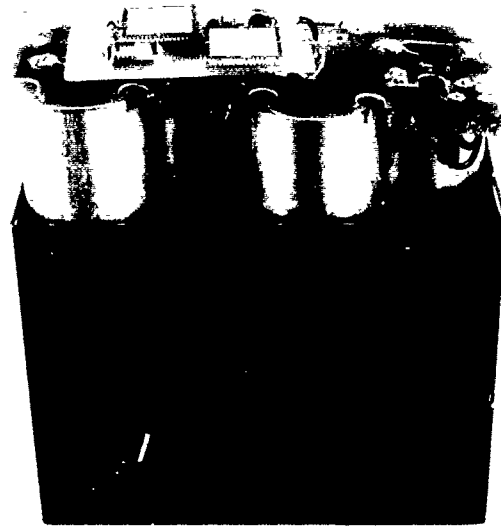
**U.S. Army Laboratory Command**

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## **"Smart" Lithium Battery**

The Electronics Technology and Devices Laboratory (ETDL) has developed a high-energy, high-capacity lithium battery with a built-in "fuel gauge" and shut-off circuitry to detect abnormal conditions, thus ensuring fail-safe operation. The battery houses a small inexpensive "smart" circuit which is designed to shut off the battery before a hazardous condition arises, automatically initiate complete discharge for non-hazardous disposal, calculate the energy removed from the battery, and display the remaining state-of-charge of the battery. These features of the "smart" lithium battery translate to the following advantages:

- Efficient low-cost usage of battery energy for high-power applications
- Estimated savings in premature battery disposal costs of \$10 million per year
- Reduced perceived need for a new battery each mission.



---

For additional information, contact:  
US Army Electronics Technology and Devices Laboratory  
Attn: SLGET-PB, Terrill Atwater/Michael Brundage  
Fort Monmouth, NJ 07703-5000  
DSN 995-3549 or (908) 544-3549

Lithium battery with "smart" circuitry.



**U.S. Army Laboratory Command**

## High Power Microwave/Millimeter Wave Components

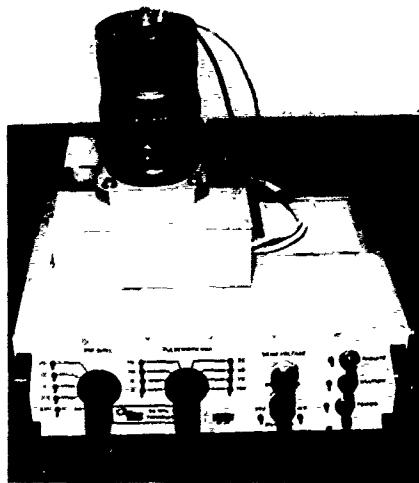
The Electronics Technology and Devices Laboratory (ETDL) is developing vacuum electronic devices in the microwave/millimeter wave spectrum. These devices are important to the development of radars, electronic jamming, and high power microwave (HPM) weapons.

The devices that have been developed for radar applications have improved detection capabilities while reducing system size. These advancements are useful not only to the Army but also to various other government and commercial agencies.

Electronics jamming has also benefited from ETDL's work; size has been reduced and capabilities increased. For example, ETDL has developed a single unit, which takes the place of two other units, which is smaller and less expensive than either of the other units.

The high power work which is being done is impacting several systems of the future; not only the Army's Space Defense work, but also systems such as a counter mine system which detonates mines at a safe distance.

140 GHz Extended Interaction Klystron Amplifier First tube of its kind, which allows detection of targets as small as a wire.



K-Band Jammer Module. First full bandwidth Traveling Wave Tube amplifier.



For additional information, contact:  
 Director, U.S. Army Electronics Technology  
 and Devices Laboratory  
 Attn: SLCE-MW, L. Kosa  
 Fort Monmouth, NJ 07703-5000  
 AV 992-0483 or (201) 532-0483



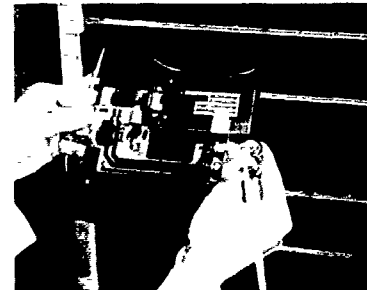
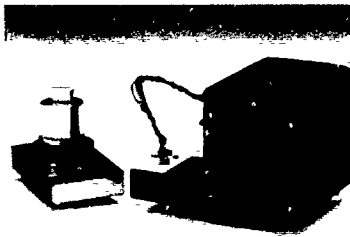
U.S. Army Laboratory Command

Time and Frequency Control

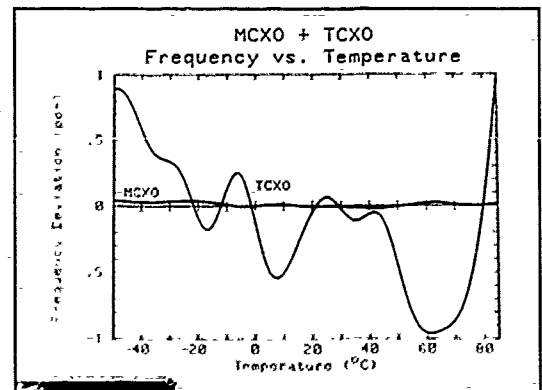
The Electronics Technology and Devices Laboratory (ETDL) is actively conducting research to develop leading-edge technology in the area of time and frequency control. The main objectives of this type of R&D are to meet the requirements of evolving and future Command, Control, and Communications (C<sup>3</sup>), Identification Friend-or-Foe (IFF), navigation, and surveillance systems for improved stability over time and in various environments, lower power consumption, smaller size, and lower cost. ETDL's quartz crystal resonator fabrication facility, housed in a class 100 clean room, is advancing the state-of-the-art through the development of novel designs and processing methods. This test facility is capable of measuring resonators and oscillators with an accuracy unsurpassed by any other facility in the world. Recent developments include the Tactical Miniature Crystal Oscillator (TMXO) and the Rubidium-Crystal Oscillator (RbXO), both the lowest power devices in their class. Ongoing projects include improving quartz material, reducing the sensitivity to acceleration, and developing a miniature atomic frequency standard.

One significant recent success is the Microcomputer Compensated Crystal Oscillator (MCXO). The MCXO provides a clock with an unprecedented combination of low power and high accuracy. The maximum daily error is 0.003 seconds for all environmental conditions and a power consumption of only 0.045 watts, even at a temperature of  $-55^{\circ}\text{C}$ . This breakthrough in clock technology was achieved through in-house research that resulted in three patents which are currently being licensed for commercial applications. Thermometry accuracy and resonator stability are the main limitations on conventional clocks and oscillators. The unique aspects of the MCXO, self-temperature sensing and high-stability resonators, overcome both limitations and thereby provide a 100X improvement in performance.

Rubidium/crystal oscillator (RbXO) with Tactical Miniature Crystal Oscillator (TMXO).



Comparative performance of the Microcomputer Compensated Crystal Oscillator (MCXO) (shown upper right) and a conventional temperature compensated crystal oscillator (TCXO).



For additional information, contact:  
 US Army Electronic Technology and Devices Laboratory  
 Attn: SLCET-EQ, Dr John R. Vig  
 Fort Monmouth, NJ 07703-5000  
 DSN 995-4275 or (201) 544-4275



U.S. Army Laboratory Command

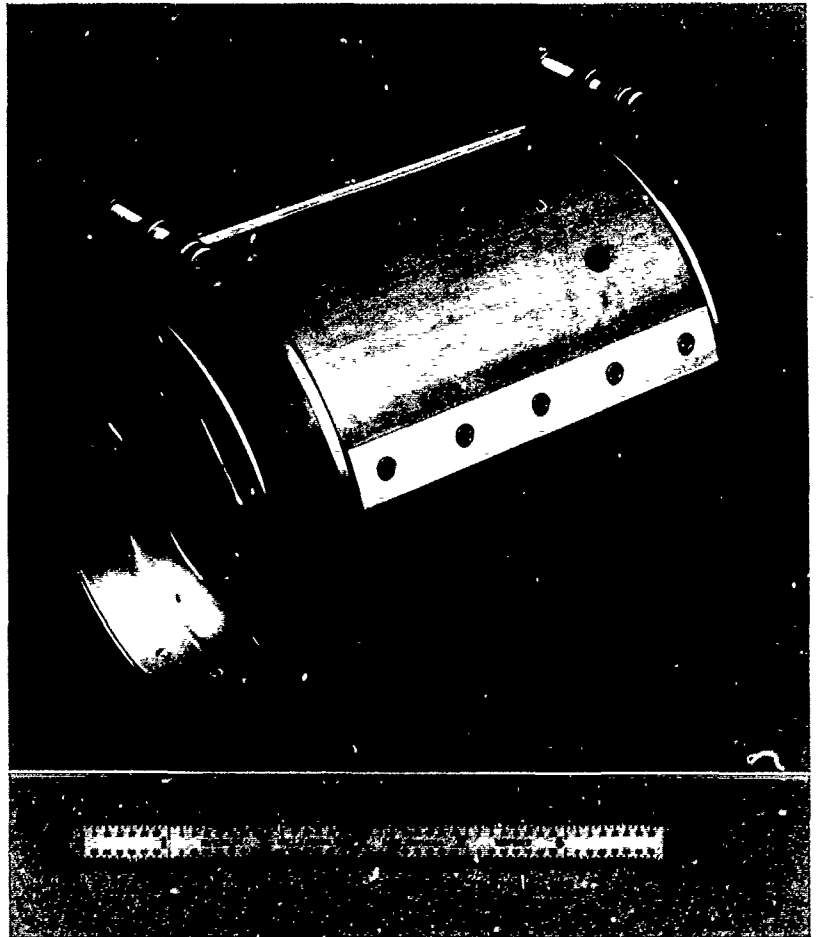
## Chaparral Target Detecting Device

The M817E1 Target Detecting Device (TDD) is the radar proximity fuze employed on the Chaparral Air Defense System. The M817E1 TDD is an evolutionary improvement of the M817 TDD, both of which were developed at Harry Diamond Laboratories (HDL). Improvements implemented in the M817E1 TDD include enhanced performance, improved producibility, and increased reliability.

The performance enhancements result in increased probability of single-shot kill against today's most advanced aircraft. The design concept of the M817E1 TDD renders it nearly impervious to any known form of electronic countermeasures (ECM). The M817E1 TDD is easily adaptable to virtually any missile system.

The M817E1 is a proven system with 26 successes in 26 government-controlled flight tests at the White Sands Missile Range. The M817E1 is presently in production at Loral Control Systems in Archibald, Pennsylvania. Several significant modifications are in progress, including extending the target detection range and applying missile guidance information to optimize fuzing points.

The Chaparral Air Defense System represents state-of-the-art deterrence against hostile aircraft.



For additional information, contact:  
 Director, U.S. Army Harry Diamond Laboratories  
 Attn: SLCHD-TA-SS, James Joyce  
 2800 Powder Mill Road  
 Adelphi, Maryland 20783-1197  
 AV 290-3720 or (301) 394-3720

The M817E1 Target Detecting Device is designed to be impervious to known electronic countermeasures.



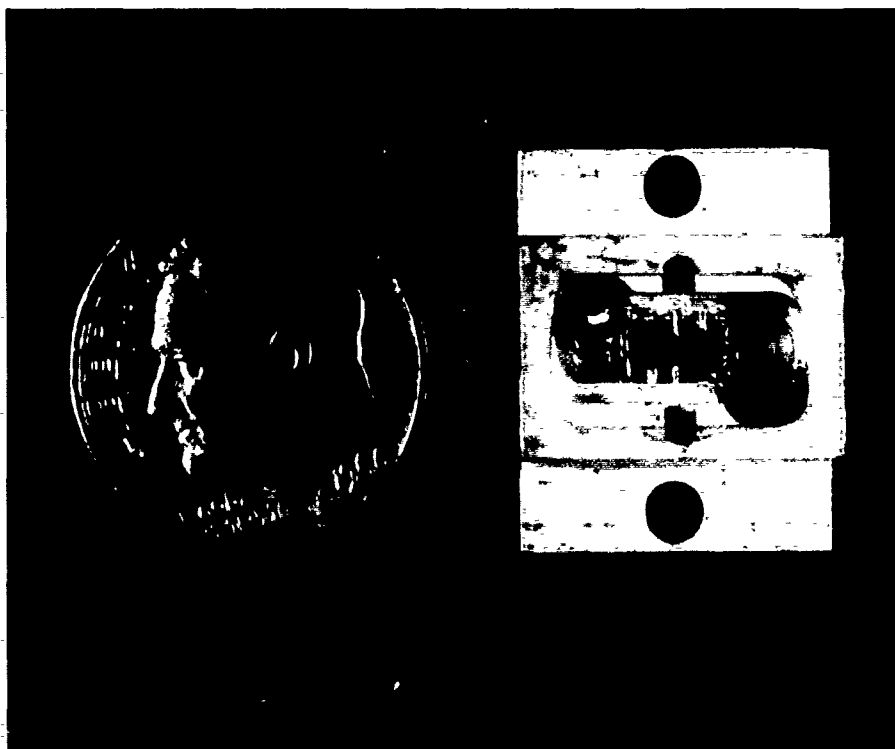
U.S. Army Laboratory Command

## Surface Acoustic Wave (SAW) Slanted Array Correlator (SAC) For Electronic Warfare Receivers

The Electronics Technology and Devices Laboratory (ETDL) recently developed advanced surface acoustic wave (SAW) slanted array correlators (SAC) which provide significantly improved device performance based on enhanced design procedures. The new SAW-SAC devices exhibit higher system dynamic range and sensitivity. As a result, they provide the only practical means to implement fast-scanning, state-of-the-art compressive receivers for electronics intelligence (ELINT) and electronic support measures (ESM) applications. The wide bandwidths (i.e., up to 1 gigahertz-GHz) provided by dispersive delay lines in these receivers allow for instantaneous sampling of multiple signals over an analysis bandwidth of up to 500 megahertz (MHz). These SAW-SAC-based receivers allow for the processing of time-coincident signals (i.e., pulse-on-pulse) while permitting the detection and classification of non-communication-type signals with widely different intensities. Moreover, they provide 100% probability of intercept in a high density signal environment.



For additional information, contact:  
Director, U.S. Army Electronics Technology  
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Fort Monmouth, NJ 07703-5000  
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SAW-SAC devices provide high system dynamic range and stability in electronics intelligence and electronic support measure applications.





U.S. Army Laboratory Command

## Machine Vision: Novel Technique for Evaluating Aging and Failure of Polymer Composites

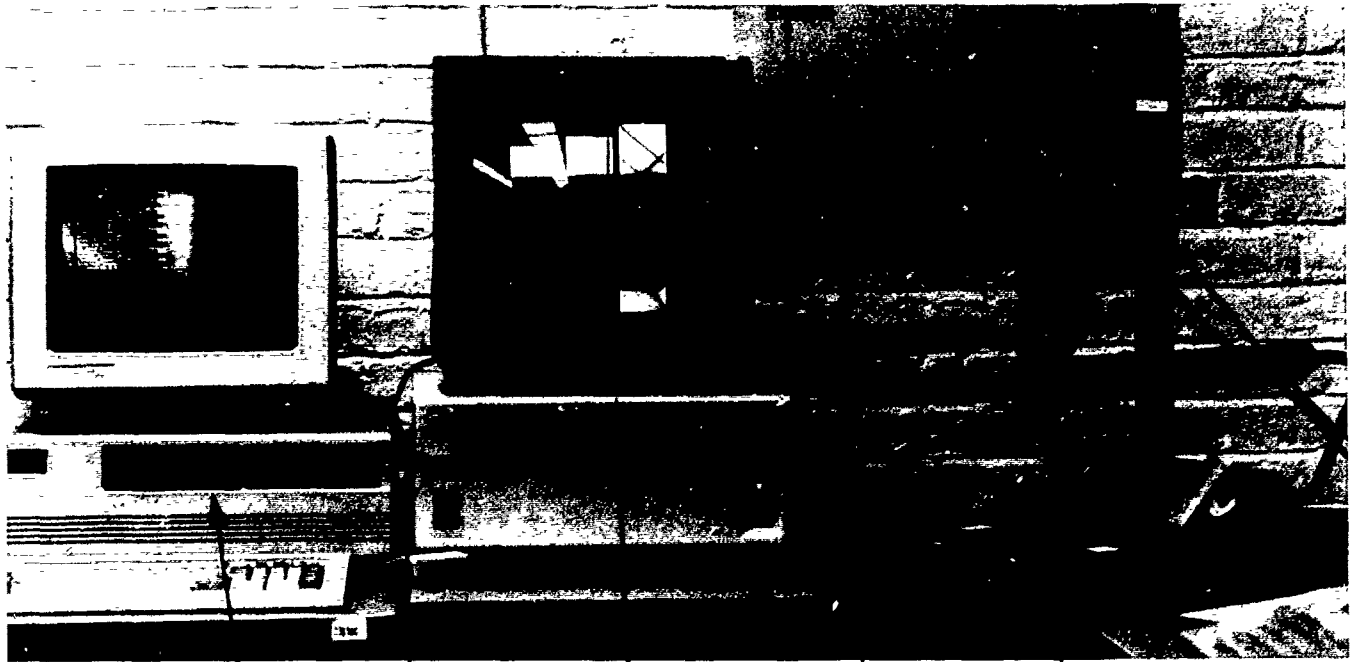


For additional information, contact:  
Director, U.S. Army Materials Technology  
Laboratory  
Attn: SLCMT-EMP, Dr. Gary Hagnauer  
Watertown, MA 02172-0001  
AV 955-5121 or (617) 923-5121

Although a goal of machine vision is to approximate human vision, digital image processing techniques can surpass human sight, reveal defects in materials, and quantitatively analyze damage that the human eye cannot detect. This technology is now being applied to analyze the fracture behavior and environmental deterioration of composite laminate materials used in the manufacture of helicopter rotor blades. Visual information obtained by digital image analysis has been directly correlated to changes in physical and mechanical properties, thereby providing an automatic predictive tool for:

- Testing and evaluation of materials
- Materials specification and qualification
- Field monitoring and damage detection/monitoring.

Machine vision is also being tried with robotics and artificial intelligence technology to automatically assess the durability of composite materials; applications to other materials and Army systems are currently under investigation.



Host Computer  
PC/AT

Interface  
Cable

Digital Image  
Processor with  
Video Monitor

Video Cable

Camera with  
12.5mm Lens



U.S. Army Laboratory Command

## Advanced Integrated Circuits

Through its research in advanced integrated circuits, the Electronics Technology and Devices Laboratory is supporting the Very High Speed Integrated Circuits (VHSIC) program. The VHSIC program is a tri-service initiative designed to exploit advanced digital microelectronics technology in order to achieve higher standards of performance for a wide range of military systems.

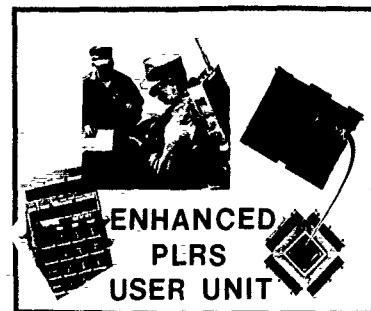
The VHSIC program has marshalled the U.S. semiconductor industries to apply advanced semiconductor technology toward improving military electronics capabilities. ETDL's partnership in the VHSIC program is resulting in widespread utilization of semiconductor technology throughout DoD, a broadening of the industrial base, and a marked improvement in products and design.

Advanced integrated circuits represent a critical step forward in defense system capabilities. The computational power of advanced integrated circuits, combined with their small size, low power needs, and high reliability, enables systems to perform as never before possible.

VHSIC technology can support both current and future systems. It not only meets special needs but builds long-term system capability in a variety of key military applications—communications, radar avionics, electronic warfare, and sonar.



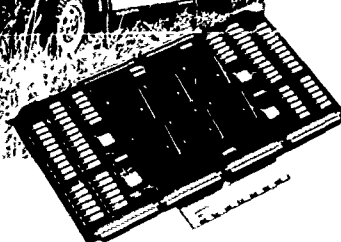
**LHX  
COMMON MODULE**



**ENHANCED  
PLRS  
USER UNIT**



**FIREFINDER  
SIGNAL PROCESSOR  
BRASSBOARD**



For additional information, contact:  
U.S. Army Electronics Technology and Devices  
Laboratory  
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Fort Monmouth, NJ 07703-5000  
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**U.S. Army Laboratory Command**

**Robotics Technology Base R&D**



Robotics research and development at the Human Engineering Laboratory (HEL) investigates how soldiers can effectively use telerobots, robots, and autonomous machines to accomplish military tasks and missions.

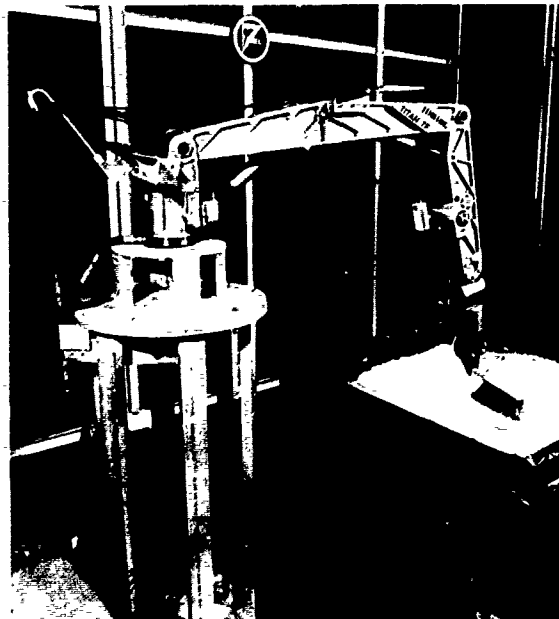
Results of some of HEL's robotics research have been applied to explosive ordnance disposal operations. HEL has enhanced the Security-Explosive Ordnance Disposal (S-EOD) robot by improving robot vision through field of view and camera angle modifications, a fifty percent increase in the work envelope, and the addition of an improved end-effector. Present soldier equipment and tools have also been adapted for use by the S-EOD robot to accomplish remote soldier's tasks.

◀ Two S-EOD telerobots, equipped with mirrors and structured lighting, poised for retrieval.

A soldier at an S-EOD robot work station uses enhanced control technology in ordnance recovery. ▼



Robotic Arm.



For additional information, contact:  
Director, U.S. Army Human Engineering Laboratory  
Attn: SLCHE-CS, SGM Ron Deerner  
Aberdeen Proving Ground, MD 21005-5001  
AV 298-5860 or (301) 278-5860





U.S. Army Missile Command

## Compact Optical to Electrical Power Conversion Unit

A power converter which transforms optical power to electrical power is being developed at the Army Missile Command (MICOM) to energize a telemetry package which monitors the reaction of missile systems to electromagnetic interference (EMI). Optical power is delivered to the sensitive test environment (missile) by a glass fiber optic cable. The optical energy is converted to electricity by photovoltaic cells in the converter. The use of a nonconducting cable to deliver power is essential to preserve the electromagnetic test environment.

The converter operates by allowing a beam of optical energy to exit a fiber optic cable as an annulus and then be reflected from a conical mirror surface to the cylindrical arrangement of photovoltaic cells. This mechanism ensures the necessary even illumination of the series of connected cells. By first allowing light to enter the fiber optic cable approximately ten degrees off axis, this conversion unit enables an optical beam to exit the cable as an annulus.

This photograph shows optical energy emerging from a fiber optic cable. MICOM is developing compact power converters utilizing fiber optics and photovoltaics.



For additional information, contact:  
Commander, U.S. Army Missile Command  
Attn: AMSMI-RD-DE-LT, Debbie Jordan  
Redstone Arsenal, AL 35898-5245  
AV 746-7457 or (205) 876-7457

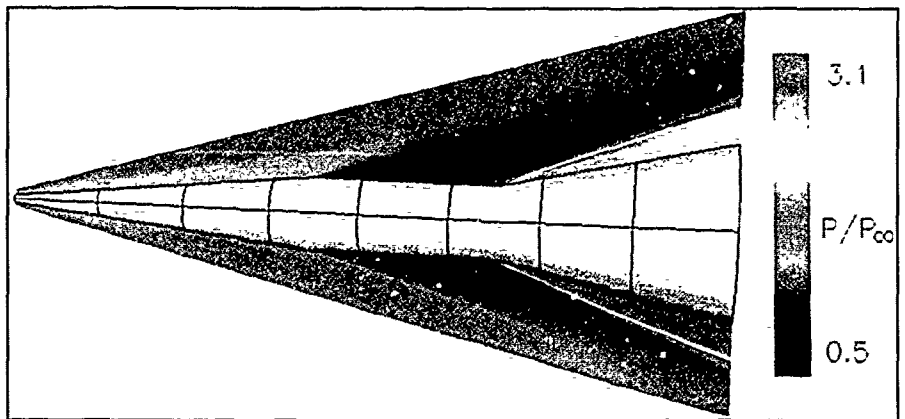


U.S. Army Laboratory Command

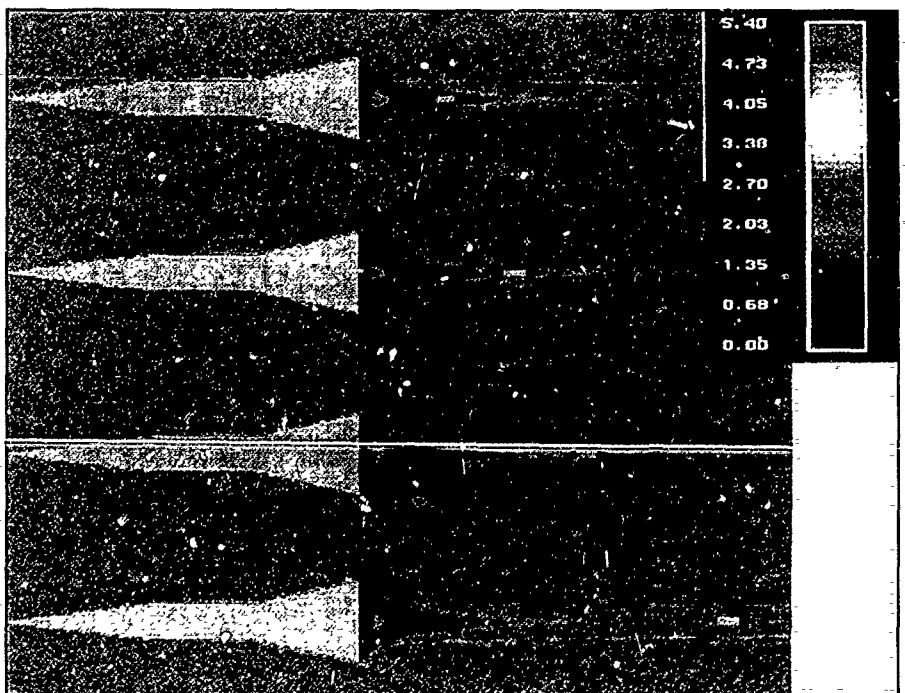
## Computational Projectile Aerodynamics

The use of supercomputers combined with numerical techniques for solving the Navier-Stokes equations has provided the ability to accurately predict projectile aerodynamics and provide insight into the associated fluid dynamics. The images presented here are computational results of a segmented kinetic energy penetrator at a flight speed of Mach 4.4. The computed flow field has been integrated to determine the aerodynamic forces acting on the parent projectile and the trailing segments. Various configurations of the parent projectile were computationally studied to provide the optimum aerodynamic behavior. Trajectory simulations using the computed aerodynamics were then conducted. This data provides valuable design guidance and will be used to help design aerodynamic range tests.

Computed pressure contours for the cone-cylinder-flare configuration (Mach=4.4, Alpha=2.0).



Computed Mach contours showing the effect of segment separation distance from the parent projectile (Mach=4.4, Alpha=2.0). Separation distance is 2, 4, 6 and 10 calibers.



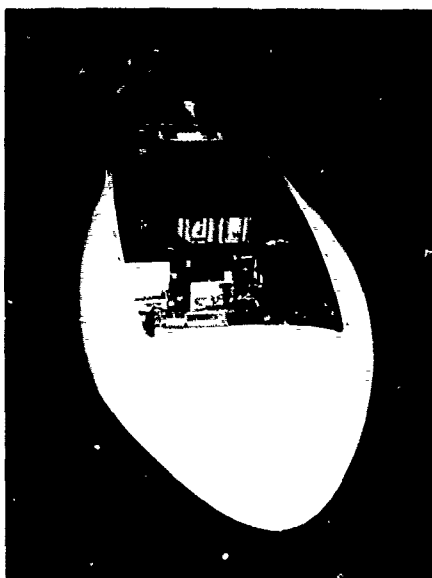
For additional information, contact:  
 Director, U.S. Army Ballistic Research Laboratory  
 Attn. SLCBR-LF, Charles J Nietubicz  
 Paul Weinacht  
 Aberdeen Proving Ground, MD 21005-5066  
 AV 298-3691 or (301) 278-3691  
 AV 298-4280 or (301) 278-4280



U.S. Army Laboratory Command

Mini-Moving Target Indicator (MTI) Radar

UAV showing Mini-MTI Radar, incorporating a lightweight, low power radar sensor.



The Mini-Moving Target Indicator (MTI) Surveillance Radar provides high performance, real-time target detection, and location and tracking of moving ground vehicles and low-flying helicopters within a 15-kilometer surveillance region.

The Mini-MTI radar has three distinct operating modes: wide-area surveillance, ground target track/classification, and helicopter track/classification. The radar signal processor, designed and constructed for this technology development, converts tens of megabits per second of raw radar data into individual target reports which are easily adaptable to radar ground stations such as Joint Surveillance/Target Attack Radar System Ground Station Module (JSTARS GSM).

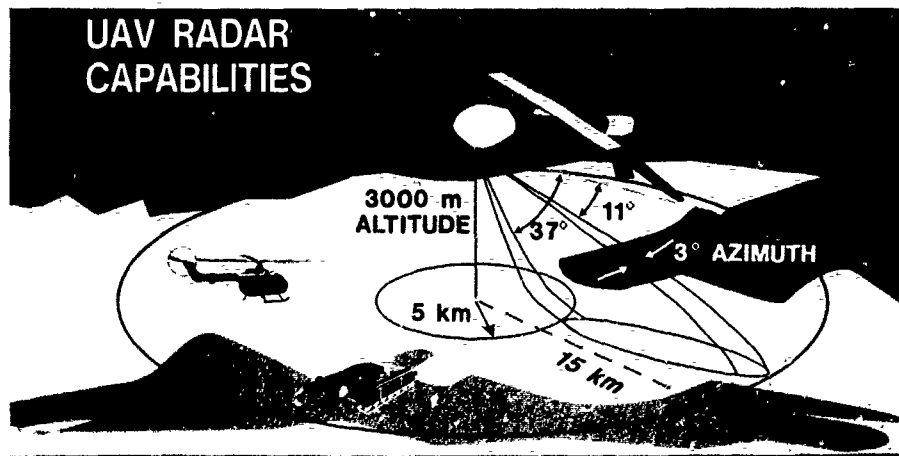
This technology base program has resulted in the design and construction of a uniquely capable radar sensor weighing less than 110 pounds and consuming approximately one kilowatt of prime power. It is currently packaged to fit in the Amber endurance unmanned aerial vehicle (UAV) but is compatible with other mid-sized UAV's.

The Mini-MTI Radar is envisioned to have an important role providing real-time target acquisition/location/classification capability for the Battlefield Commander in the Intelligence and Electronic Warfare and Fire Support mission areas. Future applications may include Aviation, Air Defense, and Maneuver Control battlefield functional areas.

Mini-MTI Radar capabilities include precision track, location, and classification of moving targets in designated sectors.



For additional information, contact:  
 Director, U.S. Army Harry Diamond Laboratories  
 Attn: SLCHE-STR, Richard Sife  
 2800 Powder Mill Road  
 Adelphi, Maryland 20783-1197  
 AV 290-2430 or (301) 394-2530





# U.S. Army Laboratory Command

## Laser Protection Materials Program

Current research in laser protection has led to development of materials used to protect against laser injury in vision blocks, visors, and personnel goggles, by application of blazed transmission gratings and holographic filters. Currently available laser eye protection (LEP) technologies are limited to multiple discrete wavelength protection; however, advances will lead to new technologies which will provide the soldier with effective protection from the most advanced broadband laser threats. Other technologies used for laser eye protection include dielectric materials, absorbing dyes, coatings, and non-linear optical materials.

The Materials Technology Laboratory's (MTL) work in laser protection materials is coordinated with the Aviation Systems Command (AVSCOM), the Tank-Automotive Command (TACOM), the Troop Support Command (TROSCOM), National Research, Development, and Engineering Center, the Letterman Army Institute of Research, and the Army Medical Materiel Development Agency.



For additional information, contact:  
Director, U.S. Army Materials Technology Laboratory  
Attn: SLCMT-BM, John Dignam  
Watertown, MA 02172-0001  
AV 955-5370 or (617) 923-5370



U.S. ARMY AVIATION  
SYSTEMS COMMAND

(AIRCREW VISOR)

LETTERMAN ARMY  
INSTITUTE OF RESEARCH

U.S. ARMY NATICK RESEARCH,  
DEVELOPMENT &  
ENGINEERING CENTER

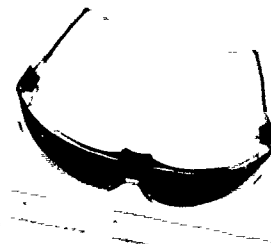
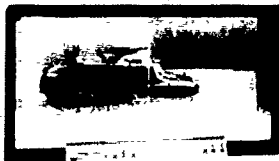
(FRONTSERVICES)

U.S. ARMY MEDICAL MATERIEL  
DEVELOPMENT AGENCY

MTL

U.S. ARMY TANK-AUTOMOTIVE  
COMMAND

(DIRECT VIEW OPTICS)





## U.S. Army Communications-Electronics Command

### Advanced Airborne Radiac System (AARS)

The Advanced Airborne Radiac System (AARS) is an asset utilized by the division chemical company to assist in the decision process to coordinate troop movement through or around nuclear contaminated areas. AARS rapidly surveys an area and identifies safe routes for troop movement. The system measures radiation dose and correlates the dose with position at the time of measurement. The collected data is transmitted to a ground station where contour map overlays indicating radiation levels are generated. These maps are then disseminated to field commanders.

The AARS prototype demonstrates the technology of airborne surveying using an Army inventory handheld radiac set, a Global Positioning System (GPS) receiver, and a radar altimeter. During a flight survey, a data base is generated in which helicopter position obtained from the GPS receiver is automatically correlated with radiac sensor data and altitude. The ground radiation dose is calculated using the measured air dose and altitude. A VHF data link is utilized to transmit data to a ground station. Programmable alarm thresholds and extensive sensor diagnostics and built-in-test-capabilities are provided.

The AARS on a test platform, the orange boom supports the Global Positioning System (GPS) antenna, the radar altimeter antenna, and the Radiac probe



The AARS operator views data on radiation levels, position, and altitude, and controls all AARS operations using the control/display unit (CDU).



For additional information, contact:  
Commander, U.S. Army Communications-Electronics  
Command Center for SW  
Attn: AMSEL-RD-SE-AST-SS, Mr. Jeffrey Zovak  
Fort Monmouth, NJ 07753  
DSN 992-3640 or (201) 532-3640





## ARMORED SYSTEMS

U.S. Army Laboratory Command

### Lightweight M-1 Tow Bar

The Materials Technology Laboratory (MTL) has developed prototype lightweight tow bars to replace the heavy, inefficient bars currently used to tow heavy tanks (such as the M1). Prototypes fabricated from fiber-reinforced composites and steel are being subjected to materials studies to assess major design criteria, including structural performance, weight, and cost. These prototypes are also being tested to determine the optimum system for field use. All prototypes feature:

- Reduced weight—current fielded steel tow bar weighs 340 pounds; graphite/epoxy composite design weighs 205 pounds; improved steel design weighs 260 pounds.
- 30% stronger than current steel tow bar, both designs.
- Replaceable, interchangeable tubes—current steel tow bar is usually discarded if either leg of the Y-shaped bar breaks; both prototypes utilize identical tubes which can be replaced in the field.
- Less manpower required to connect disabled vehicles.

This small investment in advanced materials offers multiple improvements in productivity and logistics costs, while contributing to the overall objective of lightening the forces.

The new fiber-reinforced composite tow bar is stronger and lighter than steel tow bars. It has replaceable Y-bar legs, and requires less manpower to connect it to disabled vehicles.



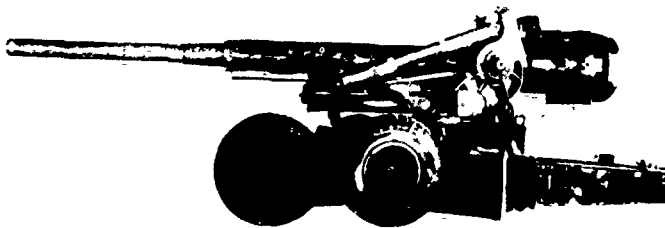
For additional information, contact:  
Director, U.S. Army Materials Technology Laboratory  
Attn: SLCMT-MRS, Christopher Cavallaro  
Watertown, MA 02172-0001  
AV 955-5745 or (617) 923-5745



**U.S. Army Laboratory Command**

## Advanced Gun Propulsion

The Ballistic Research Laboratory (BRL) conducts broad-based research in advanced gun propulsion which extends from the basic research arena, where the fundamental physics and chemistry of energetic materials are studied, to the applied research arena of weaponization. BRL is investigating such areas as insensitive munitions, high-velocity solid propulsion, liquid propellant guns, and electric propulsion with particular emphasis on Electro Thermal-Chemical (ET-C) gun technology. Interior ballistic modeling is employed, as a complement to experimental live firings, to better understand interior ballistics phenomenology and to improve ballistic performance. BRL is also exploring novel ignition concepts, as well as projectile/gun tube interactions coupled with sabot and obturator technologies and their influence on projectile performance.



Prototype of 155mm Liquid Propellant Gun



Vulnerability Testing of the Ammo Compartment in a Main Battle Tank.



**For additional information, contact:**  
 Director, U.S. Army Ballistics Research Laboratory  
 Attn: SLCBR-IB, Mr. James Dante  
 Aberdeen Proving Ground, MD 21005  
 AV 298-6701 or (301) 278-6701



**U.S. Army Laboratory Command**

## **Design and Test Automation of Microwave/Millimeter Wave Devices and Components**

The Microwave Computer-Aided Design (CAD) Laboratory was state-of-the-art layout and simulation software to support electro-optic, high temperature superconductors and advanced receiver designs as well as active device modeling and designs. This laboratory consists of the latest computer hardware and software used in the design of sophisticated microwave components.

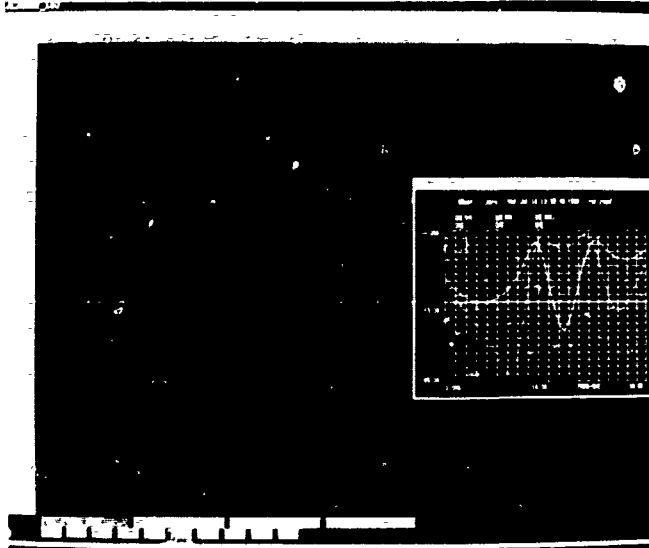
The Electronic Technology and Devices Laboratory (ETDL) maintains a state-of-the-art facility for design capture, analysis, simulation, geometric editing, layout, and measurement. This facility supports efficient and productive design, optimization, wave devices, circuits and subsystem components that are on the leading edge of technology. Examples include integrated circuits, sensors, sources/combiners, planar and conformal antenna arrays, beamformers, phase shifters, jammers, transceivers, optoelectronic devices and highly integrated microwave monolithic integrated circuits. The availability, development, and application of advanced and integrated computer-aided engineering tools provides the basis of a "Center of Excellence" for automated design and testing of this wide variety of microwave/millimeter wave components.



The CAD Laboratory supports the development of a wide variety of microwave/millimeter wave components, such as this combiner.



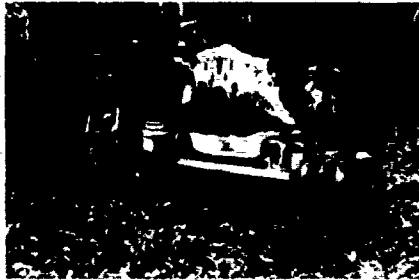
For additional information, contact:  
U.S. Army Electronics Technology and  
Devices Laboratory  
Attn: SLCEI-DT, L. Carmichael  
Dr. B. Perlman  
Fort Monmouth, NJ 07703-5000  
DSN 992-0221 or (201) 542-0221  
DSN 395-4024 or (201) 544-4024





## U.S. Army Troop Support Command

### M1A1 Decoy



A two-dimensional replica of an M1A1 tank consists of a fabric skin with a visual image, and an embedded thermal signature system mounted on a collapsible support frame. A portable generator supplies power for the thermal signature. An audio simulation device can be used with the decoy to portray battlefield sounds. Two types of devices are being investigated: a vehicle-mounted device to portray the acoustic presence of large tactical troop units and assemblages of equipment; and a man-portable device to portray the acoustic presence of individual weapons/squad-sized troop units. Both systems will use a hardened tape recording, mixing and mastering console to produce scenario tapes.



For additional information, contact:  
 Commander, U.S. Army Belvoir RD&E Center  
 Attn: STRBE-J, G.A. Orlicki  
 Ft. Belvoir, VA 22060-5606  
 AV 354-6723 or (703) 664-6723

The M1A1 tank decoy system replicates the thermal signature and visual image of the Abrams Tank.

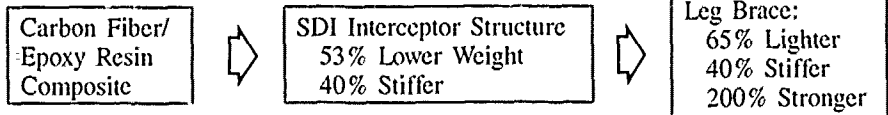


## U.S. Army Laboratory Command

# SDI Materials: Spin-Offs from Space to Medicine

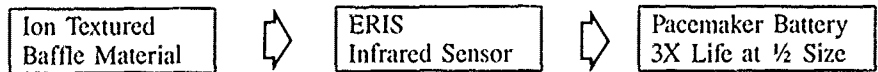


The Materials Technology Laboratory (MTL) provides advanced materials support to the Army's portion of the Strategic Defense Initiative (SDI) program. As part of this support, an advanced structural composite was developed for the strategic interceptor; a full-scale resin matrix model of the interceptor was then fabricated. The new resin matrix structure proved to be 53% lighter and 40% stiffer than the interceptor originally developed for the Exo-Atmospheric Re-entry Vehicle Interceptor System (ERIS). This resin matrix technology was adopted by the medical community and used to fabricate a full-length human leg brace which weighs only two pounds and is significantly stiffer than a conventional leg brace which weighs about six pounds.



The MTL materials support to SDI also includes development of advanced baffle materials for infrared sensors and a textured aluminum baffle which meets the optical and mechanical requirements for the ERIS. A spin-off of the aluminum baffle technology is used to coat the surface of pacemaker electrode tips, tripling the lifetime of the pacemaker battery and reducing the battery size.

*These spin-offs are being supported by the National Institutes of Health.*



◀ The carbon-composite material used by the Army's SDI program has been used to create a prototype human leg brace which is stiffer and lighter-weight than conventional steel braces.

Another SDI spinoff is the use of a textured aluminum coating to lengthen the life of pacemaker batteries. ▼



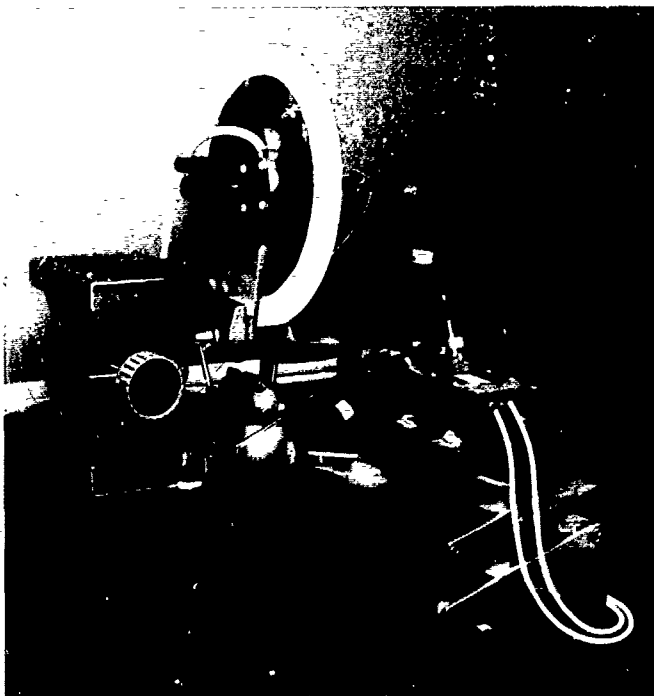
For additional information, contact:  
Director, U.S. Army Materials Technology Laboratory  
Attn SLCMT-BM, John Dignam  
Watertown MA 02172 0001  
AV 955-5700 or (617) 923-5700



U.S. Army Laboratory Command

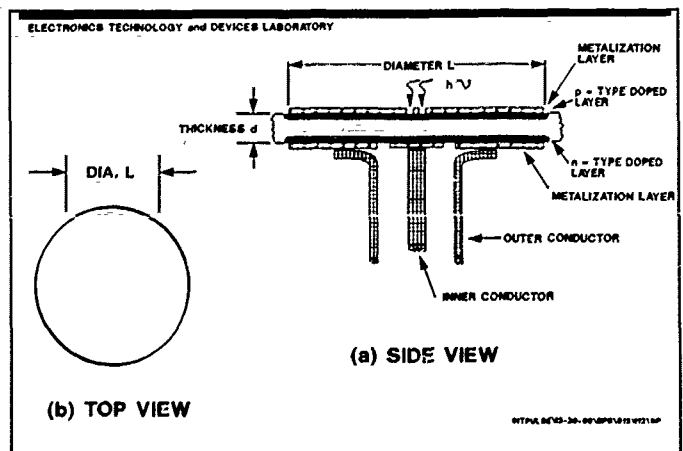
## Impulse Generator Utilizing Optical Switches

An integrated wafer-scale optically activated pulser has been fabricated to generate pulses several hundred picoseconds wide and with tens of megawatt peak power for impulse generator/jammer applications. The integrated pulser combines the energy storage, wave transmission, and switch functions into a single wafer. Patterned radial electrodes, which form a built-in capacitor, are aligned on opposite faces of a semi-insulating gallium arsenide (GaAs) wafer which efficiently stores the energy because of its relatively high dielectric constant of 13. By triggering a built-in PIN diode with a light pulse, a multi-kilovolt voltage impulse is delivered to load impedance. This integrated pulser may be directly connected to a broadband antenna.



Optically activated hybrid pulser, which consists of a radial transmission, GaAs switch, fiber optic cable, and laser diode array, is capable of the generation of tens of kilovolt pulses with nanosecond pulsewidth.

The schematic diagram of unit integrated pulser.



For additional information, contact:  
 U.S. Army Electronics Technology and Devices Laboratory  
 Attn: SLCE/ML, T. Podlesak  
 Fort Monmouth, NJ 07703-5000  
 DSN 992-0276 or (908) 542-0276





## ADVANCED ELECTRONICS

U.S. Army Laboratory Command

### Advanced High Energy Battery Development

The Electronics Technology and Devices Laboratory (ETDL) represents the cutting edge in high power lightweight battery research and development. Unlike commercial consumer users, military equipment constantly needs lighter and more powerful batteries to lighten the soldier's load and enhance his/her operating capabilities. Batteries have improved substantially since the turn of the century, and quantum increases in power have been achieved within the last ten years. Current Army lithium sulfur dioxide batteries provide a five-fold increase in energy densities when compared to the batteries used in the Vietnam War. Future developments in lithium thionyl chloride and lithium manganese dioxide systems will provide batteries with twice the energy of the current lithium batteries. This development in portable power will make a number of high power manportable electronic devices and equipment possible to survive in the future battlefield.

#### ETDL Leaders of the BATTERY TECHNOLOGY REVOLUTION in the past, present and FUTURE



FUTURE  
1 BATTERY



TODAY  
2 BATTERIES



VIETNAM ERA  
10 BATTERIES



For additional information, contact:  
Director, U.S. Army Electronic Technology  
and Devices Laboratory  
Attn: SLCEP-PB, Fee Leung  
Fort Monmouth, NJ 07703-5000  
DSN 995-4735 or (908) 544-4735



U.S. Army Laboratory Command

## PATRIOT Anti-Tactical Missile (ATM) Fuze

The PATRIOT is a sophisticated air defense system capable of intercepting incoming tactical ballistic missiles as well as carrying out its original anti-aircraft role. This dual defense capability is due largely to the M818E2 fuze designed by scientists and engineers at Harry Diamond Laboratories.

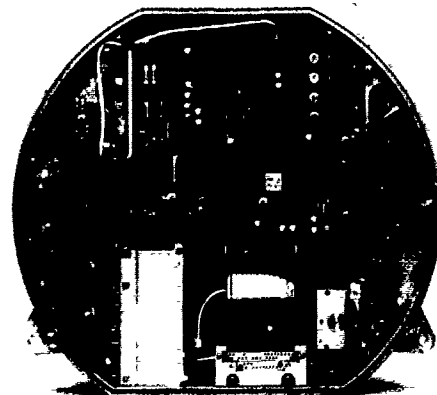
The M818E2 is a compact-pulse Doppler radar system which employs complex digital signal processing to distinguish between valid targets and electronic countermeasures. The fuze can be reprogrammed "on the fly" by ground-to-missile radio messages to accommodate a wide variety of targets and attack scenarios.

In tests at White Sands Missile Range, the PATRIOT equipped with the M818E2 fuze has performed against live targets with 100 percent success.

A PATRIOT missile, equipped with the M818E2 fuze, successfully destroys an incoming tactical ballistic missile (TBM) target in a flight test at White Sands Missile Range (WSMR).

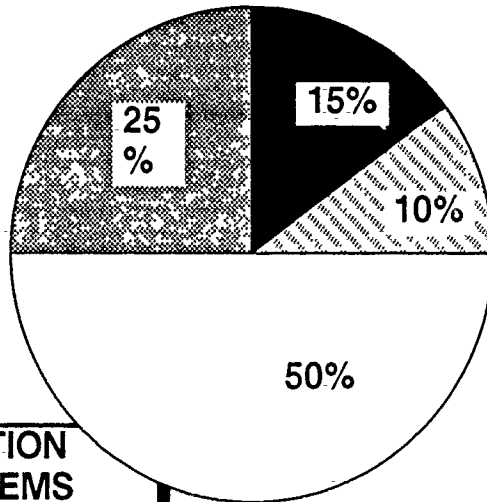


The M818E2 fuze for the PATRIOT missile



For additional information, contact:  
Director, U.S. Army Harry Diamond Laboratories  
Attn: SLCHD-ST-MS, David L. Rodkey  
2700 Powder Mill Road  
Adelphi, MD 20783-1108  
DSN 290-2610 or (301) 394-2610





**NEXT-GENERATION  
& FUTURE SYSTEMS**  
(including Advanced Technology  
Transition Demonstrations)



**U.S. Army Tank-Automotive Command**

## **Component Advanced Technology Test Bed (CATTB)**

The CATTB is an AMC test bed vehicle that combines and demonstrates a series of component technologies developed over the years under AMC and industry sponsorship.

The purpose of the test bed is to:

- Reduce development program risk
- Accelerate technology transfer
- Integrate a chassis and mission module
- Develop and validate simulation
- Provide performance specifications
- Provide smart government buyers

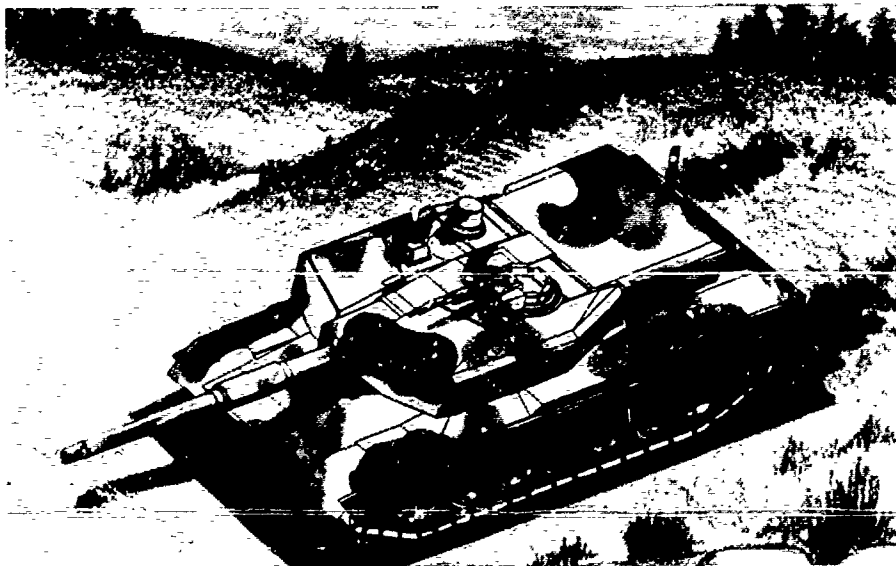
Key Features:

- Advanced Integrated Propulsion System
- Hydropneumatic In-Arm Suspension
- Advanced Track
- Vetrionics
- Embedded Training
- Countermeasure Technologies
- NBC Regenerative Filtration System
- Modular Armor Attachment
- Combat Vehicle Command and Control
- Advanced Tank Cannon (ATAC) System
- Multi-sensor Target Acquisition System (MTAS)

Benefits:

- Demonstration of key Army tech base components
- Development of computer-based design and simulation process
- Establishment of system engineering approach for integration programs
- Baseline for Tank ATTD work
- Refinement of requirements and specifications

Testing of technologies in the Component Advanced Technology Test Bed aids in the refinement of requirements and specifications.



**For additional information, contact:**  
U.S. Army Tank-Automotive Command  
Attn. AMSTA-ZT, Mr. Gene Baker  
Warren, MI 48397-5000  
AV 786-6390 or (313) 574-6390



## U.S. Army Tank-Automotive Command

# Advanced Integrated Propulsion System

The Advanced Integrated Propulsion System (AIPS) is an integrated powerpack candidate for the next generation of the U.S. Army's Main Battle Tank and other armored vehicles in the 50-70 ton range.

The objective of AIPS is to develop and demonstrate advanced technologies in a completely integrated propulsion system to provide opportunities for major advancements in space claim, performance, fuel economy, and life cycle cost.

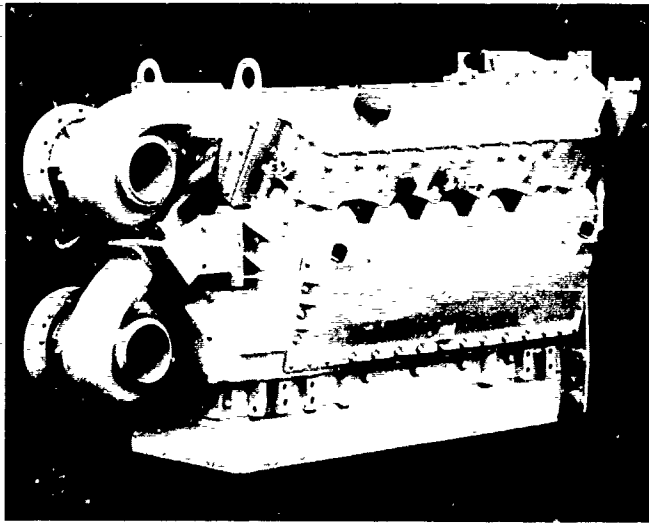
The principal goals of the AIPS are, as compared to the AGT-1500 power pack:

- 50% reduction in size
- Up to 50% reduction in fuel consumption
- 50% lower life cycle costs

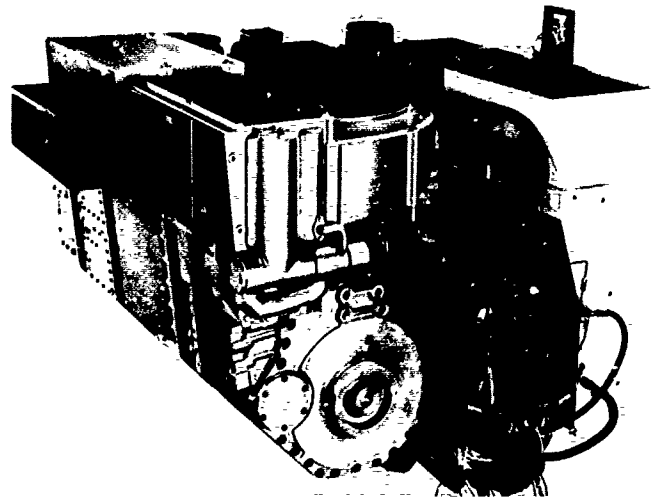
Two approaches are being pursued in the AIPS program: (1) a diesel powered system with the 12-cylinder engine shown in the left photograph and (2) a gas turbine powered AIPS shown in the right photograph. These propulsion systems are completely integrated including the engine, transmission, air cleaner, cooling system, electrical controls, and final drives as well as other ancillary equipment. Laboratory testing of components is in process and demonstration test of the complete systems were completed in June 1990.

For additional information, contact:  
U.S. Army Tank-Automotive Command  
Attn: AMSTA-RG, Dr. R. McClelland  
Warren, MI 48391-5000  
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A 12-cylinder diesel powered advanced integrated propulsion system.



A gas turbine powered AIPS.





**U.S. Army Tank-Automotive Command**

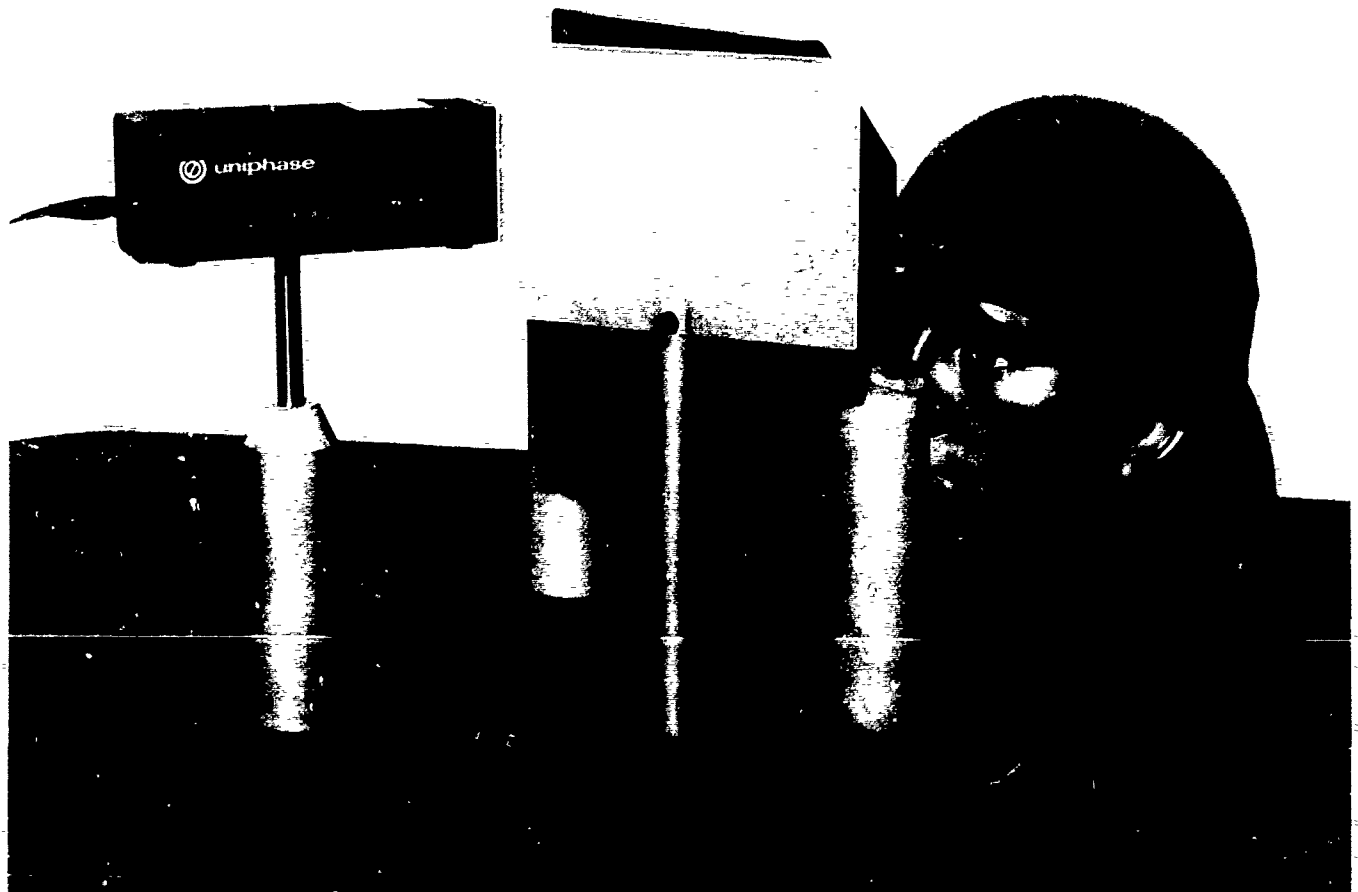
## **Laser Protected Unity Vision for Combat Vehicles**

A TACOM-sponsored study has shown conclusively that the only components of combat or tactical vehicles vulnerable to laser radiation are the optical systems (sights, sensors, eyes). Efforts have, therefore, been concentrated in developing realistic solutions to the problem of providing ocular protection for unity vision equipment, TACOM's area of responsibility. All combat vehicles are now required to protect the crew and components from damage by laser radiation. The initial requirement to protect only magnifying optics (sights) has been expanded to cover all vehicle optics, including unity vision periscopes/vision blocks.

Work is also continuing on development and integration of advanced laser threat/hazard filters on unity vision devices for future combat vehicles. Emerging threats will require new solutions including improved discrete wavelength filters and nonlinear materials with broadband response. Results from TACOM's efforts will provide substantially increased survivability for combat vehicle crews operating in the laser-rich battlefield.

For additional information, contact:  
Commander  
U.S. Army Tank-Automotive Command  
Attn: AMSTA-RSC, Dr. D. Templeton  
Warren, MI 48397-5000  
AV 786-5325 or (313) 574-5325

TACOM has developed a series of unity vision periscopes and vision blocks which include laser protection against all currently fielded laser rangefinders and designators.





**U.S. Army Tank-Automotive Command**

## **VETRONICS Crew Display Demonstrator**

The increased complexity of new combat systems requires that an efficient link between the man and machine be created to ensure the effectiveness of the soldier. The U.S. Army Tank-Automotive Command has developed the VETRONICS Crew Display Demonstrator (VCDD), a research and design tool, to optimize the Soldier-Machine Interface (SMI) in new or improved combat vehicles.

The VCDD is a full-mission, fixed-base combat vehicle simulator with two hardware/software reconfigurable crewstations capable of representing a wide spectrum of operator interfaces. The hardware's form-, fit-, and function-reconfigurability and the software's user-friendly interface, combined with a computer generated world, allow human factors engineers to design and evaluate the crew-system panels, displays, and controls in a simulated battlefield scenario.

The simulation will be used as a tool to optimize the crew station configuration in conjunction with a large sample of soldiers and to establish the information content, format, and crew interactions for the platoon, company, and battalion levels of command and control. The use of simulators will significantly reduce the time and cost required to achieve viable vehicle configurations. The VCDD is currently being used to support the MIA2 and Combat Vehicle Command and Control (CVC2) programs. Also in the near future, it will be used to support the CATTB, CATTD, ASM and BLK III programs.

The VCDD simulates the crew station configuration and establishes the information content, format, and crew interactions for various levels of command and control



For additional information, contact:  
U.S. Army Tank-Automotive Command  
Attn: AMSTA-RVI, Mr. John Brabbs  
Warren, MI 48397-5000  
AV 786-6242 or (313) 574-6242



**U.S. Army Troop Support Command**

## **Counterobstacle Vehicle**

The Counterobstacle Vehicle, developed by the Troop Support Command's Belvoir RD&E Center, is the prototype for the Countermobility Vehicle currently being developed by the Tank Automotive Command. It is a highly mobile armored vehicle based on an M88 tank retriever chassis, and is equipped with a combination mineplow/bulldozer plow and two telescopic arms which operate independently and have a reach of 32 feet. In operation, various attachments such as augers, buckets, or grappling hooks could be used with the arms to clear different types of obstacles. The vehicle is designed to provide the mobility and versatility needed to overcome the battlefield problems of minefields, antitank ditches, and large amounts of urban rubble.



For additional information, contact:  
Commander, U.S. Army Belvoir RD&E Center  
Attn: STRBE-NDM  
Ft Belvoir, VA 22060-5606  
AV 354-5470 or (703) 664-5470



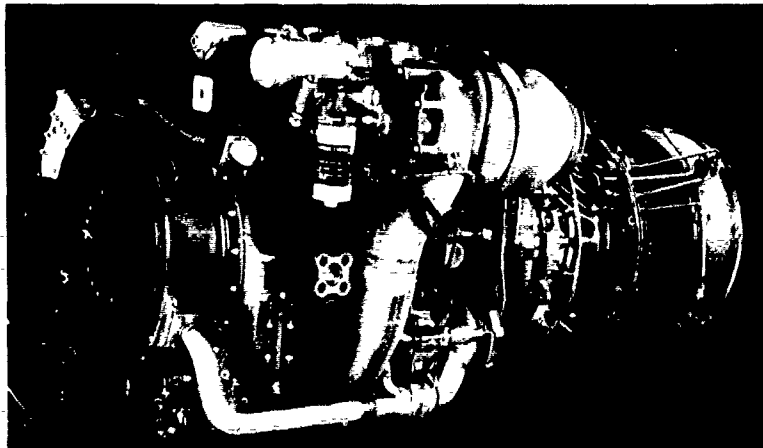
## U.S. Army Aviation Systems Command

### Rotorcraft Propulsion

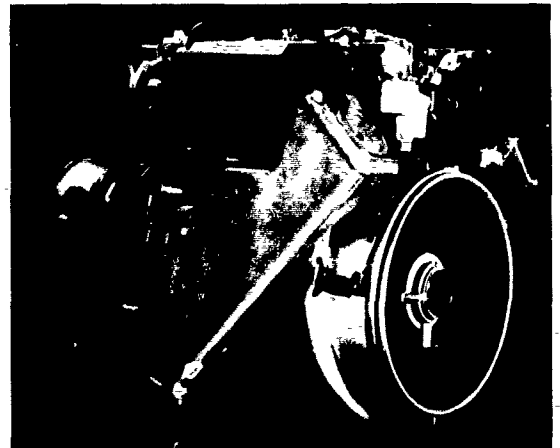
**T700/CT7 Turboshaft Engine** The T700 engine family sets the standards for helicopter engines with low-risk, more powerful derivatives that meet a wide variety of mission requirements. The T700's completely modular design ensures ease of maintenance and allows a large number of repairs to be handled on the flight line or base rather than at a depot. Modules can be replaced without exposing or separating the bearings and lubrication system, thus minimizing contamination. Features such as the split compressor casing, permit same-day, on-site, foreign-object-damage repair, thus enhancing fleet readiness.

**T800 Turboshaft Engine** The T800 engine, currently under development for the U.S. Army Light Helicopter program, is a 1200-horsepower turbine engine which will weigh less than other engines in the same horsepower class. It will provide a 20-30% improvement in specific fuel consumption as well as improved reliability, maintainability, and supportability as compared to engines currently used in the existing light fleet.

The T700 engine is used as the primary power plant for the Army's utility and attack helicopter fleet.



The T-800 engine will provide the Army with an advanced technology engine for light helicopter aircraft.



For additional information, contact:  
U.S. Army Aviation Systems Command  
Attn: AMSAV-EPE, Loren Wingate  
4300 Goodfellow Boulevard  
St. Louis, MO 63120-1798  
AV 693-1149 or (314) 263-1149

U.S. Army Aviation Systems Command  
Attn: AMSAV-EPE, John Woracek  
4300 Goodfellow Boulevard  
St. Louis, MO 63120-1798  
AV 693-1665 or (314) 263-1665



**U.S. Army Tank-Automotive Command**

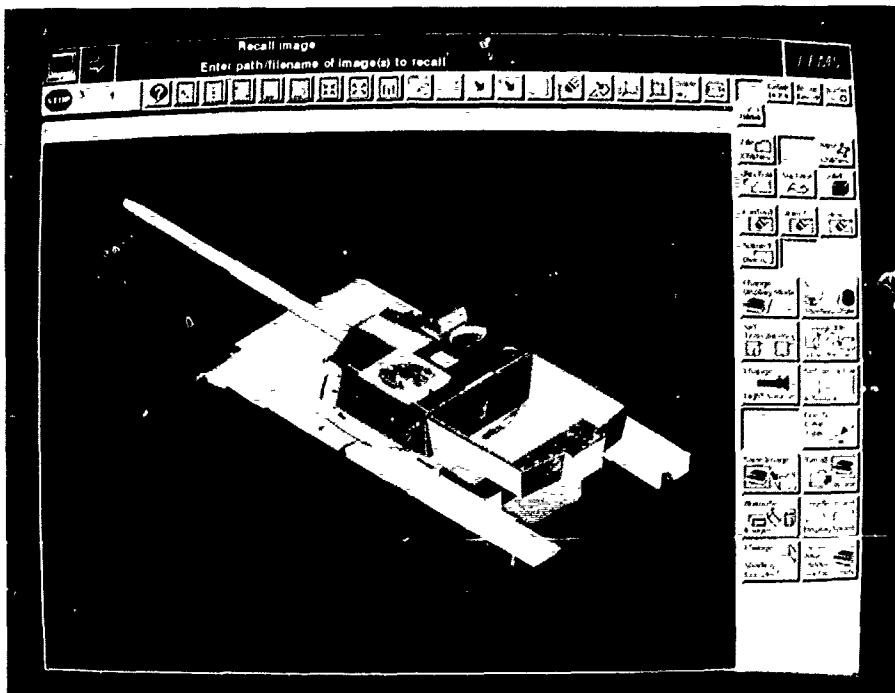
## **Concept, Design, and Manufacturing**

Advanced computer-aided design (CAD) methods are used in design, engineering, evaluation, and manufacturing at the TACOM RDE Center. Solids modeling, finite element stress analysis, component animation, production drawing generation, and numerical control manufacturing programs are shown. The benefits to Army vehicle programs and systems are:

- 10% to 20% less concept development time since ideas can be exploited more quickly than by using manual techniques
- Reduced system development time since solid models of vehicles and their components can eliminate interferences and performance problems not usually found until prototype construction
- More efficient vehicle designs result since many design iterations involving weight, power, and ballistic susceptibility can be performed
- Reduced manufacturing leadtime and costs since tooling and machining processes can be incorporated at the design stage
- Faster response to engineering changes since a 3-dimensional graphics database allows rapid visual updates as changes are made
- Reduced life cycle costs result because greater productivity and decreased lead-times occur in all phases of the vehicle life cycle

The Army of the 21st century will require more efficient and effective vehicle systems as well as increased flexibility and responsive engineering support. This technology can optimize Army vehicle design at reduced costs.

Computer-aided design (CAD) methods optimize Army vehicle design at reduced costs.



**For additional information, contact:**  
U.S. Army Tank-Automotive Command  
Attn: AMSTAT, Mr. Donald W. Cargo  
Warren, MI 48397-5000  
AV 786-6191 or (313) 574-6191





## U.S. Army Tank-Automotive Command

### Light Armored Vehicle Family

#### Mission

The Light Armored Vehicle-equipped battalion's mission is to conduct reconnaissance, security, and economy-of-force operations and, within capabilities, to conduct limited offensive or delaying operations that exploit the unit's mobility and firepower.

#### System Descriptions

The Light Armored Vehicle (LAV) family consists of various configurations with the same power pack, suspension system, and drive train, and similar hull configurations. Different weapon systems and components are added to complete the various configurations. Each version has the same performance characteristics. They swim at 6 mph, achieve highway speeds in excess of 60 mph, and provide ballistic protection against small arms fire.

**LAV-25:** Two-man turret, equipped with stabilized M242 25mm cannon. Carries up to six additional troops. Status: Fielded.

**Anti-Tank:** Equipped with M901A1 weapon station. Stows 14 TOW missiles. Status: Fielded.

**Mortar Carrier:** Fires M252 81mm mortar from vehicle mounted turntable. Status: Fielded.

**Logistics:** Cargo carrier capable of transporting 5400 lb payload. Status: Fielded.

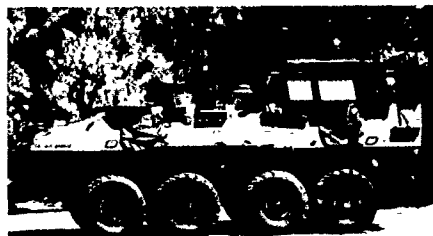
**Command and Control:** Equipped with 4 VHF, 1 UHF, and 1 HF radios. Status: Fielded.

**Maintenance/Recovery.** Knuckle crane is used to remove/replace turrets and power packs. Heavy duty winch in rear is used for recovery operations. Status: Fielded.

**Electronic Warfare.** Equipped with direction finding and jamming equipment. Status: Fielded.

**Air Defense.** Two-man turret, equipped with hybrid weapon system consisting of a 25mm cannon, Stinger missiles, and 2.75 in. rockets. Stabilization and autotrack systems provide fire-on-the-move capability. Status: In development.

**Assault Gun.** Equipped with stabilized EX35 105mm low recoil cannon compatible with all current and planned 105mm ammunition. Autoloader relieves crew of ammo handling chores. Status: In development.



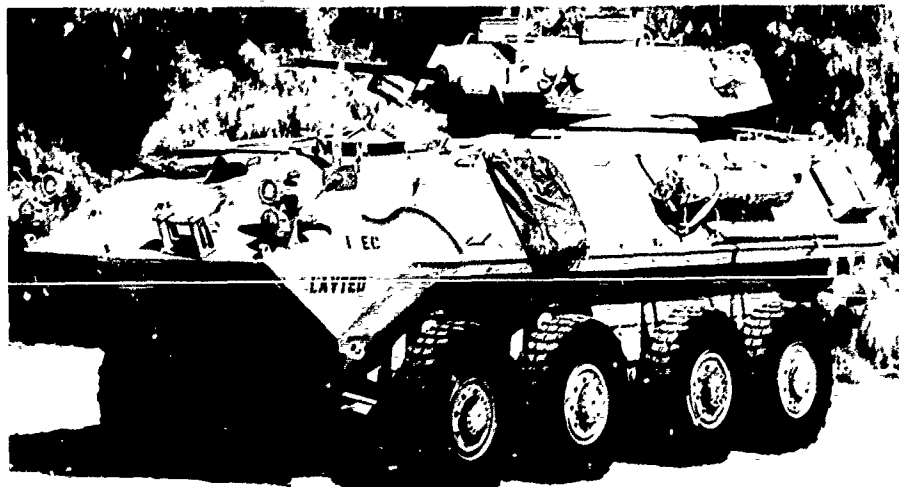
The Electronic Warfare LAV has been fielded equipped with direction finding and jamming equipment.



The Maintenance and Recovery LAV has been fielded featuring a knuckle crane and a rear winch.



The Command and Control LAV has also been fielded and is equipped with 4 VHF, 1 UHF, and 1 HF radios.



The Light Armored Vehicle LAV-25 features a two-man turret equipped with a stabilized M242 25mm cannon, and capable of carrying six additional troops.

For additional information, contact:  
CG, U.S. Army Tank-Automotive Command  
Light Armored Vehicle, Project Manager Office  
Attn: AMCPM-LA  
Warren, MI 48397-5000  
AV 786-8338 or (313) 574-8338

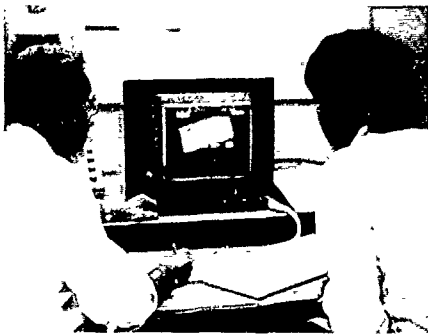


## U.S. Army Aviation Systems Command

### Army-NASA Aircrew/Aircraft Integration Program

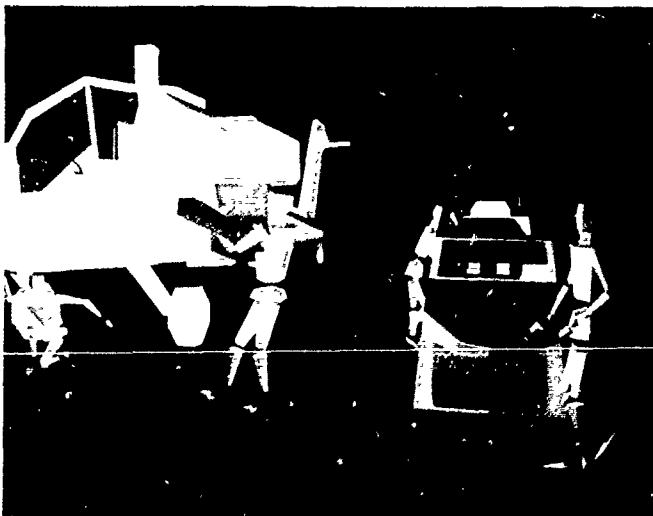
For additional information, contact:  
 Aeroflightdynamics Directorate  
 Computational Human Engineering Research Office  
 Attn E James Hartzell  
 Mail Stop 239-9  
 NASA-AMES Research Center  
 Moffitt Field, CA 94035-1000  
 AV 359-5743 or (415) 604-5743

Using MIDAS, aircraft designers can see and test hardware before they build it

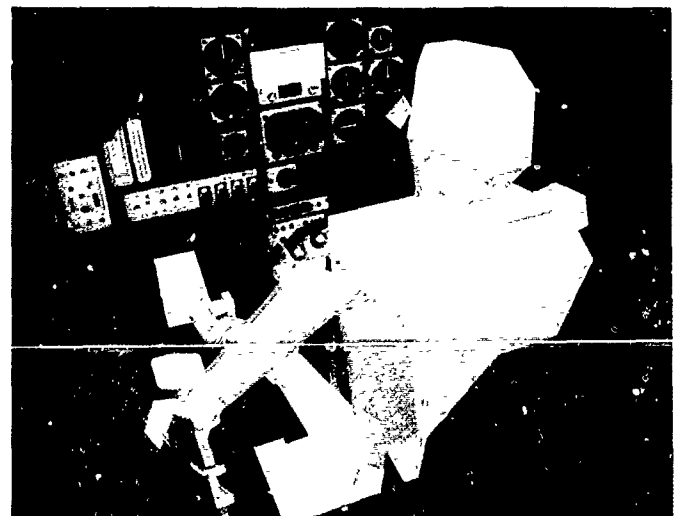


The Army-NASA Aircrew/Aircraft Integration (A<sup>3</sup>I) program is a joint Army-NASA exploratory development effort to produce a Human Factors-Computer Aided Engineering (HF-CAE) system called MIDAS (Man-Machine Integration Design and Analysis System). The program's goal is to develop an engineering environment which contains tools and models to assist design engineers in the conceptual phase of rotorcraft crewstation development and anticipate crew training requirements. The system provides designers/analysts with interactive symbolic, analytic, and graphical components which permit early integration and visualization of human engineering principles. Currently hosted on a number of networked Symbolics and Silicon Graphics workstations, MIDAS serves as the framework in which other research findings and models, developed by, or sponsored through the Computational Human Engineering Research Office, are instantiated.

MIDAS gives designers an opportunity to "see it before they build it," to ask "what if" questions about all aspects of crew performance, including training, and to correct problems early. The system is focused on helicopters, but is generic and permits generalization to other vehicles. The major elements of MIDAS currently are: 1) symbolic methods to represent and decompose the operator tasks; 2) simulation support workbench including aircraft dynamics and guidance models, human behavior/performance models, system function models, and workload models, 3) training requirements models, 4) 3-D CAD utilities for prototyping cockpit instrumentation and controls, 5) anthropometric pilot model (graphic mannequin), and 6) analysis displays to observe aspects of task performance, resource use, and load versus time.



MIDAS results are presented visually, often as a computer animation.



A MIDAS simulation of manned flight evaluates cockpit designs.

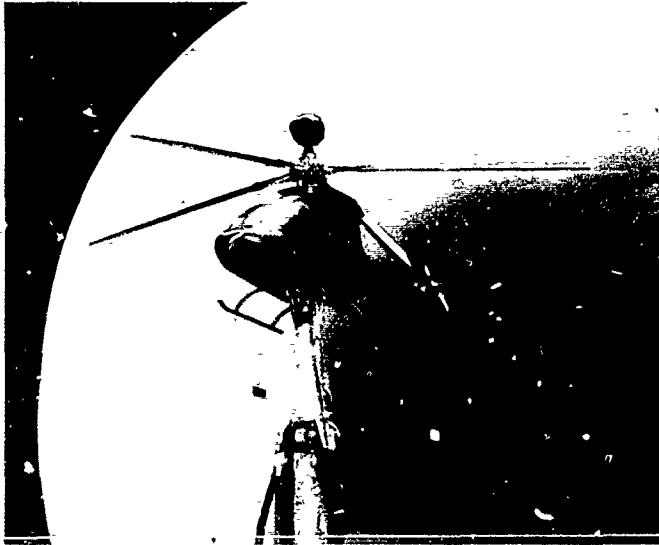


## U.S. Army Aviation Systems Command

### Aerostructures Research and Development

The Army Aerostructures Directorate, located at the NASA Langley Research Center, Hampton, VA, performs basic and applied research in rotorcraft aeromechanics and aerostructures. Individual Army researchers and scientists are experts in such disciplines as: rotorcraft aeroelasticity, aerodynamics, dynamics, vibrations, metal and composite structures, fatigue and fracture, rotorcraft crashworthiness, and acoustics. The Army/NASA cooperative agreement allows Army researchers to work alongside NASA researchers at NASA Langley Research Center with access to "world class" research facilities. The ability to utilize the numerous state-of-the-art NASA research facilities (such as a 14' - by 22' -wind tunnel, transonic dynamics tunnel, an impact dynamics branch crashtower, anechoic noise facilities, materials research laboratories, and a wide variety of test equipment and computers) gives the Army aviation community superior research capabilities at a nominal investment and operating cost.

Performance and controlability tests are conducted on the Army's OH-58 AHIP concept with mast mounted site.



Army rotor inflow measurements use a state-of-the-art laser velocimeter in NASA Langley's 14' - by 22' - wind tunnel.

For additional information, contact:  
 U.S. Army Aerostructures Directorate  
 Attn: M/S266, SAVRT-SD-D, John H. Cline  
 NASA Langley Research Center  
 Hampton, VA 23665-0001  
 (804) 864-3966



## U.S. Army Communications-Electronics Command

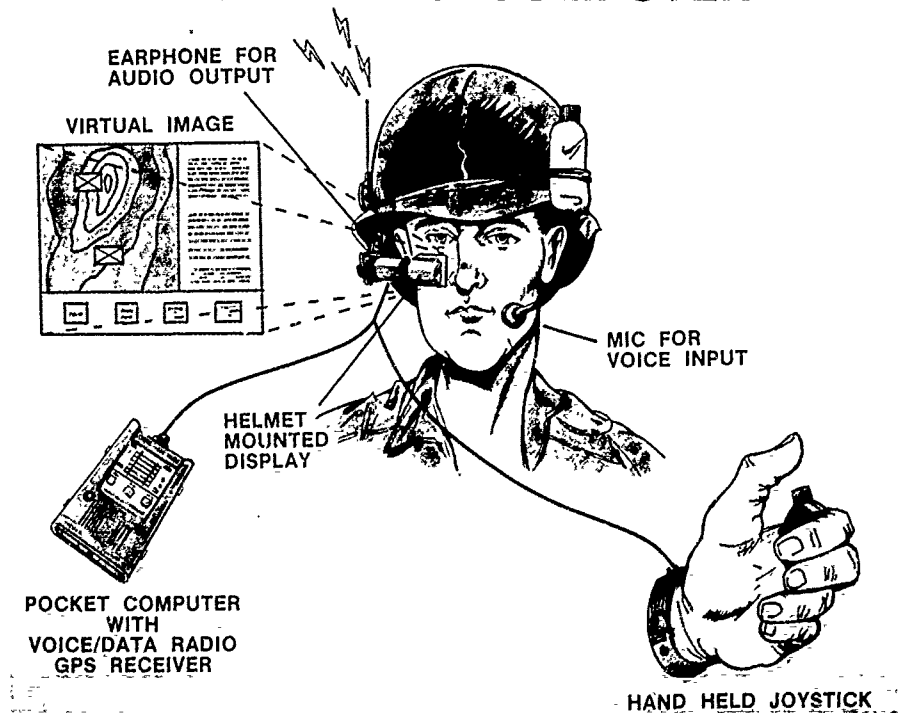
### Soldier's Computer

The Soldier's Computer is a fully-portable, lightweight, hands-free computer system designed for the individual soldier. This system will extend Command, Control, and Communications down to the soldier level. Components of the Soldier's Computer include:

- a helmet-mounted display which provides nearly the same image resolution as a desktop computer monitor;
- a pocket-sized computer;
- a hand-held input device which works similar to a mouse or joystick and requires the use of only one thumb;
- a radio local area network (LAN) which can transmit voice or datastream bits over a modulated radio; and
- a global positioning system (GPS), permitting the soldier to view a map depicting friendly, enemy, and his own positions on the battlefield.

A miniaturized helmet mounted display is used to review maintenance instructions during repair of a tank tread

### SOLDIER'S COMPUTER



For additional information, contact:  
 Commander, U.S. Army Communications-Electronics Command  
 Attn: AMSEL-RD-ASC-RA, James Schoening  
 Fort Monmouth, NJ 07753  
 DSN 992-0118 or (201) 532-0118



# U.S. Army Armament, Munitions and Chemical Command

## Detection of Biological and Chemical Agents

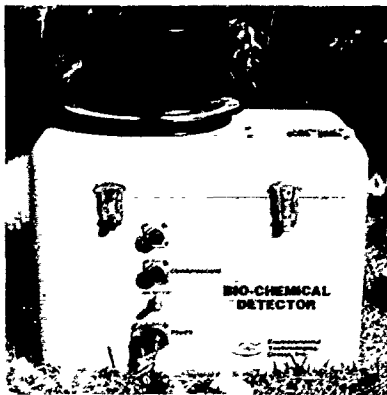
The detection of biological and chemical agents (BC Detector) is currently under development. When fielded, it will give the Defense Community its first true biological detection capability, sensing a variety of toxins and pathogens as well as the traditional chemical agents. Some key features of the final item will be:

- Man portable.
- Modular in design thus allowing the flexibility necessary to assay for new threat toxins/pathogens and to incorporate advances in technology.
- Battery supplied internal power.
- Capable of displaying both the hazard class (nerve, blister, toxin, pathogen) and a semiquantitative estimate of concentration.

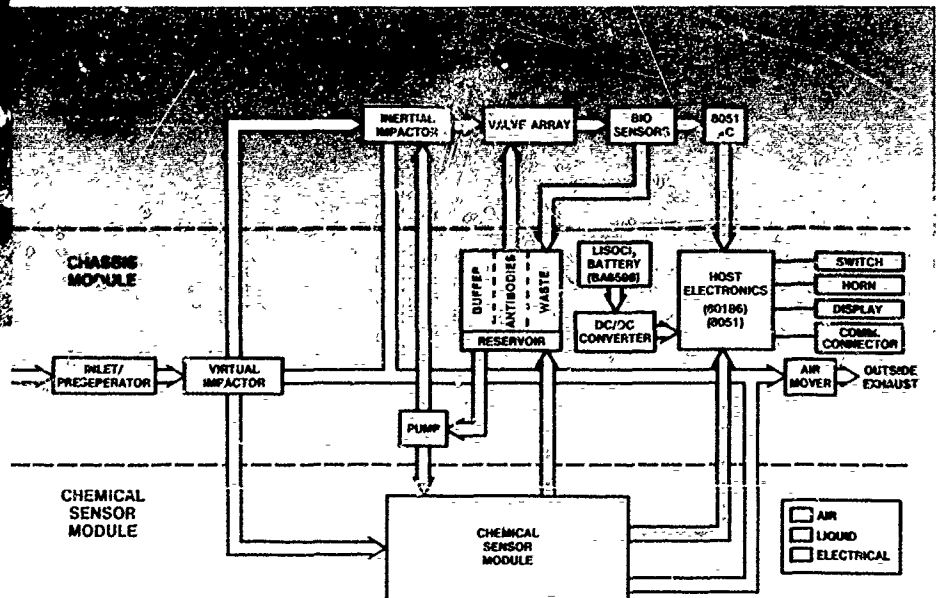
The breadboard BC Detector was delivered in March 1990. It is split into two units for test purposes: a Chassis Module for sampling and a Biosensor Module for detection. The fielded detector will be a single unit. Although not reduced to its eventual field configuration, the breadboard is portable and representative of all the technical features planned in the final design. It is capable of sampling chemical and biological threat materials, processing them, and presenting an indication of a positive response. Chemical sensing is accomplished by an Ion Mobility Spectrometer (IMS) under development by the United Kingdom under the terms of a tri-national Memorandum-of-Understanding (US, UK, Canada). Toxin/pathogen detection takes place with a Light Addressable Potentiometric Sensor (LAPS), a novel technology developed by Molecular Devices Corp. The LAPS is an extremely adaptable sensor that meets all present and anticipated biodetection needs.



For additional information, contact:  
Commander, U.S. Army Chemical Research, Development and Engineering Center  
Attn: SMCCR-DDI, Mr. Michael T. Goode  
Aberdeen Proving Ground, MD 21010-5423  
DSN 584-5580 or (301) 671-5580



The BC Detector currently under development, senses a variety of toxins, pathogens, and chemical agents. It displays both hazard class and concentration estimate.





## U.S. Army Tank-Automotive Command

# Advanced Track For Heavy Weight Class Vehicles

The XT166 and XT158L advanced track systems were developed for 45-70 ton GW future armored combat vehicles in the near term (1995).

Both systems are 25-inch-width, forged steel, double-pin, replaceable pad tracks which provide an ease of maintenance. They also offer increased durability and reduced weight through the use of computer-aided design optimization and analysis.

### Key Features:

#### XT166

- One-piece shoe body
- Integral centerguide
- Connectors without wedges, bolts, or nuts
- Non-directional

#### XT158L

- Two-piece shoe body
- Two-bolt domed centerguide
- Wedgeless, clamp-type end connectors
- Non-directional
- Replaceable roadwheel path rubber backing

Benefits of the advanced track system include a reduction of up to 1300 lbs/vehicle in track weight, an increased track life (3,000-6,000 mile durability), a ten to twenty-five percent reduction in life-cycle O&S costs, and weight class vehicle commonality.

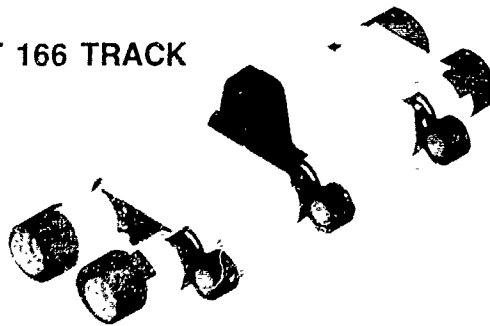
#### XT166 Track

The XT166 advanced track system with one-piece shoe body, integral centerguide, and special connectors

#### XT158L Track

The XT158L with its two-piece shoe body, domed centerguide, wedgeless connectors, and replaceable backing.

#### XT 166 TRACK



#### T158L TRACK



For additional information, contact:  
Commander, U.S. Army Tank-Automotive Command  
Attn: AMSTA-RTT, Mr. Peter T. Sturos  
Warren, MI 48397-5000  
AV 786-6414 or (313) 574-6414



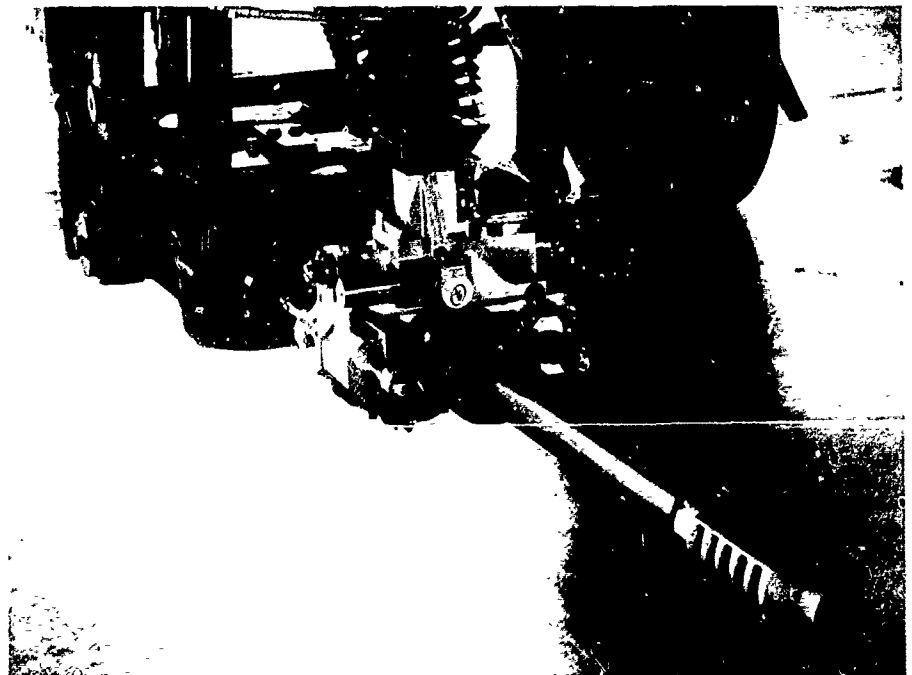
**U.S. Army Aviation Systems Command**  
**U.S. Army Armament, Munitions and Chemical Command**

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## **Integrated Air-to-Air Weapons (INTAAW) Evaluation**

The Integrated Air-to-Air Weapons (INTAAW) Evaluation is a demonstration program designed to address helicopter short-range air-to-air combat capability, currently a major U.S. Army Aviation operational deficiency. The objective of the INTAAW Evaluation program is to develop and evaluate advanced weapon technologies which have the potential to improve the air-to-air effectiveness of helicopter automatic cannon subsystems. Demonstrations will include weapon firing flight tests on an AH-64 Apache helicopter. Technologies to be evaluated include adaptive turret control and active recoil attenuation, developed by ARDEC under the Precision Aircraft Armament Control Experiment (PAACE) program, as well as air-to-air fire control. In addition to demonstrating automatic cannon subsystem air-to-air capability, the INTAAW evaluation will assist the combat and materiel developers in defining requirements and future system capabilities.

The AH-64 Apache turreted gun system will be controlled by the adaptive control system under a PAACE test.



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For additional information, contact:  
U.S. Army Aviation Systems Command  
Aviation Applied Technology Directorate (ATTD)  
Attn: Jerry Irvine, Public Affairs Officer  
Fort Eustis, VA 23604-5577  
AV 927-3272 or (804) 878-3272



U.S. Army Laboratory Command

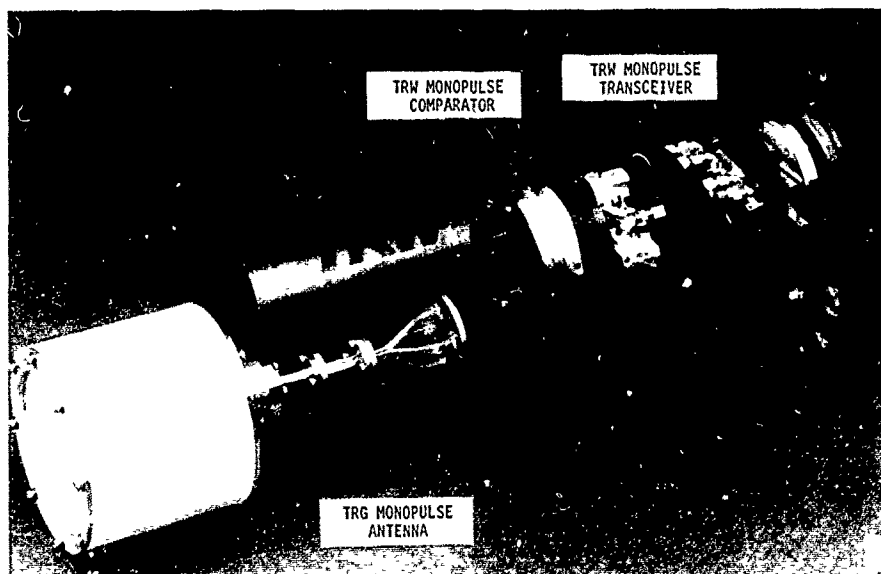
## Smart Munitions—94GHz Integrated Monopulse Transceiver

Integrated technology has been employed in the design of the 94 GHz pulsed transceiver, a component with potential application in various Smart Munitions systems. The integrated technology has allowed size and weight reductions of 10 to 1. Mechanical tolerances have been reduced considerably through the use of these techniques to reduce cost. Application of microwave/millimeter wave integrated circuits (MIMIC) technology to this planar design will:

- Provide further 10 to 1 reduction in size and weight
- Increase performance
- Improve reliability and reduce production costs

This sensor can be easily accommodated into precision-guided missile systems, such as the Multiple-Launch Rocket System—Terminally Guided Warhead (MLRS-TGW).

The 94 GHz pulsed transceiver uses size, weight, and tolerance reductions to lower costs.



For additional information, contact:  
U.S. Army Electronics Technology and Devices  
Laboratory  
Attn: SLCET-DT, E. Freibergs  
Fort Monmouth, NJ 07703-5000  
AV 995-2813 or (908) 544-2813





## U.S. Army Tank-Automotive Command

### Simulation Based Research, Development, and Acquisition

A state-of-the-art supercomputer-based analytical and physical simulation capability has been created by the U.S. Army Tank-Automotive Command (TACOM) to reduce the time and high cost of conventional military vehicle prototype-based design and development. Simulation allows:

- the quantitative evaluation of vehicle performance without building hardware
- the exploration of many design excursions and ideas
- the examination of many environmental and operational scenarios
- the saving of considerable time and money in the development and assessment process.

The ideal integration of analytical and physical simulation involves each supplying data for, and analyzing the results of, the other. Features of each type of simulation include:

*Analytical simulation* involves mathematically modeling vehicle systems and subsystems and is used for the design, modeling and engineering analysis of most aspects of combat and tactical vehicle performance. At TACOM it is based on, and integrated with:

- The Army Regional Cray-2 Supercomputer.
- A Computer Aided Design, Engineering and Manufacturing System.
- Various high speed graphics and workstations.
- A host of software products—inhouse developed and commercially available.

Current emphasis is on the simulation and analysis of military vehicle cross country mobility, ride dynamics, truck/trailer roll and maneuver stability, weapon platform firing stability, structural integrity, and system survivability.

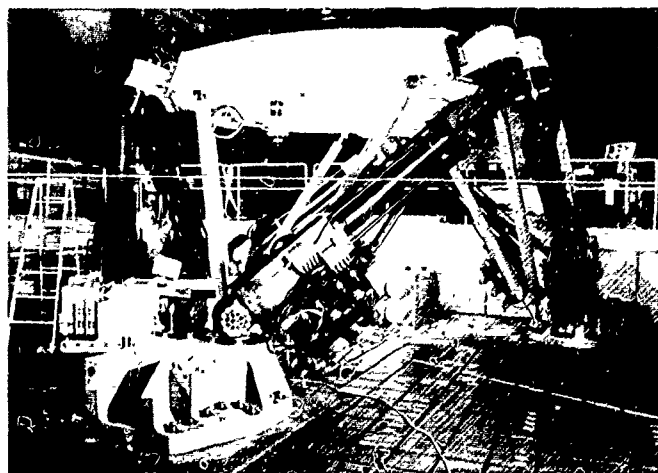
*Physical simulation* involves emulating real-time physical motions of actual vehicle systems in a computer controlled, laboratory environment to approximate the vehicle's field performance. It is centered around man and hardware-in-the-loop motion base simulators, used to evaluate various issues associated with man and machine interaction dynamics, and adaptable motion base simulators capable of "shaking" complete combat and tactical vehicle systems weighing up to 40 tons.

Physical simulation offers accelerated test schedules, repeatable test conditions, and allows collection of data otherwise difficult or impossible to obtain. It validates analytical models, addresses man-in-the-loop issues, and determines failure points of a vehicle system or subsystems.

For additional information, contact:  
Dr Ronald R. Beck  
Chief, System Simulation and Technology Division  
Research, Development and Engineering Center  
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Analytical simulation offers the ability to emulate vehicle systems and subsystems through mathematical modeling.



Physical simulation imitates real-time physical motion of actual vehicle systems to validate performance models



U.S. Army Aviation Systems Command

## Integrated High Performance Turbine Engine Technology

The Integrated High Performance Turbine Engine Technology (IHPTET) Initiative is a joint DoD/NASA/industry effort to provide revolutionary advancement in aircraft propulsion performance and operational capability.

**Man-Rated Shaft Power (Turboshaft/Turboprop) Engines:** The demonstrators for turboshaft/turboprop configurations will be divided into a Joint Turbine Advanced Gas Generator (JTAGG) phase and a Demonstrator Engine phase. The JTAGG phase will focus on improvements in core technology with a long range goal of achieving a 40% decrease in specific fuel consumption (SFC) and a 120% increase in power-to-weight for a given size engine. The Demonstrator phase of the program will address the marriage and integration of all necessary items into the JTAGG cores to provide validation of a complete turboshaft/turboprop engine utilizing advanced cold section materials, improved controls, lightweight power turbines, advanced lube systems, etc. As needs dictate, the demonstrator engines will validate achievable levels of power-to-weight, SFC and engine concept operational characteristics/capability, and prove an early assessment of integrated reliability.

At the heart of the IHPTET Initiative are the individual component technology programs (such as the swept rotor depicted here) which rely on advanced materials, innovative structures, and increased aerothermodynamics.



For additional information, contact:  
Commander, Aviation Applied Technology Directorate  
U.S. Army Aviation Systems Command  
Attn: SAVRTTY-ATP, Graydon Elliott  
Fort Eustis, VA 23604-5577  
AV 927-0040 or (804) 878-0040



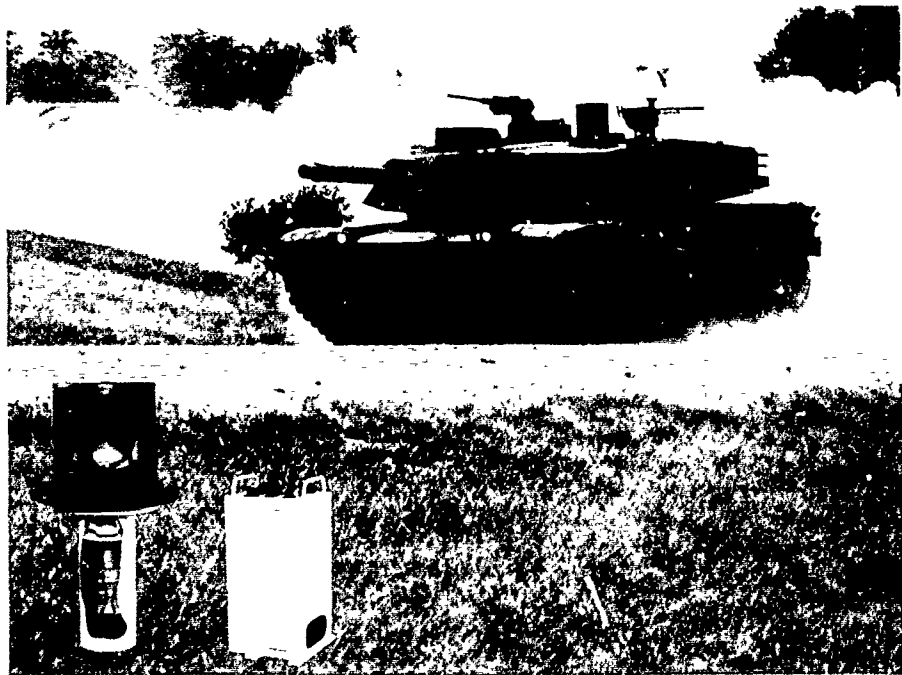
**U.S. Army Communications-Electronics Command**

## **Multi-Sensor Target Acquisition System (MTAS) Millimeter Wave Radar for Land Combat**

The Multi-Sensor Target Acquisition System (MTAS) fire control radar (FCR) is a multipurpose millimeter wave sensor system currently under development to support extended-range target surveillance, acquisition, and engagement requirements of future armored systems. The prototype systems will be integrated with advanced fire control systems as part of the effort.

The MTAS FCR operates as an independent, "hunter-kill" sensor to provide automatic search, detection, recognition, and engagement prioritization of multiple ground and helicopter threats. Operation at millimeter wave frequencies allows the sensor system to function effectively in all degraded battlefield conditions (such as adverse weather and smoke screens), searching selected areas for moving and stationary objects, classifying targets, and relaying the information on the commander's or gunner's display.

Shown are the two components of the MTAS Millimeter Wave Radar. The cylindrical assembly contains the antenna and radio frequency (RF) electronics, the rectangular radar processor is mounted within the turret



For additional information, contact:  
Commander, U.S. Army Communications-Electronics  
Command Center for NVED  
Attn: AMSEL-RD-NV-GSD, Mr. Mid Self  
Fort Belvoir, VA 22060  
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**U.S. Army Armament, Munitions and Chemical Command**

## **Fiber Optic Waveguide Based Biosensor**

The demand for field detection of a diverse source of chemical/biological warfare (CBW) threat agents has resulted in a reorientation of thinking from an agent-defined to a target-defined systems perspective. The fiber optic waveguide (FOWG) biosensor unites biological principles of specific cell molecule recognition with microelectronic technology to create a sensor with potential generic detection capabilities for chemical, biological, and pathogenic threat agents. The FOWG biosensor offers significant advantages over existing agent-defined detection methods currently available.

The hardware used with the FOWG is commercially available and is used in conjunction with modular plug-in sensing elements which negate the re-engineering of hardware for new threat agents. The sensing elements are compatible with diverse biological targets such as enzymes, antibodies, drug receptors, and genetic probes, are capable of rapid real-time field sampling and continuous monitoring, and can increase threat agent detection capabilities by orders of magnitude.

The FOWG-based biosensor is portable and easily miniaturized, and it offers numerous commercial spinoff applications in medical diagnostics, as well as industrial and environmental monitoring.

The fiber optic waveguide (FOWG) biosensor combines biological principles and microelectronic technology to create a chemical/biological warfare (CBW) threat agent detector.



For additional information, contact:  
Commander, U.S. Army Chemical Research,  
Development, and Engineering Center  
Attn: SMCCR-RSB, Dr. James J. Valdc.,  
Aberdeen Proving Ground (EA), MD 1010-5423  
DSN 584-3564 or (301) 671-3564



U.S. Army Armament, Munitions and Chemical Command

## Regenerative Pressure Swing Filtration System

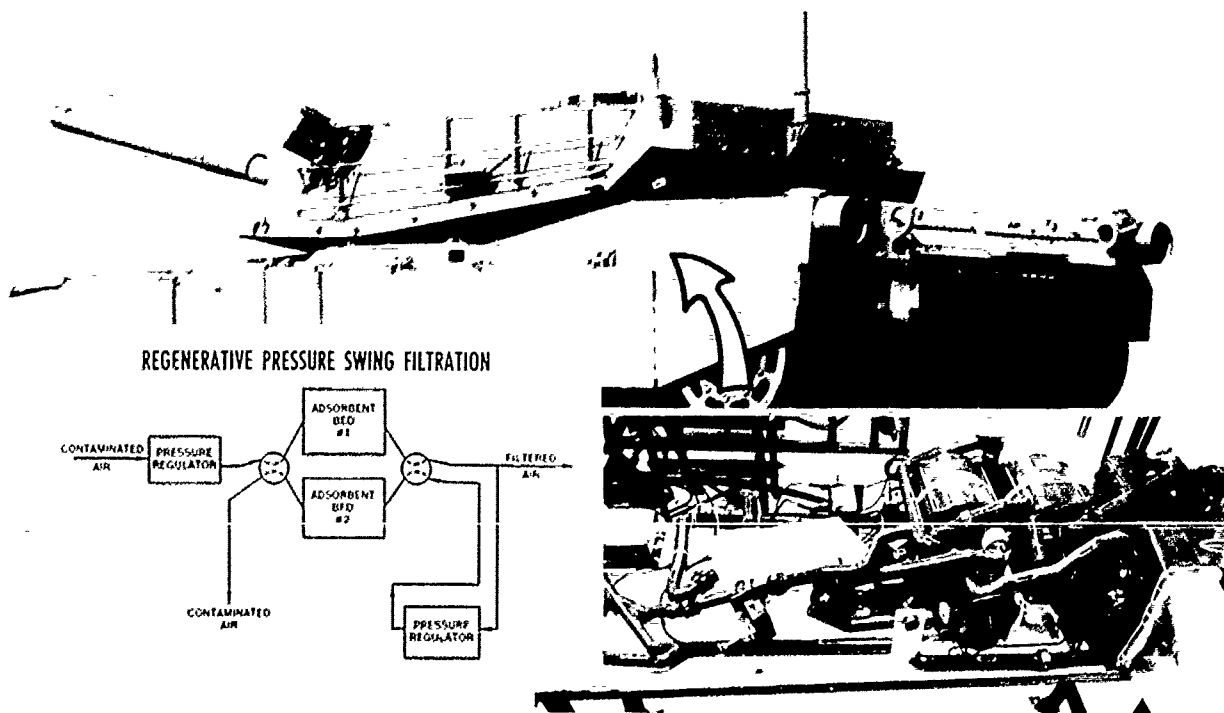
The U.S. Army Chemical Research, Development and Engineering Center (CRDEC) is conducting a program in advanced air filtration technology in support of the U.S. Army Tank Automotive Command's (TACOM) Armored Systems Modernization (ASM) Program. The CRDEC effort provides a unique opportunity for the armored combat system community to explore the potential of regenerative filtration for collective protection equipment.

The regenerative pressure swing adsorption (PSA) equipment for collective protection is based on a two-sorbent bed system where contaminated air is filtered in one sorbent bed under high pressure. A portion of the filtered air is then diverted to the second sorbent bed for purging contaminants. By alternating the airflow process through switching valves, continuous filtered air is provided to a combat system.

The CRDEC effort is to acquire isotherm and multicomponent isotherm data under various parametric conditions. This data will be used to develop an engineering design mathematical model that will be used for evaluation and/or design of PSA filtration equipment. PSA prototypes will be designed and tested to validate the mathematical model.



For additional information, contact:  
Commander, U.S. Army Chemical Research, Development  
and Engineering Center  
Attn: SMCCR-PPC, Mr. Josiah T. Mok  
Aberdeen Proving Ground, MD 21010-5423  
DSN 584-5691 or (301) 671-5691





## U.S. Army Aviation Systems Command

### Expert System Diagnostics

To combat such aircraft maintenance problems as poor troubleshooting techniques, excessive false removal rates, and increased skill level requirements due to increased system complexity, the Aviation Applied Technology Directorate of the Aviation Systems Command has developed a number of expert systems for diagnostics:

The Pi diagnostic system is a knowledge-based system for fault isolation of the CH-47D Chinook flight control system. It is programmed in "C" language and is hosted on a portable maintenance computer. Used at the AVUM level, Pi is operated with a minimum of keystrokes. It recommends calibrations, adjustments and component replacements to correct aircraft problems. Test flights can be reduced by 50%.

The Intelligent Fault Locator (IFL) uses expert system techniques to fault locate problems encountered on the AH-64A Apache helicopter. It is a diagnostic program for the flight line technician. IFL is capable of systematically, accurately, and rapidly troubleshooting selected subsystems. Although written in "LISP" development language, re-coding in "C" will allow the IFL to be hosted on a portable maintenance aid such as the Contact Test Set. Results have shown a 48% improvement in fault location time with 98% accuracy.

The Pi diagnostic system can be operated with a minimum number of key strokes, employing a menu driven user interface



The IFL is intended to improve fault location problems currently encountered on the AH-64A Apache helicopters



For additional information, contact:  
Commander, Aviation Applied Technology Directorate  
U.S. Army Aviation Systems Command  
Attn: SAVRTTY-ASR, John F. Tansey  
Fort Eustis, VA 23604-5577  
AV 927-5620 or (804) 878-5620



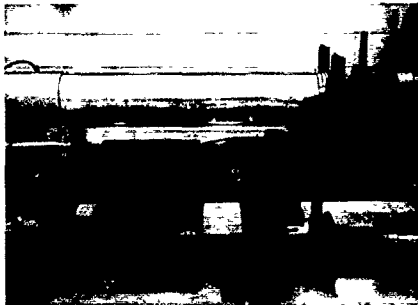
U.S. Army Armament Munitions and Chemical Command

## Advanced Tank Cannon (ATAC) System

**XM291 Gun.** The Advanced Tank Cannon (ATAC) System consists of the XM291 Gun, the XM91 Autoloading system, and a family of 140mm ammunition. The XM291 Gun is a solid propellant tank cannon with an integral mount and recoil mechanism, fires two-piece 140mm ammunition with twice the muzzle energy of the standard 120mm M256 Gun. By means of a simple tube change, the system can also fire one-piece conventional and advanced 120mm ammunition.

**XM91 Autoloading System.** During operation of the XM91 Autoloading System, the selected ammunition type is identified, the telescoped cell containing that cartridge is moved to the loading port, and the loading door is opened. The rammer mechanism then moves forward and grasps the rim of the stub base, the round gripper mechanism which holds the cartridge in place is released, and the inner cell moves forward. Docking of the inner cell with the breech occurs on full extension and the round is seated into the gun. The ram head and the inner cell then retract to their original position and the loading door is closed. The down loading sequence is similar. A rear port is provided at the rear of the autoloader for that procedure.

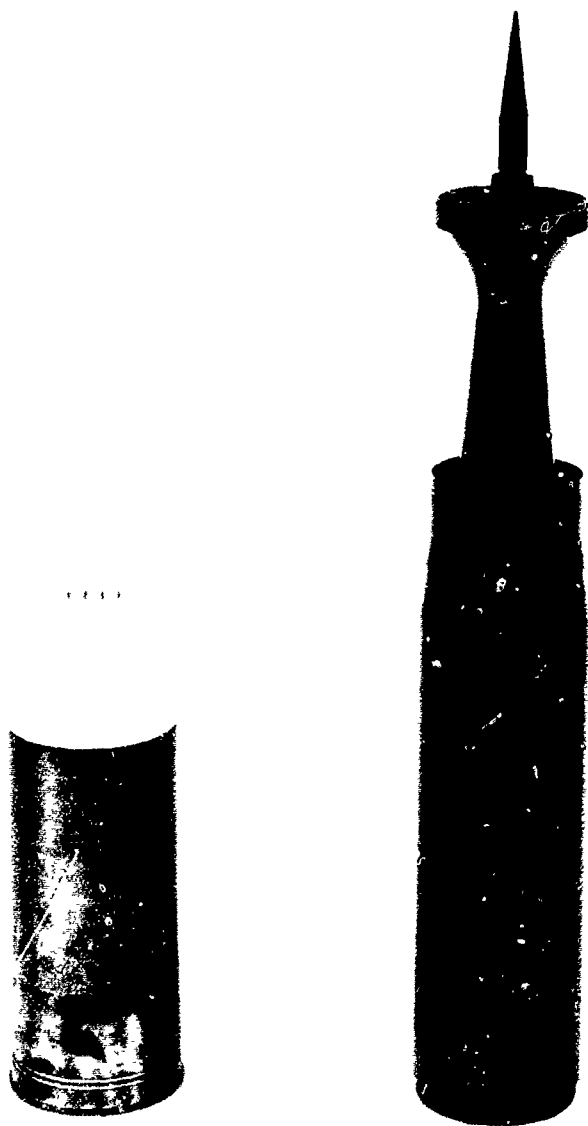
The XM91 Autoloader offers automatic loading, downloading, and rearming functions.



XM291 gun fires both 120mm and 140mm ammunition by way of a simple tube change.

**The ATAC System Family of 140mm Ammunition.** The ATAC 140mm family of ammunition consists of three cartridges: a Kinetic Energy Cartridge, a Chemical Energy Cartridge and a Training Cartridge for both combat rounds. Each cartridge consists of a forward and a rear component. The rear component, which is identical for all three cartridges, consists of a stub base and primer assembly (similar to that of a standard 120mm cartridge), a combustible side wall, an ignition system, and propellant. The forward component houses the appropriate projectile and propellant in a combustible cartridge case. The case also contains a relay charge at its base for transfer of ignition from the rear component. A snap joint joins the two components, allowing cartridge removal from the breech. These cartridges offer a muzzle energy that is double that of the standard 120mm system.

The ATAC System family of 140mm ammunition offers muzzle energy double that of the standard 120mm system



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For additional information, contact:  
Project Manager for Tank Main Armament Systems  
ARDEC  
Attn: SFAE-AR-TMA-AT, Ted Riddle  
Picatinny Arsenal, NJ 07806-500G  
DSN 880-6746





**U.S. Army Communications-Electronics Command**

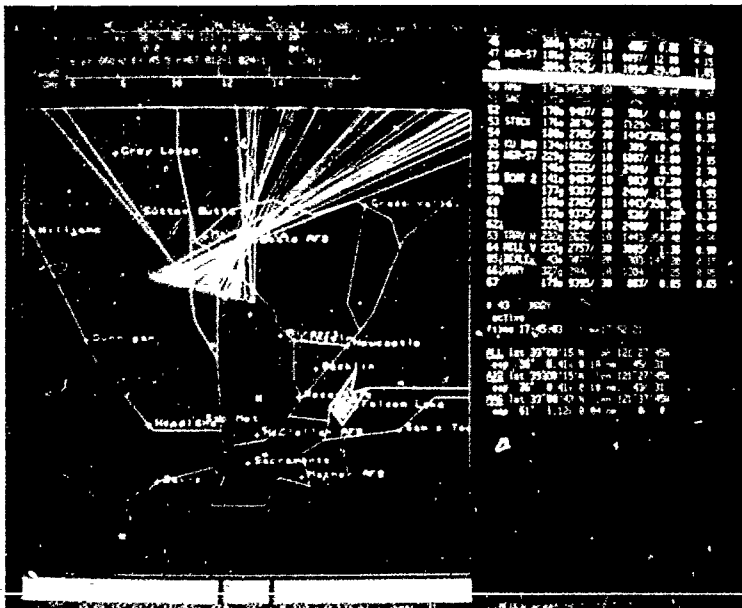
**Miniaturized Electronic Support Measures/  
Electronic Intelligence Direction-Finding  
Location and Intercept (MEDFLI) System**

The MEDFLI is a laboratory test bed consisting of microwave and millimeter wave direction-finding receivers and antennae along with a high speed signal processor called the Modular Adaptive Signal Sorter (MASS). The purpose of the MEDFLI test bed is to develop state-of-the-art tactical Electronic Support Measures/Electronic Intelligence (ESM/ELINT) technology, and to demonstrate these capabilities for both airborne and ground collection applications.

The MEDFLI itself intercepts radar signals, characterizes and identifies them, and provides the locations of the emitters in real-time. This technology can then be transitioned to advanced development applications for unmanned aerial vehicles, ground-based common sensors or helicopter payloads.

The MEDFLI system consists of the MEDFLI ESM/ELINT test bed, the radar measurement set (RMS-4), and the ELINT analysis work station.

The MEDFLI test bed is designed to demonstrate state-of-the-art tactical ESM/ELINT technology for both airborne and ground collection applications. Below: MEDFLI display shows parametric data, lines of bearing (LOB), and geolocations of intercepted emitters. Right: MEDFLI ground station and UAV.



For additional information, contact:  
Commander, U.S. Army Communications-Electronics  
Command Center for EW/RSTA  
Attn. AMSEL-RD-EW-TS, Dr. Frank Elmer  
Fort Monmouth, NJ 07753  
DSN 995-3201 or (201) 544-3201



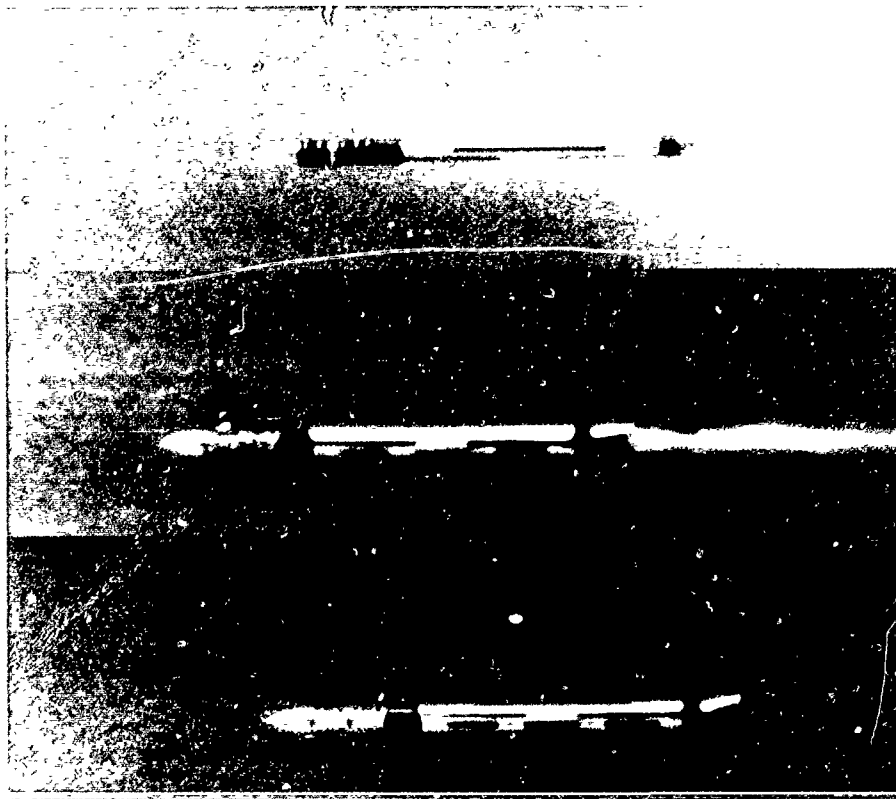
**U.S. Army Missile Command**

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## **Hypervelocity Rocket/Close-In Air Defense (CIAD)**

The CIAD Technology Demonstration Program played a major role in the introduction of hypervelocity rocket and multi-penetrator, kinetic energy warhead technology to defeat lightly armored targets using a shotgun concept. The objective of this program was to demonstrate the effectiveness of small, low cost, unguided, hypervelocity rockets with nonexplosive, multi-penetrator warheads against targets such as helicopters or armored personnel carriers. Unguided rockets are an effective alternative to more complex, expensive guided missile systems and have several advantages such as lower system weight, greater range, and higher firing rate compared to gun systems. Several multi-penetrator warheads were developed and extensively tested for the anti-armor and air defense roles. All warhead designs use a unique inertial arm and penetrator release device which eliminate the need for any timing or pyrotechnic device.

A successful flight test program was conducted with several warhead configurations against ground and aerial targets to determine rocket accuracy, warhead performance, and penetration effects.



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For additional information, contact:  
Commander, U.S. Army Missile Command  
Attn: AMSMI-RD-SS-SD, James R. Burt, Jr.  
Huntsville, Alabama 35898-5252  
AV 746-7231 or (205) 876-7231



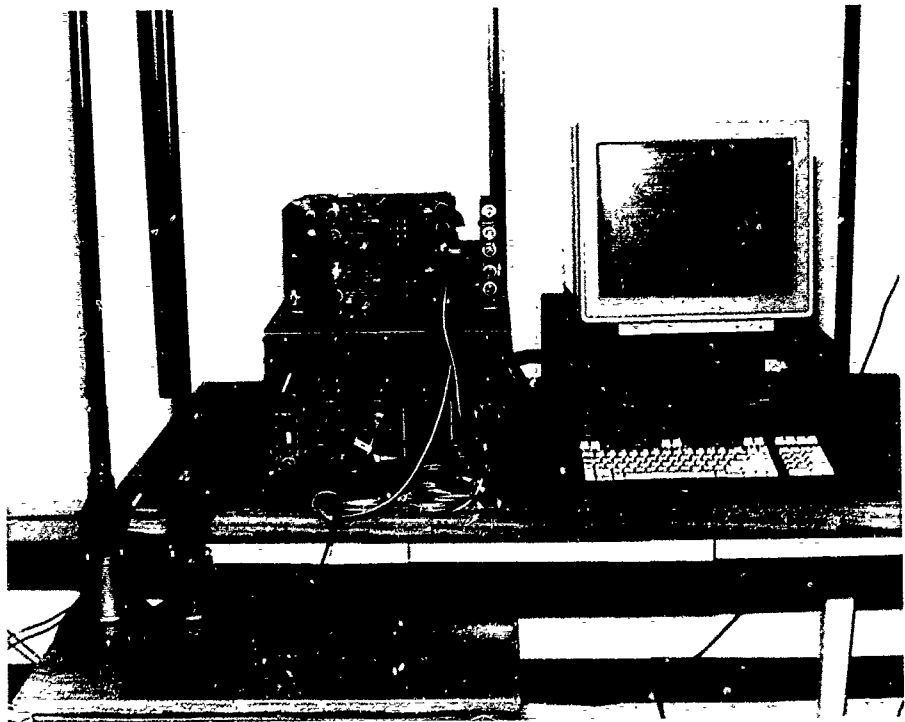
## U.S. Army Communications-Electronics Command

### Combat Vehicle Command and Control (CVC<sup>2</sup>)

Combat Vehicle Command and Control (CVC<sup>2</sup>) is a joint research and development program undertaken by the United States and the Federal Republic of Germany to demonstrate the technology for a fully automated, integrated, and interoperable lower echelon command, control, and communications (C<sup>3</sup>) system for ground combat vehicles.

The CVC<sup>2</sup> program emphasizes developing this C<sup>3</sup> system for American and West German main battle tanks, and will give vehicle commanders real-time tactical displays and other data-linked information providing maps of friendly and enemy locations, logistics data, diagnostics, and prognostics. This system significantly enhances battlefield integration and synchronizes maneuver force elements from the individual combat vehicle up to and including the battalion level. Further armor specific tactical data messages will be transmitted among terminals over the Single Channel Ground-to-Air System (SINCGARS) combat radio network.

The CVC<sup>2</sup> node hardware includes two SINCGARS radios, an adaptable program interface unit (APIU), a transportable computer unit (TCU), and a monitor. The APIU, TCU, and monitor are common hardware items, the SINCGARS is presently in production.



For additional information, contact:  
Commander, U.S. Army Communications-Electronics  
Command Center for C<sup>3</sup>  
Attn: AMSEL-RD-C<sup>3</sup>, John Basarab  
Fort Monmouth, NJ 07753  
DSN 995-3789 or (201) 994-3789



U.S. Army Armament, Munitions, and Chemical Command

## Laser Standoff Chemical Detector



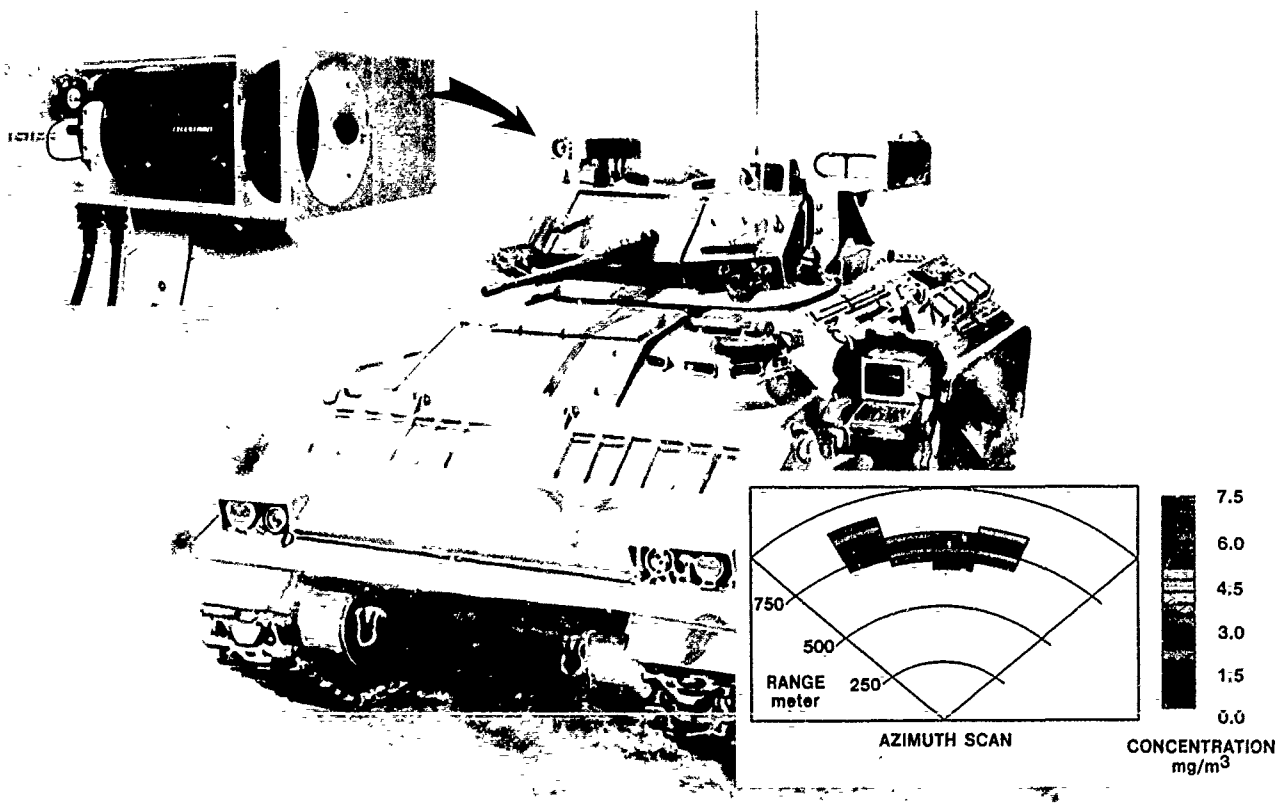
For additional information, contact:  
 Attn: Commander, U.S. Army Chemical Research,  
 Development and Engineering Center  
 SMCCR-RSP, Dr Silvio L. Emery  
 Aberdeen Proving Ground, MD 21010 5423  
 DSN 584-2437 or (301) 671-2437

A chemical detector using lasers can remotely detect chemicals at distance and provide a map describing the concentration distribution over the path traversed by the laser light. This technology, LIDAR (Light Detection And Ranging) requires several different laser wavelengths, depending on the chemical of interest. Previous systems required multiple lasers, which made the systems large, complex, heavy, and expensive. Advances in laser technology have made it possible for a single laser to rapidly produce multiple wavelengths. The U.S. Army Chemical Research, Development, Engineering Center (CRDEC) is sponsoring the development of this technology and has a working prototype, which has been integrated into a complete LIDAR system. The system is installed in a vehicle and can be moved to any test site.

The laser standoff chemical detector is suitable for the chemical warfare reconnaissance mission. Capabilities of this LIDAR system include the following:

- Detection of chemical vapors and aerosols in the atmosphere
- Detection of chemical contamination on surfaces
- Ranging and mapping of chemical concentrations

This system also has civilian applications, such as environmental monitoring and chemical accident detection/mapping.



Using technology sponsored by CRDEC, the Standoff Chemical Detector provides both a map and a concentration distribution of chemicals.



## U.S. Army Tank-Automotive Command

# Standardized Army VETRONICS Architecture (SAVA)

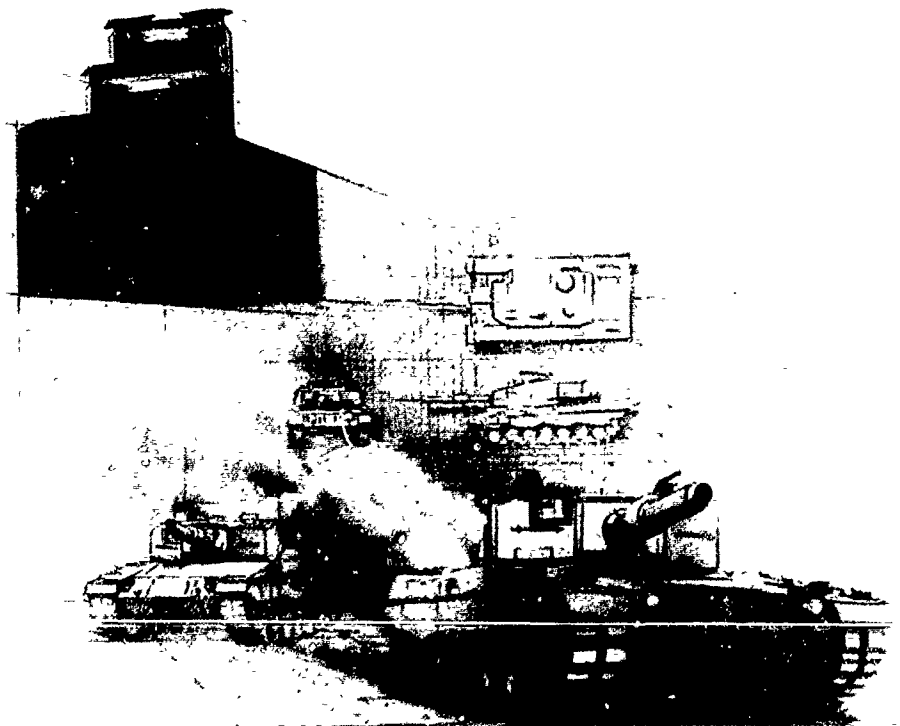
The Standard Army VETRONICS Architecture (SAVA) represents a highly modular building block electronic vehicle integration architecture which will provide for intra-vehicle communications, enabling vehicle subsystems to communicate with each other and with the crew. The SAVA provides four globally shared functions common to all vehicle subsystems:

- Data Distribution and Control
- Power Distribution and Control
- Computer Resources
- Crew Interfaces (Controls/Displays)

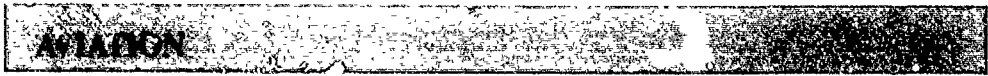
The four shared functions are provided by a set of Common/Standard Modules (plug-in Printed Circuit Boards (PCBs)); Standard Stations (boxes into which the PCBs are plugged); and Standard Station-to-Station Wiring (contains Power and Data Buses).

The SAVA allows vehicle subsystems and mission subsystems (such as Battlefield Management System and Fire Control) to communicate with each other over power and data buses. Modular design enables mission-specific reconfiguration and easy incorporation of new generation subsystems.

Standard Army VETRONICS Architecture (SAVA) provides a highly modular approach to intra-vehicle subsystem communications



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Commander  
U.S. Army Tank-Automotive Command  
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Warren, MI 48397-5000  
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## U.S. Army Aviation Systems Command

### Avionics Integration



The battalion planner provides efficient updating of threat and intelligence data, and transfers digital map data to the aircraft.

The U.S. Army Avionics Research and Development Activity (AVRADA), part of the Aviation Systems Command (AVSCOM), is involved in avionic integration to ensure that the soldier in the field is supported by the most modern combat-capable aviation force in the world. AVRADA's System Testbed for Avionic-Research (STAR), an NUH-60 modified Black Hawk helicopter, is a major tool for testing and integrating non-developmental items (NDI) and prototype avionic devices. Hardware and software for advanced avionic architectures, as well as sophisticated controls and displays, are being developed and integrated using advanced cockpit automation techniques. The STAR is currently being instrumented to demonstrate the tri-service Integrated Communications, Navigation, and Identification Avionics (ICNIA) system.

AVRADA has already demonstrated that voice can be effectively used to control radio, navigation, and other cockpit functions. Voice Interactive Avionics (VIA) are intended to assist in all command and control functions, thus reducing the pilot's workload and increasing operational effectiveness.

Automated mission planning, which provides quick response to the battlefield environment, is also an essential part of a modern avionic suite. The company-level avionics mission planning system (CLAMPS) provides the pilot and aircraft systems with updated mission parameters and a knee board formatted card for time, distance, and heading. The battalion planner provides timely updating of threat and intelligence data, as well as transfer of digital map data to the aircraft.

AVRADA's efforts in avionic integration play a major role in national defense through skill and insight. These efforts continue to be part of the dramatic electronics technology explosion.

The STAR uses a modified Black Hawk helicopter, like this one, for testing and integrating prototype avionics devices.



For additional information, contact:  
US Army Avionics Research and Development Activity  
Attn: SAVAA-P, Bobbi Campbell  
Fort Monmouth, NJ 07703-5401  
AV 995-2781 or (201) 544-2781



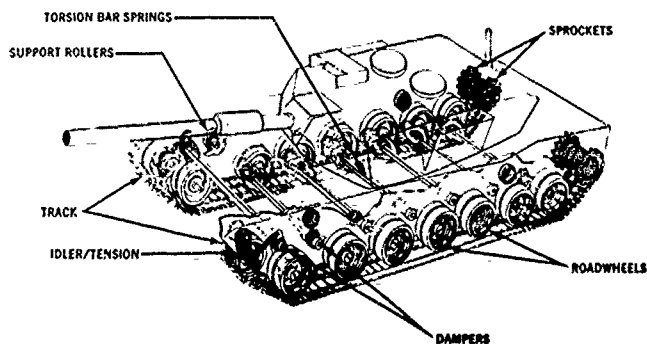
## U.S. Army Tank-Automotive Command

### Combat Vehicle Suspension Technology

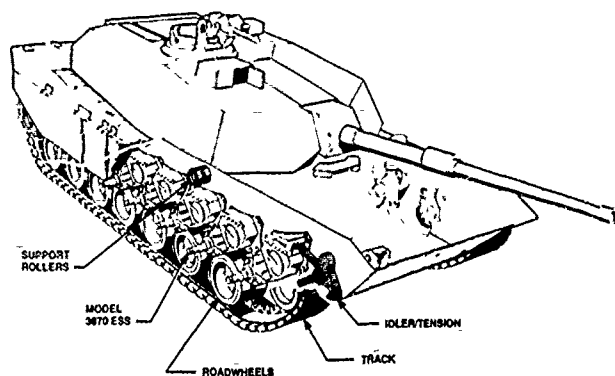
As an example of state-of-the-art combat vehicle suspension technology, the External Suspension System provides all suspension components and functions exterior to the heavy weight vehicle hull. The system provides the ability to be tuned for optimum vehicle springing and damping for all gross vehicle weights (GVW) within the heavy weight class (45-70 tons). The suspension system has the capability to have height control and lockout installed on an optional basis as vehicle mission requires. Features and benefits of the External Suspension System include:

- Modular design (fewer parts)
- Optimum spring and damping
- Weight class commonality
- Ability to install vehicle height control and suspension lockout
- Weight savings over torsion bar
- Reduced suspension system weight (1500 lbs.)
- Eliminate internal hull space claim (17 cu. ft.)
- Lower vehicle silhouette (5 inches)
- Improved roadwheel and track life (10%)
- Reduced suspension life cycle O&S cost (10-25%)
- Vehicle weight class commonality (optimized for all 45-70 ton GVW vehicles)

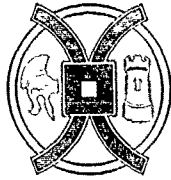
For additional information, contact:  
Commander, U.S. Army Tank-Automotive Command  
Attn: AMSTA-RTS, Mr Mike Whitmore  
Warren, MI 48397-5000  
AV 786-8687 or (313) 574-8687



The heavy weight vehicle suspension system occupies a considerable amount of volume because of its torsion bar rotary damper design.



The External Suspension System offers weight savings, a modular design, and an increase of usable volume under armor.



## U.S. Army Troop Support Command

### The Soldier System

The Soldier System represents the effective integration of the individual soldier with materiel, operations, training, environment, and leadership. The Natick Research, Development, and Engineering Center is the lead organization for developing the Soldier System.

The Soldier System consists of all items/equipment worn, carried, or consumed by the soldier in the field, and all external controllable factors that affect how well a soldier performs his mission. The major components of the system are food, clothing and protective equipment, shelters, weapons, and communications devices.

The goal of treating the soldier as a system is to enhance individual and unit effectiveness and survivability. The soldier will be considered for the first time using a total system approach based on mission performance requirements and logistics support constraints. Any item to be added to the Soldier System will be considered and weighed against the total system.

#### IMPROVED COMBAT EFFECTIVENESS

- Individual Weapons  
(Ammunition, Grenades,  
Sighting)
- Communications Equipment
- Load-Carrying Equipment
- Shelters
- Training
- Optical Devices/Eye  
Protection
- Aural Protection
- Soldier-Carried Missiles
- Airdrop
- Masks
- Food and Water
- Clothing, Life Support and  
Equipment



For additional information, contact  
U.S. Army Natick Research, Development and  
Engineering Center  
Attn: STRNC-AS, Cpt David T. Yancey  
Natick, MA 01760-5000  
DSN 256-5543 or (508) 651-5543



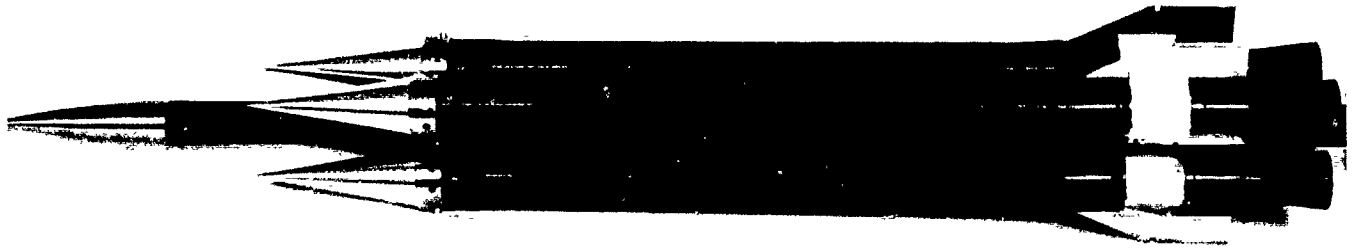


**U.S. Army Missile Command**

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## **Advanced Kinetic Energy Missile (ADKEM)**

The Advanced Kinetic Energy Missile (ADKEM) is a multi-mission, multi-platform kinetic energy missile. It can attack and destroy tanks and aircraft (both rotary and fixed wing); it can be launched from light and heavy platforms such as helicopters and tanks. The ADKEM is designed to at least double the effectiveness of current launch platforms equipped with current armament. ADKEM significantly increases the survivability of these platforms by permitting them to remain almost totally concealed (crew-safe defilade), while attacking the target at Mach 6 velocity with a very lethal kinetic energy penetrator. The missile can also be modified to carry an explosive, fragmenting warhead.



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**For additional information, contact:**  
Commander, U.S. Army Missile Command  
Attn: AMSM-RD-ST-WF, Steve Cornelius  
Redstone Arsenal, Alabama 35898  
AV 788-0326 or (205) 842-0326

The Advanced Kinetic Energy Missile (ADKEM) can attack and destroy either ground or air (rotary or fixed wing) targets when launched from either surface (armored or light truck) or air (helicopters) platforms.

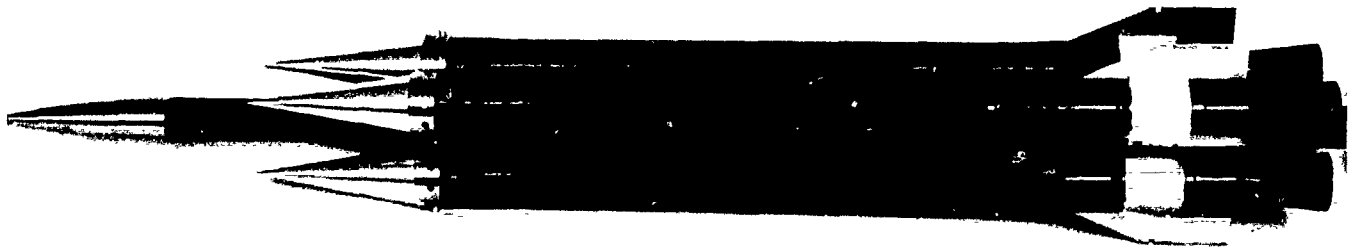


**U.S. Army Missile Command**

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For additional information, contact:  
Commander, U.S. Army Missile Command  
Attn: AMSMI-RD-ST-WF, Steve Cornelius  
Redstone Arsenal, Alabama 35898  
AV 788-0326 or (205) 842-0326

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ARMORED SYSTEMS

U.S. Army Troop Support Command

## Microclimate Cooling System

The Microclimate Cooling System is an electric-powered cooling and heating system complete with M48 nuclear, biological, and chemical (NBC) filtration. The unit was designed for use in armored vehicles. Its primary function is to provide cooled air for crew members operating in NBC environments where they must wear Mission-Oriented Protective Posture (MOPP) gear. The cooling unit is used with a ventilated facepiece, which provides pure breathing air, and a cooling vest, which distributes cooled air to the crewmember's torso area. In operation, the system can provide 36 cubic feet of air per minute at a temperature of 60 degrees Fahrenheit. The unit is 20 inches wide, 29½ inches high, 17½ inches deep, and weighs 200 pounds.



For additional information, contact:  
Commander, US Army Belvoir RD&E Center  
Attn: STRBE-FED  
Ft. Belvoir, VA 22060-5606  
AV 354-6031 or (703) 664-6031



U.S. Army Troop Support Command

## Enhanced Protection for Countermining Operations: Light Forces Protective Equipment for Low Intensity Conflict

The Body Armor System, Individual Countermining Set consists of anti-fragmentation trousers, mine blast overboots, and ballistic goggles used in connection with the standard Personal Armor System for Ground Troops (PASGT) helmet and vest. The trousers, which weigh seven pounds, contain 13 layers of Kevlar ballistic material, which is effective against low velocity fragments and blast. The one and one-half pound overboots are an anti-blast design using "V" shaped inserts in the soles. Currently, Center experts are studying the possibility of adding a Kevlar lining to the insoles. The Kevlar lining would add an additional three ounces to the weight of each overboot. Goggles for the system are ballistic clear polycarbonate. They provide protection from low velocity fragments up to five grains in size, traveling up to 700 feet per second.

The basic set provides additional antipersonnel ballistics protection beyond the standard PASGT helmet and vest for personnel involved in dismounted countermining operations. The set significantly upgrades protection for the individual with a minimum effect on his mobility. In operation, it would be used by soldiers engaged in mine detection and neutralization operations.



For additional information, contact:  
Commander, U.S. Army Belvoir RD&E Center  
Attn: STRBE-NA  
Ft. Belvoir, VA 22060-5606  
AV 354-5577 or (703) 664-5577  
or  
Natick RD&E Center  
Attn: STRNC-ICAA  
AV 256-5449 or (508) 651-5449



## U.S. Army Armament, Munitions and Chemical Command

### Smoke Effects

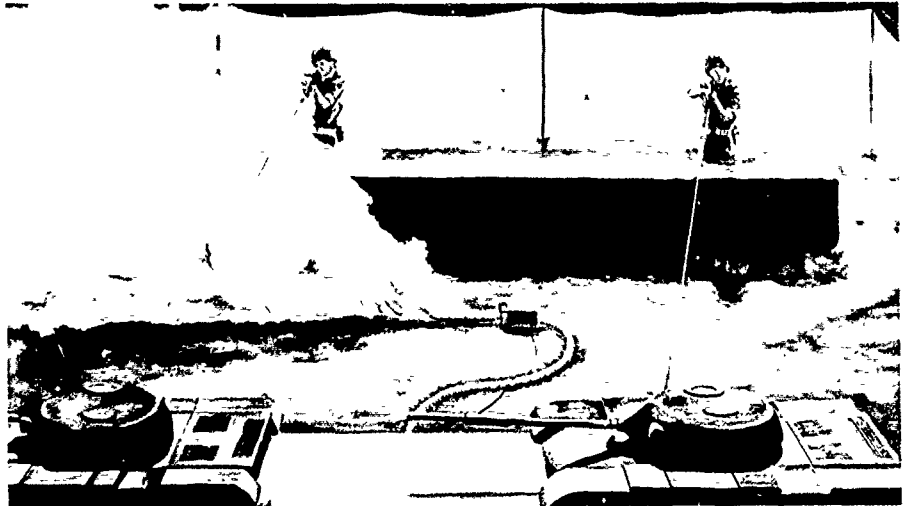
Smoke deliberately used as an obscurant on the battlefield is one of the most ancient battle tactics. Recorded use of smoke as a visual cloak dates to the Peloponnesian Wars (circa 431-404 B.C.). There are various ways that smoke can be used during military operations. Camouflage smoke prevents enemy surveillance of maneuvers by covering friendly forces; blinding smoke surrounds enemy positions, limiting their range of vision; and decoy smoke confuses and misleads enemy forces by disguising one's true position.

Such a traditional asset as smoke has been subjected to several "high tech twists." The entire chain of electro-optical, infrared, and millimeter wave devices linking a weapon to a target is susceptible to new types of smoke. Smoke can provide effective countermeasures to these devices.

Smoke can provide battlefield obscurants which effectively counter the operation of electro-optical, infrared, and millimeter wave devices



For additional information, contact  
 Commander, U.S. Army Chemical Research, Development  
 and Engineering Center  
 Attn: SMCCR-MUS-A Mr Paul Schabdach  
 Aberdeen Proving Ground, MD 21010-5423  
 DSN 584-2325 or (301) 671-2325





AVIATION

U.S. Army Aviation Systems Command

## Multipurpose Small Power Unit Program

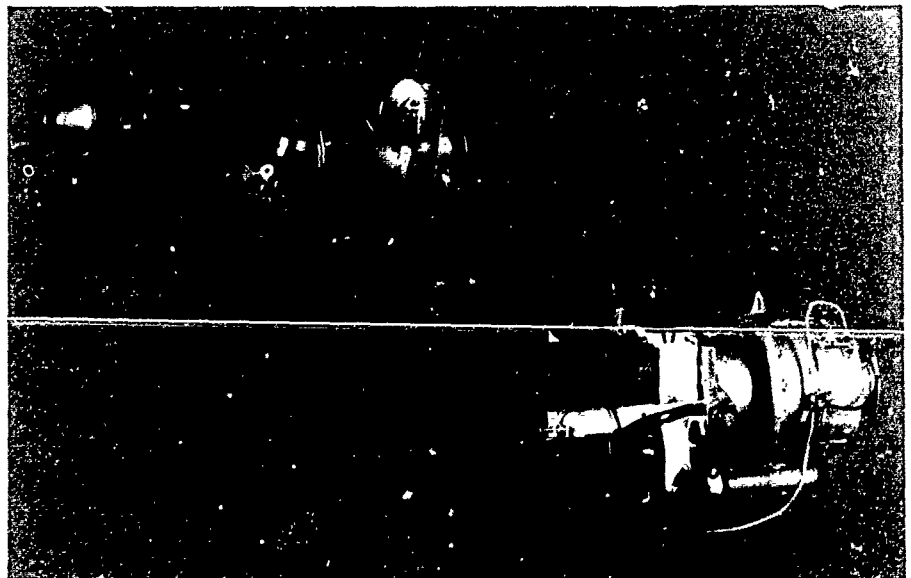
The Multipurpose Small Power Unit (MPSPU) four-year demonstrator engine program features competitive contracts awarded in June of 1986 to validate advanced gas turbine engine technology in the 50- to 120-horsepower class for Auxiliary Power Units (APUs). MPSPU technology will enhance the APU option for the light helicopter and for armored systems modernization.

Program goals are to significantly increase performance and improve reliability over current small power units, to validate the concept of family power units derived from a baseline 50-horsepower unit, and to reduce development and production costs of future small gas turbine engines. The MPSPU program will reduce time and risk of small gas turbine engine full-scale development for a variety of primary and secondary power applications, including aircraft, armored vehicles, shelters, missiles, and unmanned aerial vehicles.

The MPSPU basic program includes testing to measure noise, exhaust emissions, and contingency power. The basic program requires demonstrations of user and depot level maintainability, limited durability, successful starts on interchangeable electric and hydraulic starting systems, and starts on cold fuel. A special sand ingestion test and demonstration of power section weight are also required.

An enhanced program funded by the light helicopter project was added to the basic MPSPU contracts to improve the viability of this technology for light helicopter secondary power. The enhanced program includes secondary power system analyses of each light helicopter candidate airframe based on MPSPU technology. The enhancement requires delivery to the government of two modified power units under each contract, followed by extended durability and minimum energy start testing by the contractors.

The MPSPU program is a competitive program aimed at developing advanced auxiliary power units for army aircraft, armored systems, vehicles, shelters and missile systems



For additional information, contact:  
Aviation Applied Technology Directorate  
Attn: SAVRTTY-ATP, M. L. Pederson  
Ft. Eustis, VA 23604-5577  
AV 927-2771 or (804) 878-2771



## U.S. Army Armament, Munitions and Chemical Command

### Remote Smoke System



For additional information, contact:  
Commander, U.S. Army Chemical Research, Development  
and Engineering Center  
Attn: SMCCR-MUS-A, Mr. Paul Schabdach  
Aberdeen Proving Ground (EA), MD 21010-5423  
AV 584-2325 or (301) 671-2325

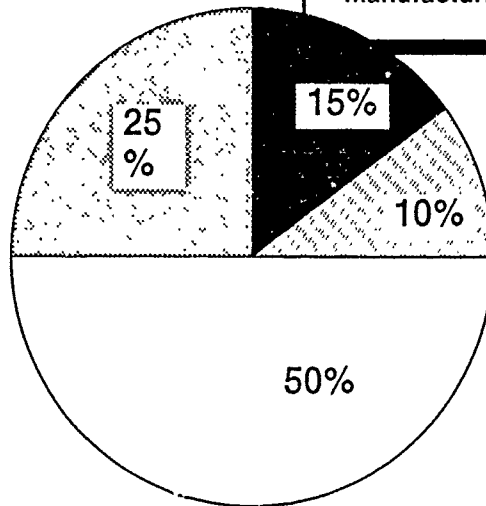
The Human Engineering Laboratory (HEL) conducts the Soldier Robot Interface Program (SRIP). This program explores the use of fiber optics and compressed video systems for visual guidance of remote vehicles, and their effect on the human operator. The HEL activities provide a unique opportunity for the smoke/obscurant community to explore and develop prototype remote smoke systems to interface with robotic vehicles already under test and evaluation.

The U.S. Army Chemical Research, Development and Engineering Center (CRDEC) has developed a remote smoke system using the basic design of the commercially available remote control devices that parallels the onboard controls. This remote system covers a five-mile radius and is able to generate visible screening smoke for a maximum of one-half hour. This program serves as a test bed for second generation systems employing infrared and millimeter wave screening capabilities.



## SYSTEMIC ISSUES

- Soldier-Oriented Research and Development
- Chemical and Biological Defense
- Nuclear Survivability
- Logistics Research and Development
- Software Process Development
- Insensitive Munitions
- Installation Infrastructure Technology
- Environmental Quality Technology
- Operation & Support Cost Reduction
- Terrain, Weather, and Atmospheric Effects
- Manufacturing Technology





## LIGHT FORCES



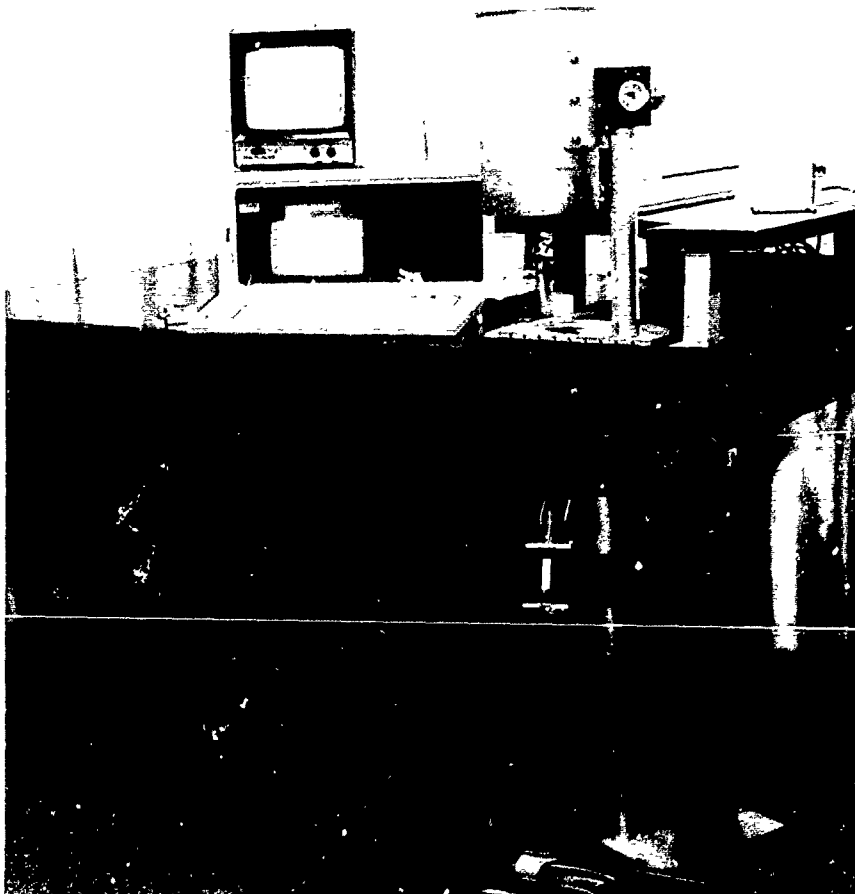
U.S. Army Laboratory Command

### Fluorescent Target Detection System

The Atmospheric Sciences Laboratory (ASL) has developed the Fluorescent Target Detection (FTD) System, which utilizes laser-induced fluorescence to detect ground-based military materials. The FTD System has also shown the potential for detecting chemical substances. The FTD System uses a nitrogen laser and an intensified video camera to scan targets which are not detectable with infrared or visual methods. It includes a computer software package for image processing. The system can be either aircraft-mounted, vehicle-mounted, or carried by the soldier.

The FTD system can indicate the presence of:

- Chemical Contaminated surfaces
- Mines and Explosives
- Weapons and Motorized Equipment.



The FTD System scans and enhances targets imperceptible to infrared or visual methods



For additional information, contact:  
U.S. Army Atmospheric Sciences Laboratory  
Attn: SLCAS-AR, Ms. Jill Thompson  
White Sands Missile Range, NM 88002-5501  
AV 258-2434 or (505) 678-2434

## SOLDIER SUPPORT



U.S. Army Laboratory Command

### Nuclear Simulation Radiation Facilities

**AURORA**—The Aurora Pulsed Radiation Facility, the world's largest gamma ray simulator, provides simulated nuclear radiation and high-power microwave environments for testing the survivability of both tactical and strategic hardened military electronic systems. Aurora's versatility has been shown by the variety of systems it has tested, from the guidance and control system of the Peacekeeper missile to the M-109 Howitzer (nuclear projectile launcher) to the M-1 tank. Moreover, this facility lessens the dependence of materiel developers on the use of underground nuclear testing.

The unique features of the facility include production of high-intensity X-rays, electron-dense environments (for Source Region electromagnetic pulse simulation), and the production of high-power microwaves.

Aurora was the recipient of the 1989 Secretary of Defense Productivity Excellence Award.

Simulated environments such as those produced by the Aurora Pulsed Radiation Facility decrease the cost of determining transient radiation effects on military electronic systems.



For additional information on AURORA, contact  
Director U.S. Army Harry Diamond Laboratories  
Attn: SLCHD-NW RS, Mark Caruso  
2800 Powder Mill Road  
Adelphi, MD 20783 1197  
DNS 290-2290 or (301) 394-2290

**HIFX FLASH X-RAY FACILITY**—Electronic components and small electronic systems can be tested for radiation effects at the HIFX Flash X-Ray Facility, a three-part, five-megavolt Van de Graaff machine which can produce up to 2.5 kilojoules of total stored energy in a pulse width of approximately 25 nanoseconds. HIFX can be configured for two modes of operation, positive or negative polarity, with a dose up to 60 kiloRads. Each shot can be reproduced within a ten percent reliability factor 12 times per hour.

The HIFX facility also provides the customer with a state-of-the-art data acquisition system for taking measurements during radiation tests. The data acquisition system includes computer-controlled 1 Giga-sample/second transient digitizers and dual-beam oscilloscopes. The facility also provides dosimetry analysis and, when necessary, computer analysis of each shot.

**COBALT-60 RADIATION SOURCE FACILITY**—The Cobalt-60 (Co-60) Radiation Source Facility offers the customer several possibilities for radiation effects testing. Two workbenches in the exposure room are available for setting up tests, while two tables in the control room accommodate instrumentation to monitor the object being tested during the time of radiation exposure.

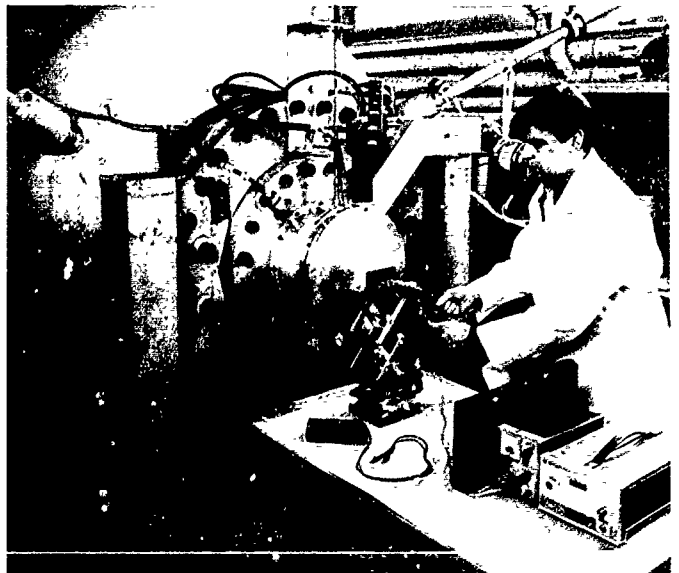
Three distinct radiation sources, "A," "B," and the air source, can be used independently of each other. A and B are used for testing small objects which are placed in a watertight exposure can, lowered into a 12-foot-deep pool, and exposed to radiation sources for a predetermined amount of time. The radiation sources are doubly-encapsulated cobalt-60 source pencils placed in a holder.

Larger test objects are exposed in air using the third radiation source, raised from the bottom of the pool by an elevator. To control the exposure rate, the test object can be placed a predetermined distance from the source.

Co-60 facility for radiation source testing.



HIFX facility tests electronic components for radiation effects.



For additional information on HIFX or Cobalt 60, contact:

Director, U.S. Army Harry Diamond Laboratories  
Attn: SLCHD-NW-RS, Marc Litz or Bill Lilley  
2800 Powder Mill Road  
Adelphi, MD 20783-1197  
DNS 290-2238 or (301) 394-2238



## SOLDIER SUPPORT



U.S. Army Medical Research and Development Command

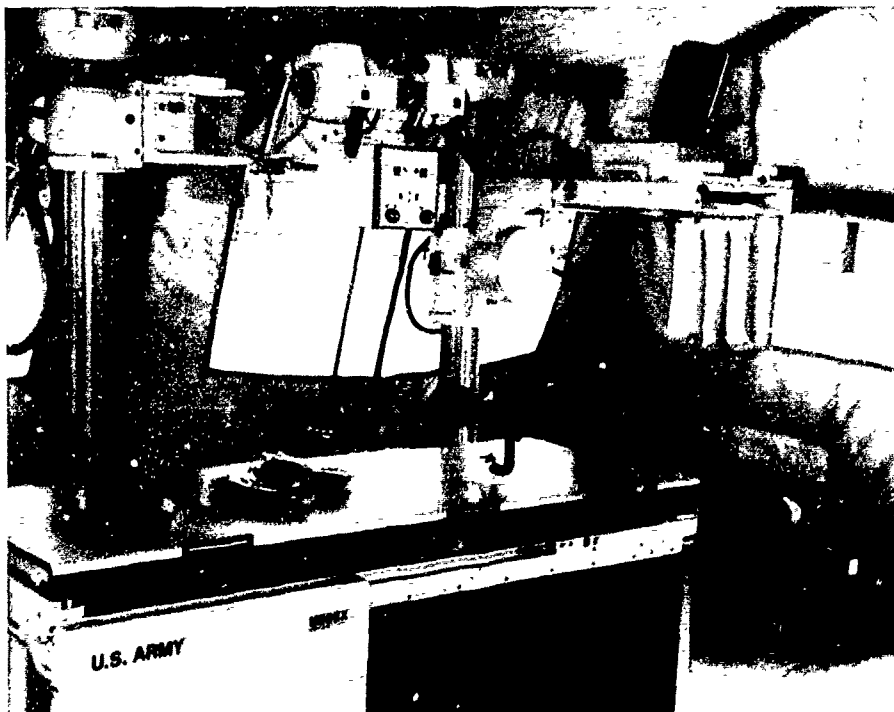
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### Military Field Radiographic and Fluoroscopic System

The Military Field Radiographic and Fluoroscopic System provides high quality radiographic and fluoroscopic images in battlefield conditions. This state-of-the art diagnostic tool has remarkable utility under wartime conditions. The system:

- Can be set up in less than two hours
- Requires no tools to assemble/disassemble
- Is adaptable to any field situation
- Uses X-ray film that can be handled in daylight
- Can be operated automatically and manually
- Has self-diagnosis capability, ensuring easy maintenance
- Fully complies with U.S. Food and Drug Administration regulations, even when operated from poorly regulated field power sources
- Is easy to move. Each component can be handled by a single soldier.

The Military Field Radiographic and Fluoroscopic System is a state-of-the-art diagnostic tool. It is easy to move, can be set up in less than two hours, and the X-ray film can be handled in daylight.



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For additional information, contact:  
Commander, Medical Materiel  
Development Activity  
Attn: SGRD-UMS, Maj. Warren Heineman  
Fort Detrick, MD 21702-5009  
AV 343-7584 or (301) 663-7584



## ARMORED SYSTEMS

**U.S. Army Armament Munitions and Chemical Command**

### **Ammunition Container (AMCON) and Hooklift Interface Kit (HIK)**

The AMCON is a flat-rack concept for the Palletized Loading System (PLS) vehicle under development by the Project Manager for Ammunition Logistics and by the Human Engineering Laboratory. The primary features of AMCON are:

- Compatibility with container ships
- NATO interoperability
- Rear wall ramps outward for light vehicle recovery
- Low stacking profile provides ability to retrograde multiple flat racks per trip
- Connectivity between the commercial intermodal shipping system and the U.S. Army supply system
- Using an aircraft compatible kit, AMCON can be loaded directly onto all U.S. Air Force cargo aircraft.

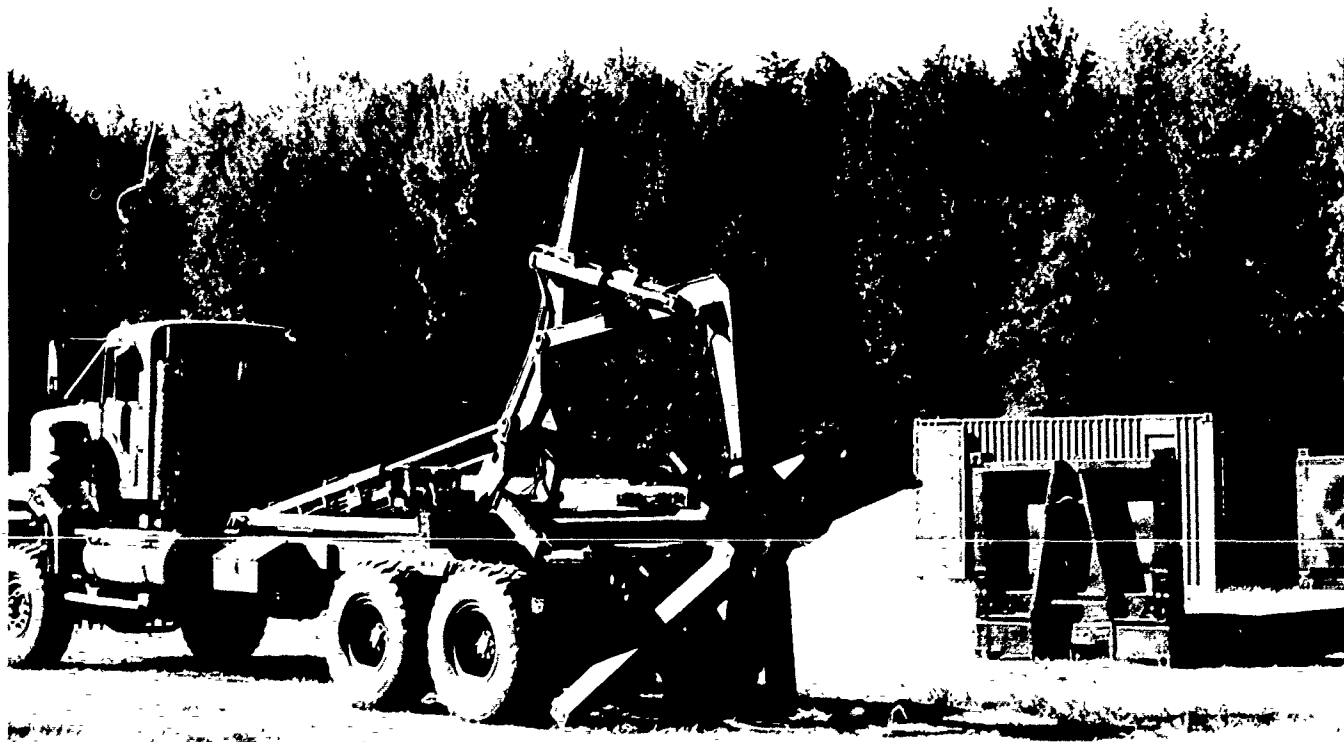
The HIK extends the flexibility of the PLS vehicle by providing the ability to interface with loaded commercial containers and the Army's family of shelters.

Advantages of the HIK are:

- Ability to pick up loaded containers or shelters without the PLS flatrack or other Materiel Handling Equipment (MHE)
- Significant reduction in time, personnel, and MHE required to pick up a container or shelter.



For additional information, contact:  
Project Manager for Ammunition Logistics  
Attn: AMCPM-AL, Doug Chesnulovitch  
Building 455  
Picatinny Arsenal, NJ 07806-5000  
DSN 880-4737 or (201) 724-4737



## SOLDIER SUPPORT



U.S. Army Medical Research and Development Command

### Steam Vacuum Pulse Sterilizer System

The Steam Vacuum Pulse Sterilizer System (SVPSS) is a microcomputer controlled automatic steam sterilizer which employs a pressure/vacuum pulsing conditioning principle for air removal. The SVPSS, consisting of a Steam Vacuum Pulse sterilizer module and a power module, was designed to provide sterile instruments, linens and solutions for the field hospital applications. The steam vacuum pulse system removes a higher percentage of air from the sterilization chamber using a vacuum, which forcibly removes air from the chamber and makes it more reliable than conventional autoclaves. The SVPSS will replace the current sterilizer at Combat Support, General, and Field hospitals. Notable advantages are: increased throughput capacity; minimization of water consumption using a condensate recovery system; built-in self-test equipment; and a modular design which permits dual mode operation by time-sharing (unwrapped and liquid loads running concurrently).

A total of six completed prototypes have been manufactured. Initial Operational Test and Evaluation has recently been completed on the prototypes. All other Army testing has been completed. The SVPSS is currently scheduled to undergo a Milestone III In-process Review in 1QFY91 where a fielding decision will be made.

The SVPSS, which uses a steam vacuum pulse technology, doubles the throughput capability over conventional autoclaves.



For additional information, contact:  
Commander, U.S. Army Biomedical Research  
and Development Laboratory  
Attn: SGRD-UBZ, Dr. James Nelson  
Fort Detrick, MD 21702-5010  
AV 343-7584 or (301) 663-7277

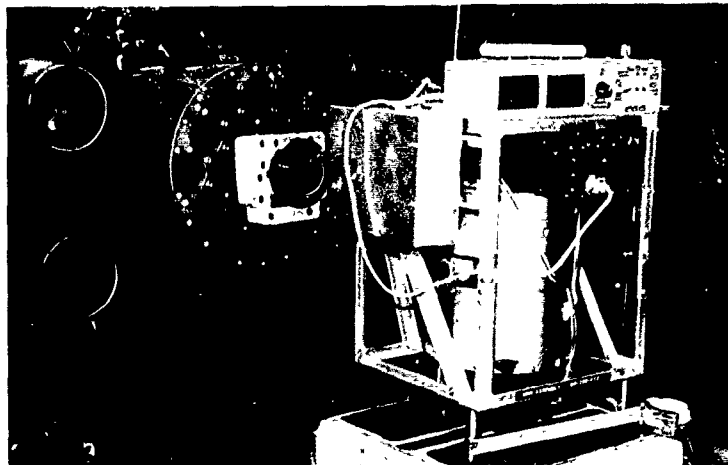
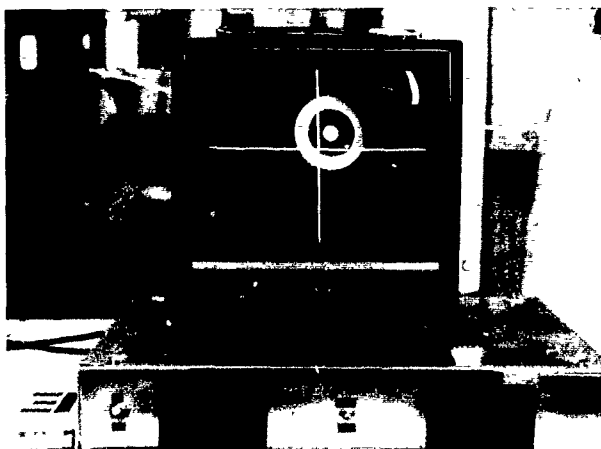
## AVIATION



### U.S. Army Aviation Systems Command

## Advanced Boresight Equipment (ABE)

The Advanced Boresight Equipment (ABE) program is a U.S. Army Aviation Systems Command's (AVSCOM) Aviation Applied Technology Directorate (AATD), Fort Eustis, Va., effort to reduce the logistics burden and Operation and Support (O&S) costs associated with boresighting combat helicopters. The ABE program will develop lightweight boresight hardware which can be used to quickly align the weapons, sensors, and sighting systems on multiple aircraft types. Program goals are to develop hardware which allows rapid boresighting (15 minute boresight check of all weapons, sensors, and sighting systems), is lightweight (less than 105 pounds), requires a maximum of two operators (one trained), and is applicable to all aircraft requiring boresighting. ABE breadboard hardware has been successfully demonstrated, and the Army, Navy, and Air Force have signed a Tri-service memorandum of agreement for execution of a Joint Demonstration and Validation (DEM/VAL) program.



The ABE program is a Tri-service effort to develop lightweight hardware which allows rapid boresighting and is non-aircraft type specific.



For additional information, contact:  
Aviation Applied Technology Directorate (AATD)  
Attn. Jerry Irvine, Public Affairs Officer  
Fort Eustis, VA 23604-5577  
AV 927-3272 or (804) 878-3272

## AIR DEFENSE



U.S. Army Laboratory Command

### Rapidly Deployable Air Defense Tactical Operations Center (RADTOC)

The Rapidly Deployable Air Defense Tactical Operations Center (RADTOC) is designed to optimize tactical operation center configurations, thus enhancing operational efficiency. These benefits accrue from reduced emplacement and displacement times and a human engineering soldier-machine interface. The RADTOC is rapidly deployable, has ergonomically engineered work stations, is functional in both stowed and deployed configurations, and is adaptable for use at various echelons.

The RADTOC facility has been developed for both demonstration purposes and for use in research conducted by the Human Engineering Laboratory (HEL) in such areas as command and control methods used during combined arms counter-air operations, and manpower and personnel requirements for tactical operation centers within the Forward Area Air Defense (FAAD) battalion.



For additional information, contact:  
Director, U.S. Army Human Engineering Laboratory  
Attn. SLCHE-AD, Dr. James Walrath  
Aberdeen Proving Ground, MD 21005-5001  
AV 298-5957 or (301) 278-5957

The Rapidly Deployable Air Defense Tactical Operations Center (RADTOC) optimizes tactical operation center configurations and enhances operating efficiency.





## LIGHT FORCES



### AMC Field Assistance in Science and Technology

## Ultra-Lightweight Camouflage

The Ultra-Lightweight Camouflage Netting systems are made with a close-knit fabric that is virtually snag-free with respect to current lightweight camouflage screening systems (LESS). A garnish material is sewn on top of the close-knit fabric to give it the appearance of natural vegetation. The garnish material has the same visual and radar properties as the current LCSS in the field, and has the same outside appearance but with distinct advantages over current systems.

In response to a request by the AMC Field Assistance in Science and Technology Office (AMC-FAST), the Belvoir Research, Development, and Engineering Center (BRDEC) developed two of these new camouflage systems. One system, Large Area Camouflage, is designed for Brigade-Size Tactical Operations Centers and a second, TOW\* Net, is designed for use on High-Mobility, Multi-purpose Wheeled Vehicles (HMMWVs) with TOW missile systems. The following shows the advantage of the new systems:

#### Large Area Camouflage:

- New system weight 400 lbs. (in contrast to old camouflage system weight of 850 lbs.)
- New system volume 35 cu. ft. (in contrast to old camouflage system volume of 65 cu. ft.).

#### TOW Net:

- New system weight 331 lbs. (in contrast to old system weight of 491 lbs.)
- New system volume 2 cu. ft. (in contrast to old system volume of 3.75 cu. ft.).

Primarily because of these size and weight reductions, the new Ultra-Lightweight Camouflage Netting systems provide the following benefits: 40% shorter installation times, reduced transportation requirements, and reduced deployment manpower needs. In addition, these new systems provide camouflage effectiveness which is equal to or better than that of old systems.

Ultra-Lightweight Camouflage Netting offers reduced weight, shorter installation times, and less deployment manpower needed than conventional systems



For additional information, contact:  
Commander, U.S. Army Belvoir Research,  
Development and Engineering Center  
Attn: STRBE-JDA, Michael Doney  
Ft. Belvoir, VA 22060-5606  
AV 354-6771 or (703) 664-6771

\*TOW stands for Tube-Launched, Optically-Tracked, Wire-Guided

## SOLDIER SUPPORT

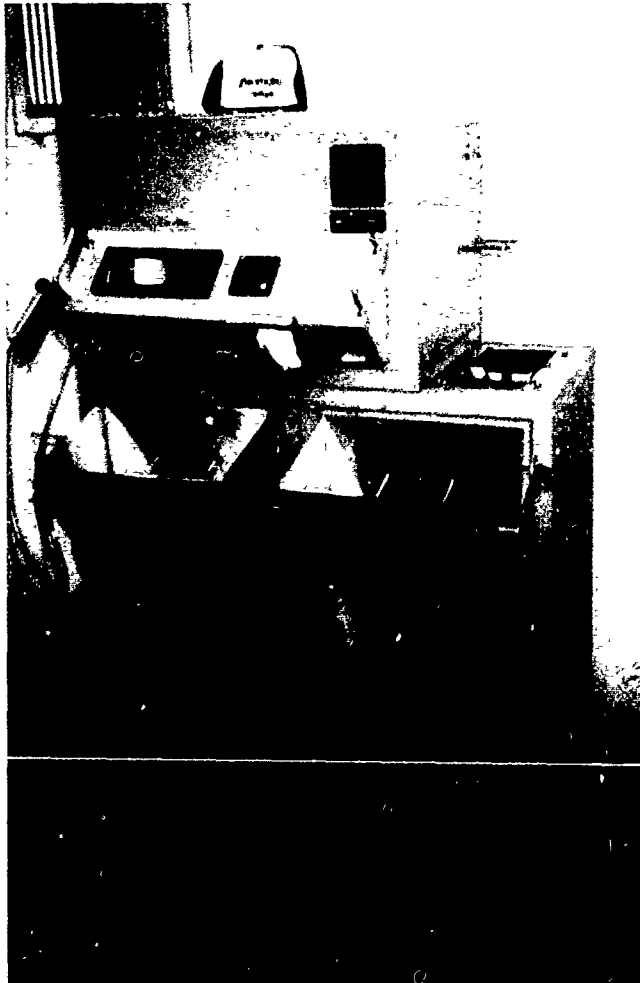


U.S. Army Medical Research and Development Command

### Resuscitative Fluids Production System (REFLUPS)

REFLUPS provides field mobile and shipboard medical organizations with an on-site capability to produce selected IV and irrigating fluids used in the course of providing medical care. Locally available potable water meeting standards of DOD-STD-1399, "Interface Standard for Shipboard Systems," and STANAG 2136/QSTAG 245, "Minimum Standards for Water Potability," is purified to the standards of United States Pharmacopeia (USP) XXI monograph, page 1124, for Water For Injection (WFI). The system produces WFI using the filtration processes of prefiltration, carbon adsorption, reverse osmosis, deionization, ultrafiltration, and membrane filtration. The WFI is then proportioned with concentrated additives to produce Ringer's lactate solution, isotonic saline injection solution, and red blood cell wash solution. These reconstituted products are pumped through a sterile docking device and packaged in transparent plastic IV bags. An automated quality control system monitors internal processes to verify sterility and to detect pyrogenicity in REFLUPS products.

REFLUPS allows field mobile and shipboard medical facilities to produce IV and irrigating fluids for medical care.



For additional information, contact:  
Commander, Medical Materiel Development Activity  
Attn: SGRD-UMS, Maj Warren Heineman  
Fort Dietrich, MD 21702-5009  
AV 343-7584 or (301) 663-7584

## SOLDIER SUPPORT



U.S. Army Medical Research and Development Command

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### Miniature Dental X-Ray System

The Miniature Dental X-Ray System is a lightweight, hand-held x-ray system that produces radiographic diagnostic images. The system consists of an x-ray source subsystem and a filmless imaging subsystem. Output DC (direct current) voltages can be either 50, 60, or 70 kilovolts at a fixed current of 3 milliamperes. Exposure times are selectable from 4 milliseconds to 2.048 seconds. The system operates from internal lead-acid batteries, and is rechargeable from external power sources such as 110/220 Volts Alternating Current (VAC) and 24 Volts Direct Current (VDC) vehicular sources. The system requires approximately 210 watts of power. Ready for deployment, the entire system will weigh no more than 25 pounds and will fit into a rugged suitcase-type container. A Preplanned Product Improvement (P<sup>2</sup>I) for the system is the filmless imaging subsystem.

The Miniature Dental X-Ray System is a compact, portable x-ray system currently under development. Here, a technician demonstrates a prototype.



---

For additional information, contact:  
Commander, Medical Materiel  
Development Activity  
Attn: SGRD-IJMS, Maj. Warren Heineman  
Fort Detrick, MD 21702-5009  
AV 343-7584 or (301) 663-7584

## AIR DEFENSE



U.S. Army Laboratory Command

### Acoustics Forecast System

The Atmospheric Sciences Laboratory (ASL) is pursuing a program to enable passive detection, identification, and location of rotary wing aircraft. As part of this program, ASL has developed the Acoustics Forecast System which is designed to predict meteorological conditions favorable for accurate passive detection of rotary wing aircraft. The system incorporates acoustics and meteorological models to generate meteorological forecasts using available battlefield upper air weather information.

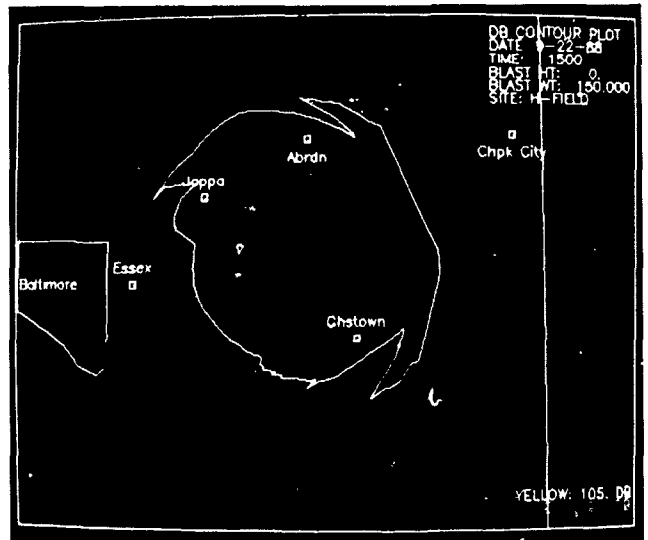
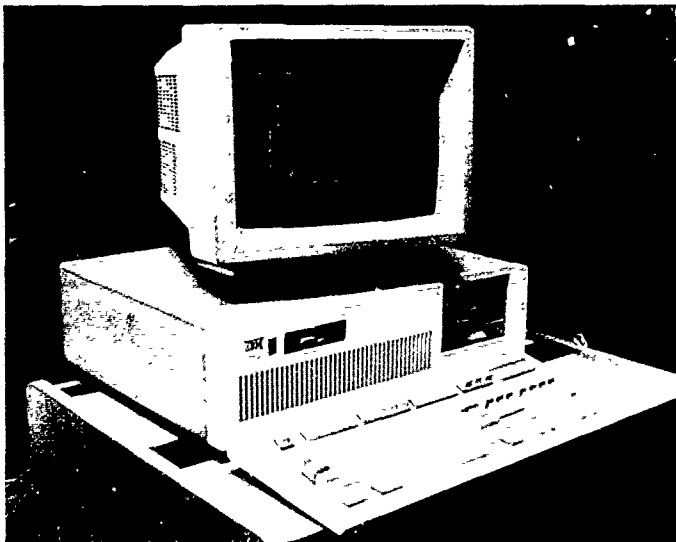
This program takes advantage of the fact that, under favorable meteorological conditions, rotary wing aircraft generate sufficient sound energy to propagate over tactically significant ranges (i.e., greater than 20 kilometers). During these conditions, passive acoustic sensors using modern signal processing can be used to detect, identify, and locate rotary wing aircraft.



For additional information, contact:  
U.S. Army Atmospheric Sciences Laboratory  
Attn: SLCAS-AS, Mr. Robert McPeck  
White Sands Missile Range, NM 88002-5501  
AV 258-4382 or (505) 678-4382

Acoustics Forecast System  
workstation traces sound paths  
from rotary wing aircraft.

Contour plot outlines acoustic activity.  
Acoustical data is gathered by passive sensors



## FIRE SUPPORT



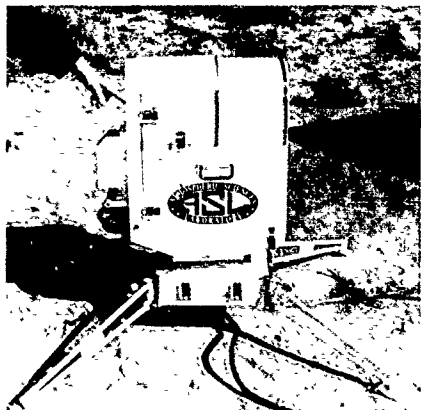
U.S. Army Laboratory Command

### Radiometric Atmospheric Profiler

The Radiometric Atmospheric Profiler is being developed to passively measure vertical profiles of atmospheric temperature and density.

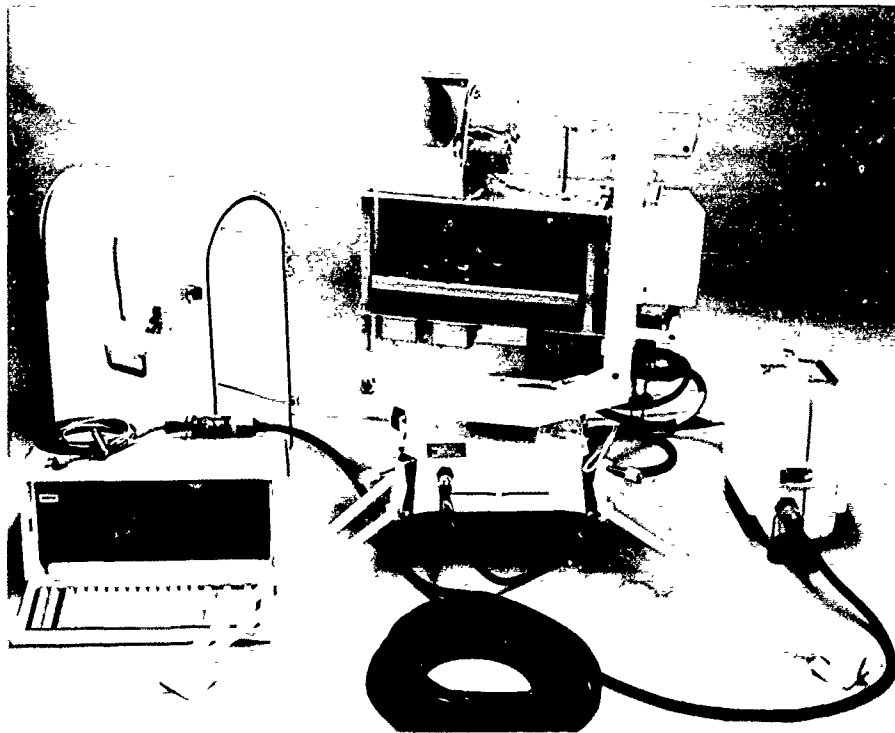
The system features radiometers which operate by passively sensing the natural thermal radiation of the atmosphere. As an essentially passive receiver, the profiler is capable of relatively covert operation. It can also provide near real-time measurements and, being automated, can be operated unattended. It is intended to replace the logistically cumbersome meteorological balloon.

The Radiometric Atmospheric Profiler will provide measurements of upper air temperature and density required for Army aviation, artillery corrections, and prediction of the dispersion of nuclear, biological and chemical (NBC) and smoke clouds.



Above, the Radiometric Atmospheric Profiler, compact in design, is easily transportable.

Right, the Profiler and work station showing internal components of radiometer



For additional information, contact:  
US Army Atmospheric Sciences Laboratory  
Attn: SLCAS-AR, Dr. Edward Measure  
White Sands Missile Range, NM 88002-5501  
AV 258-3307 or (505) 678-3307

## SOLDIER SUPPORT



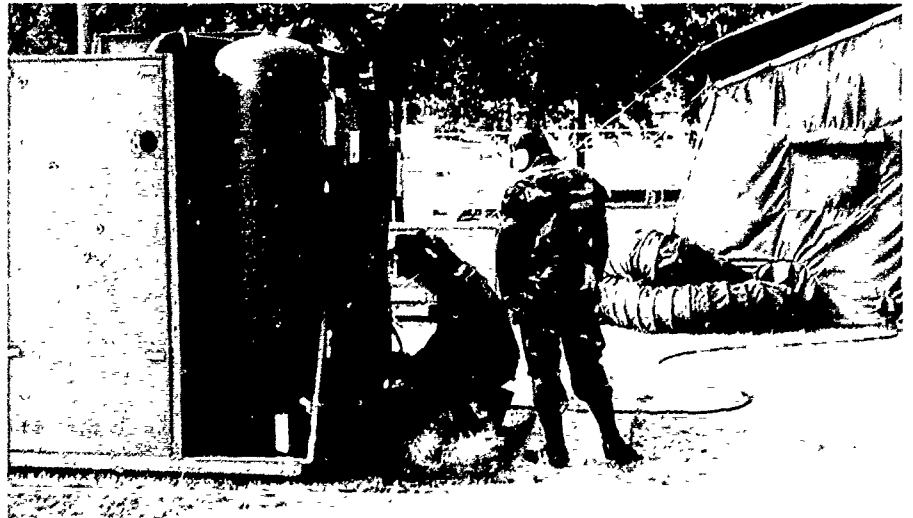
U.S. Army Medical Research and Development Command

### Field Medical Oxygen Generating and Distribution System

The Field Medical Oxygen Generating and Distribution System (FMOGDS) is intended for use throughout a theatre of operation to include nuclear, biological, and chemical (NBC) environments. The device will provide distribution of medical grade oxygen to the patient site and simultaneously recharge medical oxygen cylinders. It will be equipped with easily changeable NBC filters and be of a modular construction to achieve 85 percent system maintenance capability at the organizational level. The system employs a molecular sieve/pressure swing adsorption (PSA) process to produce nitrogen depleted gas. The process uses synthetic zeolite to separate the oxygen and nitrogen molecules, and pressure to control the adsorption/desorption process. Compressed air is supplied to one molecular sieve bed which retains the nitrogen and allows oxygen and argon to pass through. When the molecular sieve in the first bed becomes nearly saturated with nitrogen, the bed is vented and allowed to equilibrate with atmospheric pressure causing most of the adsorbed nitrogen to be desorbed and discharged from the bed. Simultaneously, some of the nitrogen-depleted oxygen product from the second molecular sieve bed is flushed back through the first bed to complete the desorption process. The product from this process will be medical grade oxygen that meets all U.S. Pharmacopeia requirements.

The system includes pressure and purity monitors at the production site, patient site, and at the ward. It also incorporates a 5-hour automatic oxygen backup supply equipped with audible/visual alarms and a fault indicator system. The system is equipped with easily changeable NBC filters, is designed for contamination avoidance, and is easily operated by personnel wearing Mission Oriented Protection Posture (MOPP) gear up to and including Level IV.

The FMOGDS provides and distributes medical grade oxygen for use in nuclear, biological and chemical environments



For additional information, contact:  
Commander, Medical Materiel Development Activity  
Attn: Maj Warren Heinman  
Fort Detrick, MD 21702-5009  
AV 343-7584 or (301) 663-7584

## SOLDIER SUPPORT



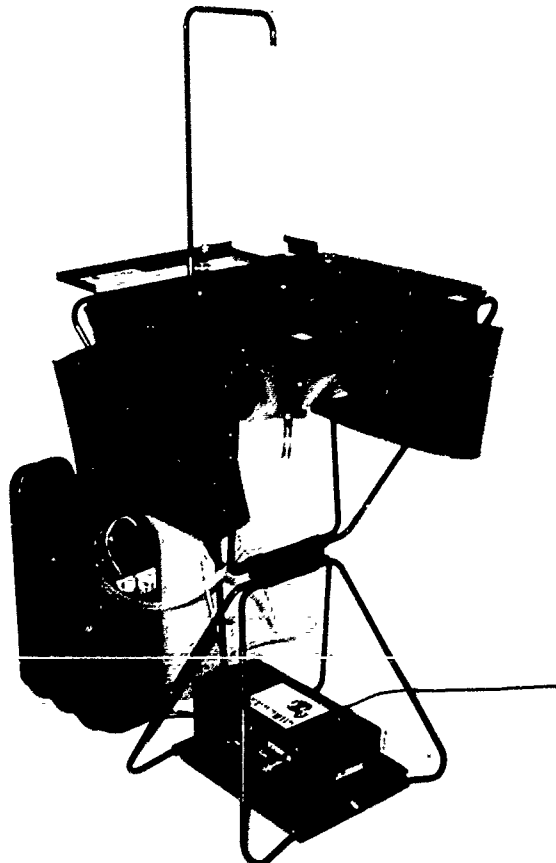
U.S. Army Medical Research and Development Command

### Portable Surgical Scrub Sink

The U.S. Army Biomedical Research and Development Laboratory (USABRDL) has developed a lightweight, low-cost, highly portable surgical scrub sink for field hospitals. The sink weighs 25 pounds and consists of a collapsible anodized aluminum frame that supports a waterproof fabric basin. The box mounted at the base of the sink contains a ground fault circuit interrupter protected centrifugal pump and in-line thermostatically controlled heater. A footpedal actuated switch and valve assembly controls the water flow from pressurized or nonpressurized sources. The sink can be operated from 110- or 220-volt electrical sources. With no compromise in functional capability, the new design is less than half the weight and volume of the existing surgical scrub sink.

The first prototype scrub sinks underwent user evaluation by the Army Medical Department Test Board and underwent field tests at exercise Orchid Sage at Fort Drum, NY. Although initially designed for the Special Operations Forces and Forward Surgical Teams, the response of the field units to the new scrub sink design was so enthusiastic that a complete Technical Data Package (TDP) was developed for procurement of replacements for all field hospitals. A draft Military Specification and Operator's Manual were provided with the TDP. The USABRDL also fabricated 10 sinks to fill the immediate need of the far-forward medical units.

With no loss in function, the new Army Portable Surgical Scrub Sink is 50% lighter and more compact than existing surgical scrub sinks



For additional information, contact:  
Commander, U.S. Army Biomedical Research  
and Development Laboratory  
Attn. SGRD-UBZ, Dr. James Nelson  
Fort Detrick, MD 21702-5010  
AV 343-7277 or (301) 663-7277

## SOLDIER SUPPORT



U.S. Army Medical Research and Development Command

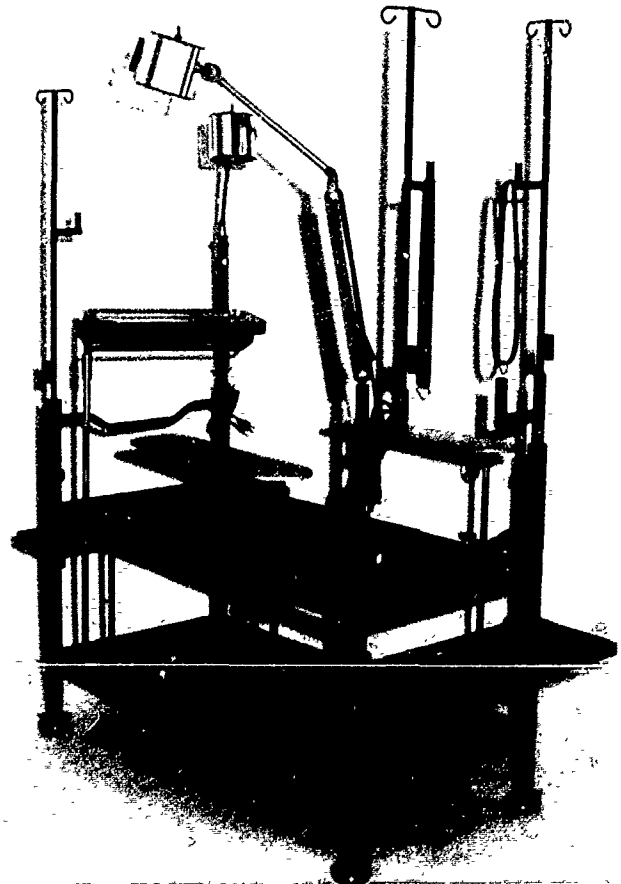
### Far-Forward Surgical Table with Accessories

The U.S. Army Biomedical Research and Development Laboratory designed, fabricated and field tested a lightweight, easily assembled, and easily packaged surgical table for far-forward use. Accessories provided as integral components to the surgical table package include surgical lighting, IV poles, armboard, and an instrument tray.

The table and all components weigh 85 pounds and can be assembled by one person without tools in approximately 5 minutes. All structural parts of the table are fabricated from square aluminum tubing and storage shelves are made from polypropylene mesh. Specifically designed for the Special Operations Forces (SOF) and Forward Surgical Teams (FST), the table directly accommodates a standard field litter as the operating platform.

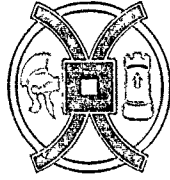
The initial prototype litter was field tested by the 44th Medical Brigade in Honduras and by medical elements at exercise Orchid 5 gge at Fort Drum, New York. The results of the field tests were overwhelmingly positive, and few design changes were needed. Based on the results of the field tests, ten tables were fabricated to satisfy the immediate need of the FSTs of the 44th Medical Brigade, the 307th Medical Battalion, and the Navy Special Warfare Group II. A complete Technical Data Package was prepared for future acquisition.

For additional information, contact:  
Commander, U.S. Army Biomedical Research  
and Development Laboratory  
Attn SGRD-UBZ, Dr James Nelson  
Fort Detrick, MD 21702-5010  
AV 343-7584 or (301) 663-7277



The newly designed surgical table for far-forward use includes surgical lighting, IV poles, armboard, and surgical tray. The entire ensemble weighs just 85 pounds.





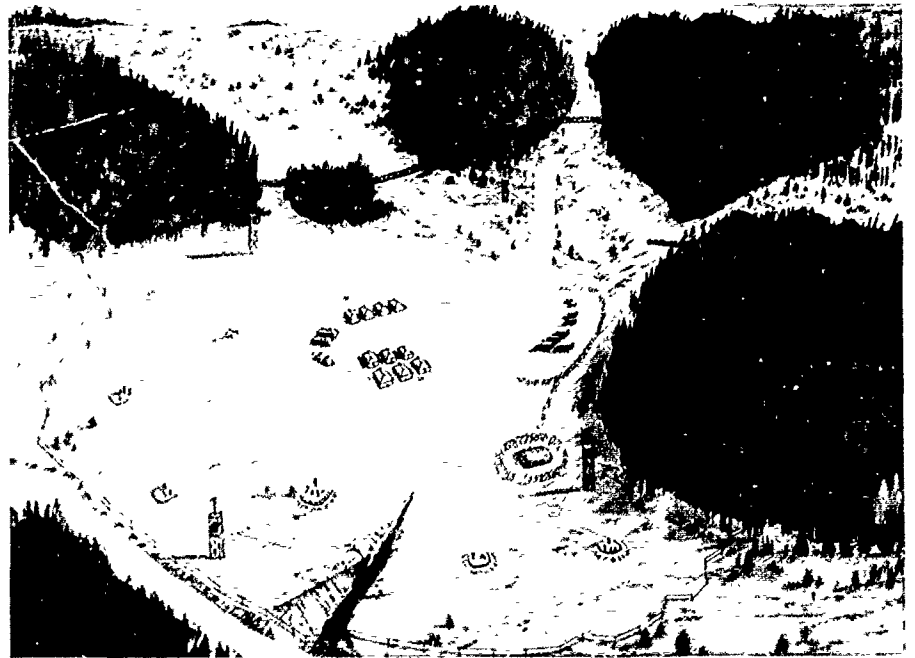
## LIGHT FORCES

U.S. Army Troop Support Command

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### Security and Force Protection Enhancement Resources (SAFER)

SAFER components have been selected to enhance the security of U.S. personnel by providing equipment for the detection, assessment, delay, and response to security threats. A combination of military and commercial components have been integrated into a system specially designed for Low Intensity Conflict operations. Components include passive infrared sensors; seismic sensors; active infrared sensors; rapidly deployable detection sensors; razor tape concertina; low-light intensified cameras for remote assessment; night vision devices for manual assessment of intrusions; and secure hand-held radios.



For additional information, contact  
Commander, U.S. Army Belvoir RD&E Center  
Attn STRBE-NAB  
Ft Belvoir, VA 22060 5606  
Av 354-6875 or (703) 664-6875

## SOLDIER SUPPORT



U.S. Army Armament, Munitions and Chemical Command

### Three Dimensional Anthropometry to Improve NBC Respirator Design

Improving nuclear, biological, and chemical (NBC) respirator facial peripheral seals and bringing the mask closer to the face will both increase respirator protection and improve interfacing with other military equipment such as sighting devices. In the past, only caliper-type measurements were available on a limited number of facial dimensions. The Advanced Protective Systems Integration Laboratory has acquired and upgraded a commercially available head scanning device, the Sculptronix, that permits the collection of over 600,000 data points around the full circumference of the head in only 0.7 seconds. The data points are currently collected at 0.03 inch intervals but could be collected at even higher resolution if required. It also has the capability of making measurements while the person being scanned is talking, to determine the full range of facial motions. This increased sensitivity permits the fine detailed measurement of any region of the face to allow designers to work to very tight tolerances. Software has been developed to do both global surface measurements and caliper measurements from any point to any point(s) on the surface of the head. These data points are displayed as a full human headform of the individual scanned or they can be presented as a headform representing both the radial and frontal plane statistics of the number of people scanned. Waterlines of any level of the head can also be presented in both graphic and tabular form. The data generated is used for computer-aided design of respirators and the molds to manufacture them.

The system can scan any three dimensional object within a 12-inch diameter cylinder 15 inches long and convert it into measurements to operate a numerical controlled milling machine or provide comparison with a previously scanned standard of the same object.

The process has both military and industrial applications, directly related to improving the AMC mission.



For additional information, contact:  
Commander, U.S. Army Chemical Research,  
Development and Engineering Center  
Attn: SMCCR-PPI, Dr Ronald A. Weiss  
Aberdeen Proving Ground (EA), MD 21010-5423  
AV 584-2313 or (301) 671-2313

Sculptronix is used by the Advanced Protective Systems Integration Laboratory to improve NBC respirator facial seals and to interface with other military equipment.





## SOLDIER SUPPORT

### AMC Field Assistance in Science and Technology

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## MILES-Compatible Practice Grenade and Claymore Mine

In order to meet the U.S. Army's immediate need, Harry Diamond Laboratories (HDL) has developed two training devices that will interface with the Multiple Integrated Laser Engagement System (MILES) for field tactical exercises: a hand grenade and an M18A1 anti-personnel (Claymore) mine.

Today's soldiers need a MILES-compatible hand grenade trainer so they can learn to use the grenade effectively in various tactical situations, including military operations in urban terrain. They must learn the casualty-producing effects and capabilities of the grenade and its application in these operations. Currently this type of training hand grenade does not exist. One laser design has been proposed that would cost approximately \$1500.

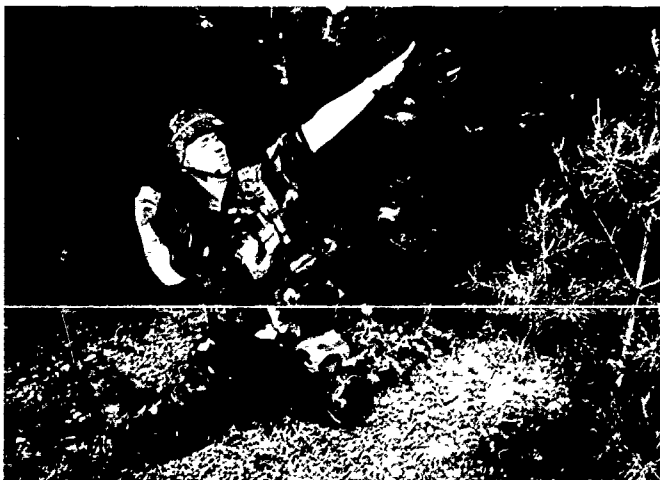
A cost-effective training device does not exist that accurately portrays the force multiplier available from the Claymore mine to the maneuver force elements. A laser mine prototype that incorporates a pyrotechnic has been designed with an expected cost of \$2500.

HDL engineers have developed both a non-exploding hand grenade and a Claymore mine that provide visual and audible indications of action and are capable of triggering the MILES body harness. An electronic circuit has been added to the MILES harness to detect the specific frequency of the audible tone of the grenade or Claymore mine. Since this circuit is identical to the ones required for the practice grenade or Claymore mine, only one additional circuit is required to detect a grenade or mine detonation. Both of these training devices can be produced at a unit cost of under \$100—substantially lower than the costs of the laser prototypes mentioned above.

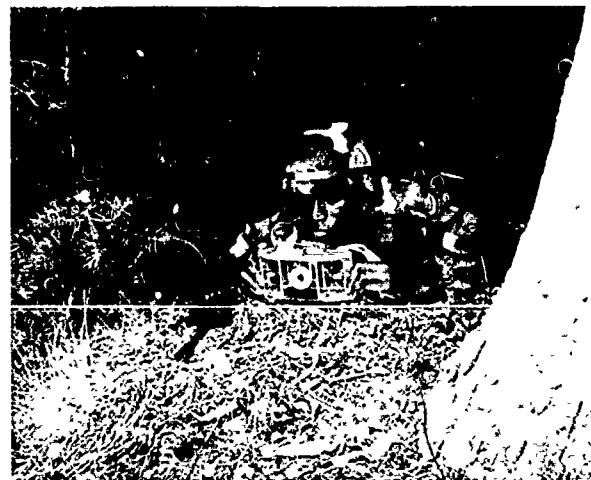


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For additional information, contact:  
Director, US Army Harry Diamond Laboratories  
Attn: SLCHD-TA-FD, Dr. Carl J. Campagnuolo  
2800 Powder Mill Road  
Adelphi, MD 20783-1197  
DSN 290-3193 or (202) 394-3193



The training grenade throwing technique is no different from that used for a regular grenade.



Soldier demonstrates Claymore training device which will integrate with MILES system.

## SOLDIER SUPPORT



U.S. Army Laboratory Command

### Effectiveness of Electromagnetic Pulse Hardening

Battlefield survival in a nuclear environment means that sophisticated equipment continues to operate. That survivability depends on hardening against the threat of electromagnetic pulse (EMP), which can destroy functional capability. Each Department of Defense component is required to develop and maintain a nuclear survivability program applicable to its major systems. Scientists at Harry Diamond Labs can assist customers in fulfilling those DoD requirements.

The EMP Simulation and Instrumentation (S&I) Branch has the expertise to operate free-field electromagnetic pulse (EMP) simulators, three mobile instrumentation systems, a variety of non-fixed-site measurement instruments used to measure the response of systems under test, and a continuous wave instrumentation and simulation (CWIS) test facility. The branch is directly involved in the development of a single set of guidelines and practices for designing EMP hardness into systems as well as assessing and maintaining that hardness throughout the life of the system.

The EMP Hardening Technology Branch can custom design devices to protect specific types of equipment against the effects of EMP resulting from high-altitude nuclear bursts. For example, custom devices have been developed through product improvement programs (PIP) sponsored by Communication Electronics Command, which funded programs for many Army fielded systems.

Scientists in the EMP Physics Branch test systems to determine and analyze the effectiveness of hardening measures.



The CWIS test facility conducts experimental vertically-polarized tests.

An AN/GSC-52(V)2 satellite communications terminal system, with dish at left and two vans, center, is tested for survivability. HDL instrumentation is at right.



For additional information, contact:  
Director, U.S. Army Harry Diamond Laboratories  
Attn. SLCHD-NW-ES, Todd Waltemyer or  
Tom Bock (EMP S&I)  
Attn. SLCHD-NW-EH, John Beifuss (EMP Hardening)  
Attn. SLCHD-NW-EP, Joseph R. Mileta  
(EMP Physics Branch)  
2800 Powder Mill Road  
Adelphi, MD 20783 1197  
AV 356-2303 or (703) 490-2303





**U.S. Army Aviation Systems Command**

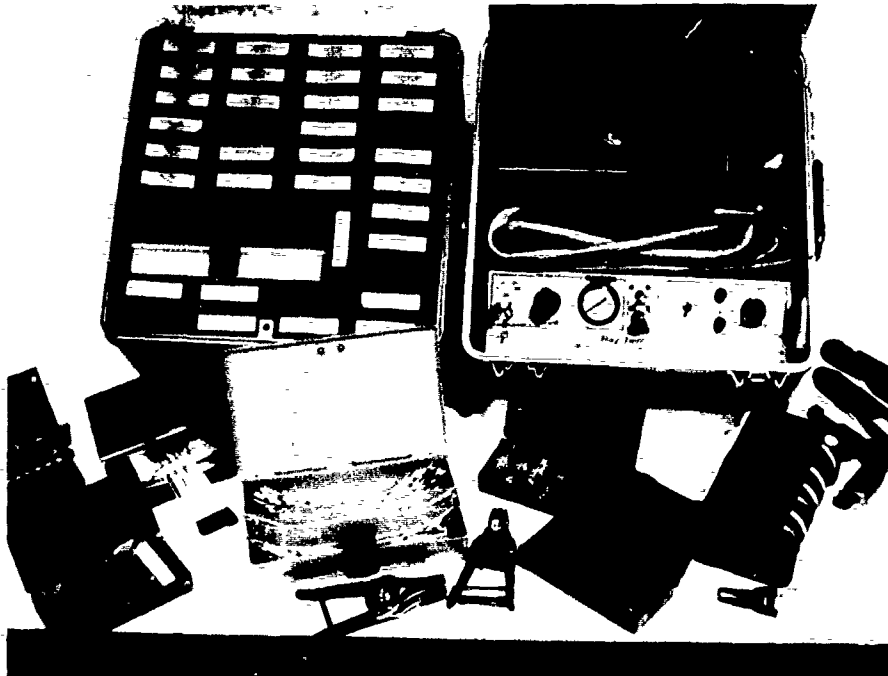
## **Aircraft Combat Maintenance/Battle Damage Repair**

The Aviation Applied Technology Directorate (AATD) of the Aviation Systems Command (AVSCOM) has developed generic prototype Aircraft Combat Maintenance/Battle Damage Repair (ACM/BDR) kits to enable aviation maintenance units to repair battle-damaged helicopters expediently.

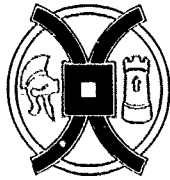
The ACM/BDR fluid line repair kit provides tools to repair damaged hydraulic lines. Since spare hydraulic lines are not available in sufficient numbers during combat, the ability to repair damaged hydraulic lines is essential in returning damaged aircraft to service.

Similarly, the ACM/BDR wiring repair kit is designed to drastically reduce wire repair times during combat. It provides repairers with damage inspection, assessment, and repair tools and techniques. The kit contains new repair tools and material simpler to use and superior in quality compared to those currently in use. The new wiring kit will permit more rapid turnaround of battle-damaged aircraft during combat.

The ACM/BDR wiring repair kit contains state-of-the-art tools, repair materials, and test equipment designed to assist aviation maintenance units in quickly returning damaged aircraft to battle.



For additional information, contact:  
Commander, Aviation Applied Technology Directorate  
U.S. Army Aviation Systems Command  
Attn. SAVRTY-ASR, John F. Tansey  
Fort Eustis, VA 23604-5577  
AV 927-5620 or (804) 878-5620

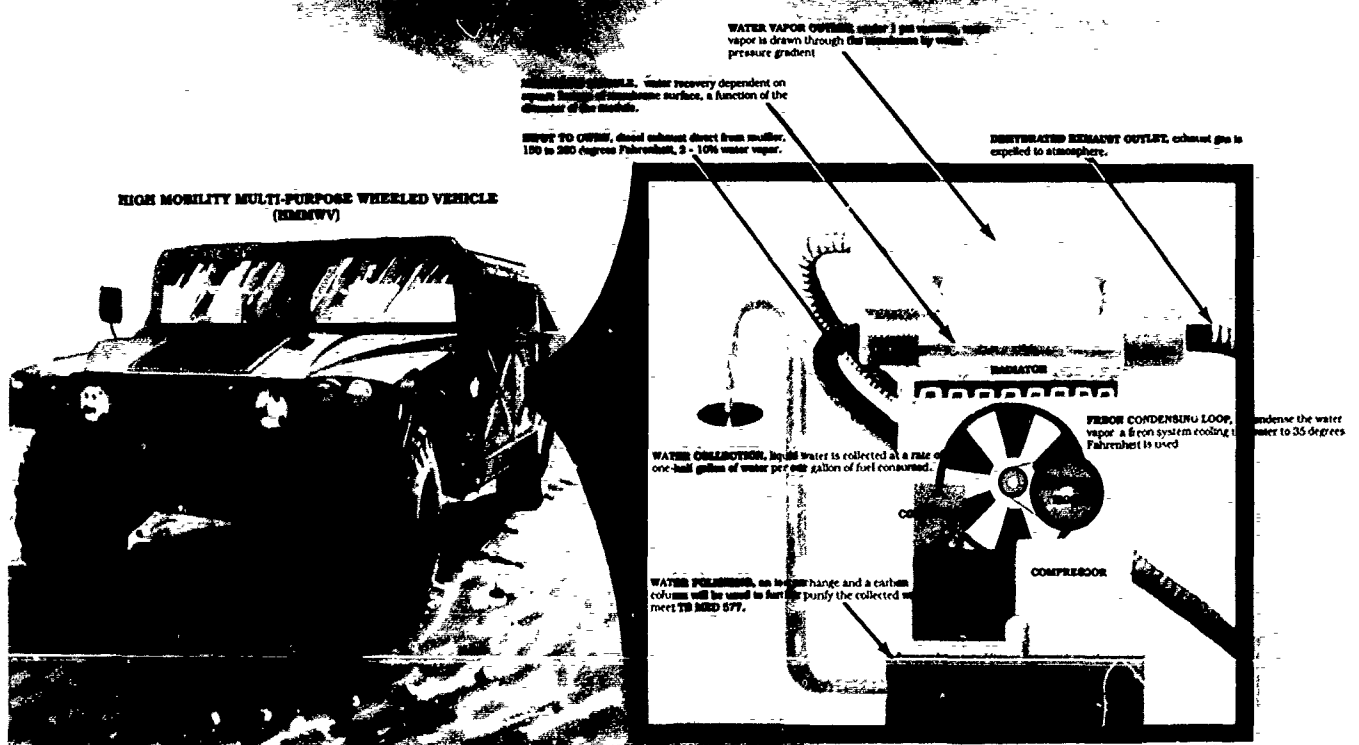


## SOLDIER SUPPORT

U.S. Army Troop Support Command

### On-Board Water Recovery Unit (OWRU)

The Belvoir Research, Development, and Engineering Center (BRDEC) has developed the On-Board Water Recovery Unit (OWRU) to provide Special Operation Forces with an alternative means of water resupply in desert and nuclear, biological, and chemical (NBC) environments. The OWRU operation is based on a method of recovering potable water from engine exhaust using a gas separation membrane. It will be used on the High Mobility Multi-Purpose Wheeled Vehicle (HMMWV) of the Desert Mobility Vehicle System (DMVS).



For additional information, contact:  
Commander, U.S. Army, Belvoir RD&E Center  
Attn: STRBE-FS, Janet Hall  
Fort Belvoir, VA 22060-5606  
AV 345-7401 or (703) 355-7401





## U.S. Army Medical Research and Development Command

### Lightweight Medical X-Ray System

The U.S. Army Biomedical Research and Development Laboratory has entered into a collaborative research effort with the University of Wisconsin-Madison to produce a second generation prototype lightweight medical X-ray system. The unit will weigh less than 75 pounds, and have the same operational capability of machines that weigh 800 pounds or more. This system will satisfy the high mobility requirements of the Special Operations Forces while being able to replace larger units in definitive care facilities.

The first generation system consists of a 30 pound X-ray machine and a 16 pound self-contained rechargeable power supply that can deliver 25-50 exposures per charge. This system operates between 60 and 90 kVp with manual or automatic exposure control and uses either 8"x10" or 10"x12" receptors. A radiation protection survey showed the system to be safe for operators and patients. Clinical trials at Womack Army Community Hospital proved the system produced diagnostic quality radiographs, although minor positioning difficulties were identified.

The second generation prototype will have improved circuit components and a higher capacity X-ray tube to provide 14"x17" images. Accessories for positioning and maneuvering will also be developed during this 12-month collaborative effort.

For additional information, contact:  
Commander, U.S. Army Biomedical Research  
and Development Laboratory  
Attn: SGRD-UEZ, Dr. James Nelson  
Fort Detrick, MD 21702-5010  
AV 343-7584 or (301) 663-7277

A rugged, lightweight low capacity X-ray  
system for forward combat casualty care.





### U.S. Army Medical Research and Development Command

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## Wheeled Litter Carrier

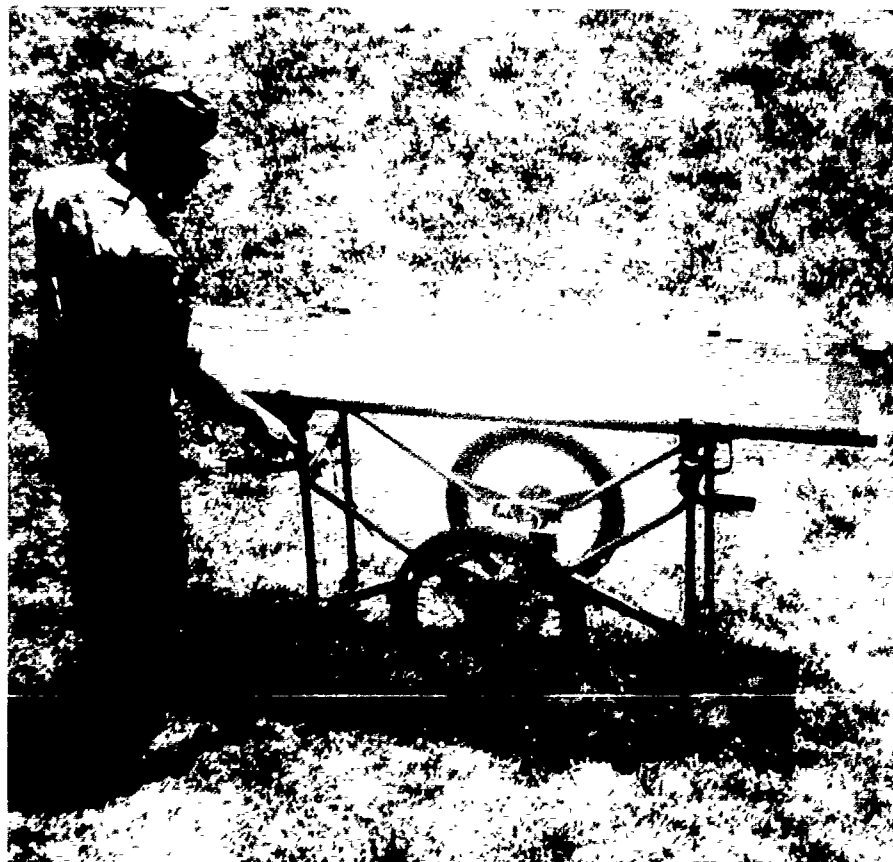
The U.S. Army Biomedical Research and Development Laboratory (USABRD) developed the Wheeled Litter Carrier to provide a lightweight, stable, wheeled device for transporting litter patients. It is patterned after a West German gurney but its tubular aluminum frame makes it lighter and easier to use. The carrier weighs 46 pounds and folds to reduce storage volume. The litter is securely held to the carrier by easy-to-use litter clamps and is supported at a convenient height of 32 inches from the ground. Two sixteen inch pneumatic tires provide a cushioned ride and make the carrier easy to handle in fixed facilities and easy to maneuver over rough terrain in the field.

Extensive field testing of the carrier by field units, and its use in Honduras, proved it to be a rugged and useful device for transporting litters in a variety of environments.

A Low Rate Initial Production contract for 1,964 carriers was completed in August 1988 and a contract for 9,071 carriers was awarded in February 1990 with delivery scheduled to be complete in June 1991.

The USABRD is currently developing accessories to enable the carrier to meet the specialized needs of various field units.

The new Wheeled Litter Carrier, developed by USABRD, has a tubular aluminum frame which makes it lighter and easier to use.



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For additional information, contact:  
Commander, U.S. Army Biomedical Research and  
Development Laboratory  
Attn SGRD-UBZ, Dr James Nelson  
Fort Detrick, MD 21702-5010  
AV 343-7277 or (301) 663-7277





## ARMORED SYSTEMS

U.S. Army Laboratory Command

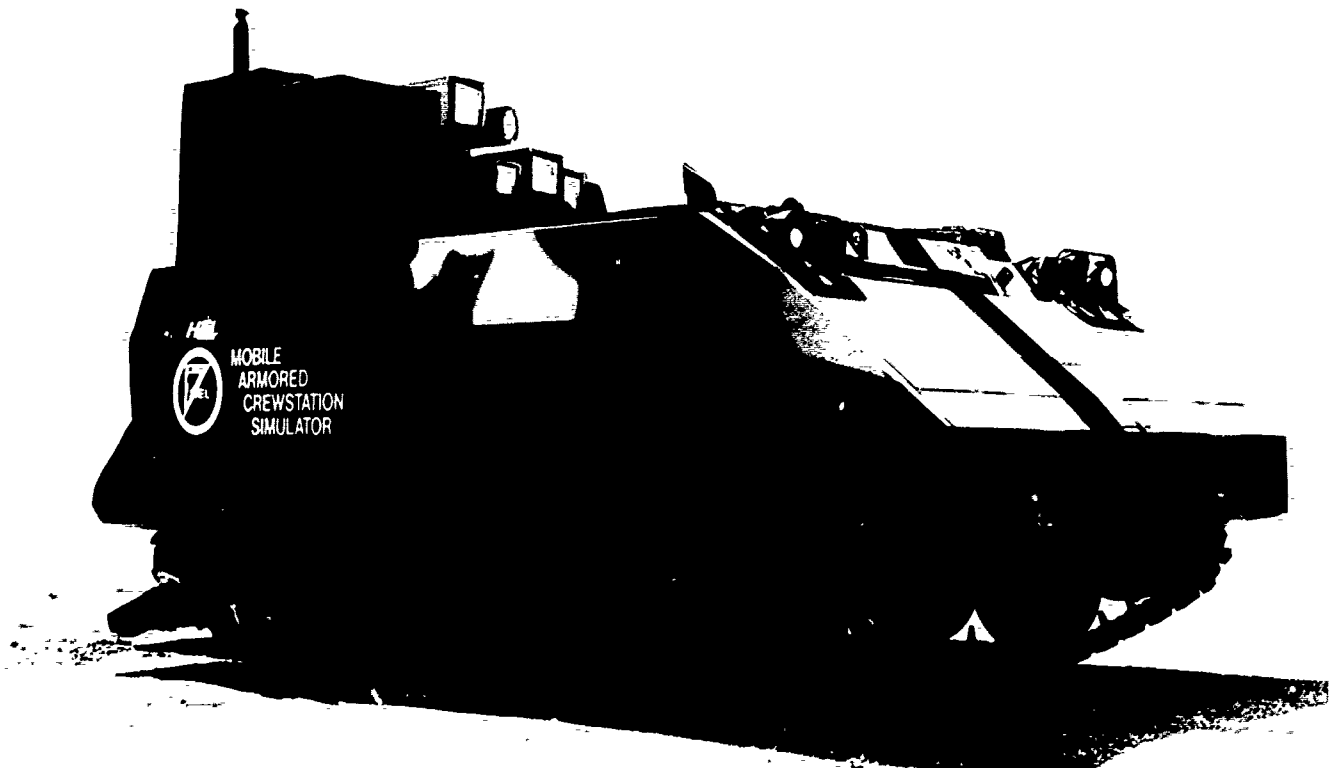
### Mobile Armor Crew Station Simulator (MACS)

The Mobile Armor Crew Station Simulator (MACS) is a research vehicle designed to examine the geometry, controls, and displays of future armored vehicles so that soldier ability can be matched with equipment capability. The MACS gathers performance data in the areas of indirect vision, reduced crew task distribution, sensor display system integration, and crew station configuration. Areas of vital interest to the developers of future armored systems are:

- Indirect Vision: Indirect viewing devices (e.g., closed circuit television, low-light level, and thermal systems) are used for driving, navigation, and target acquisition in day and night conditions.
- Task Distribution: The crew size can be varied from two to four. Overall crew tasks differ from current systems because of the indirect vision requirement and remote gun design. The proper distribution of those tasks between two, three, and four crew members has a direct impact upon the combat effectiveness of the system.
- Systems Integration: The technology available in this area is sufficient to completely overwhelm the user with data; the challenge is to make the technology transparent and to provide the crewman with what he needs when he needs it, and no more.
- Crew Stations: The crew stations are designed to accommodate the full range of physical variables and to meet the requirements of sustained operation in all external environments.



For additional information, contact:  
Director, U.S. Army Human Engineering Laboratory  
Attn: SLCHE-CC-LHD, Mr. Ron Whittaker  
Aberdeen Proving Ground, MD 21005-5001  
AV 298-5918 or (301) 278-5918



The Mobile Armor Crew Station Simulator (MACS) researches performance data for indirect vision, crew task distribution and station configuration, and sensor display system integration.



## ARMORED SYSTEMS

U.S. Army Field Assistance in Science and Technology

### Auxiliary Power Unit (APU) for the MIAI Tank

During training and "Silent Watch" operations, systems within the MIAI tank are operated for extended periods of time without the main engine running. This drains the tank's batteries and can prevent the tank from restarting. Another mode to operate the systems is with the engine idling; however, this consumes precious fuel and shortens the life of the engine.

To solve these problems, Harry Diamond Laboratories engineers modified a commercially-available diesel generator to provide auxiliary power to the MIAI tank. The original alternator and its associated wiring were replaced with a high-efficiency, three-phase alternator which employs rare-earth materials in its permanent magnets. The output of the auxiliary power unit (APU) is rectified and filtered to provide 28 volts direct current at a maximum power of 2,000 watts.

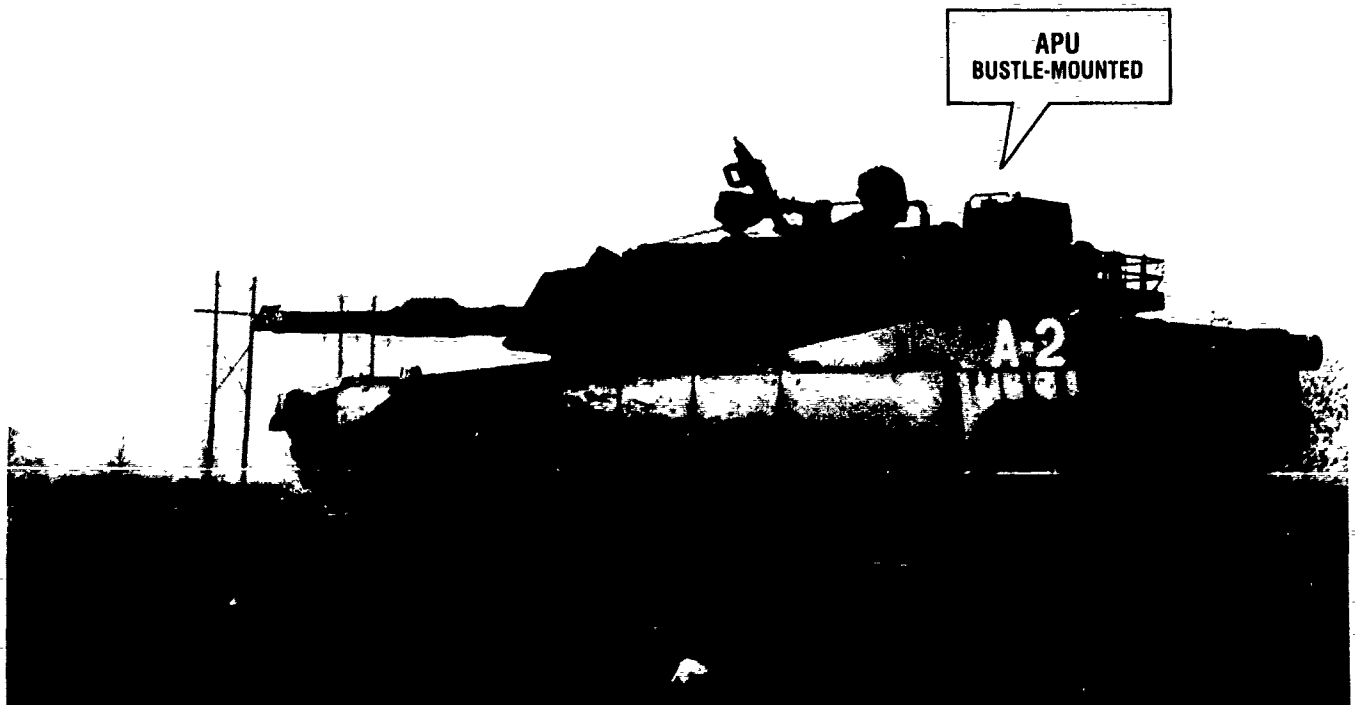
The APU provides the following attractive features:

- No discharge of the tank's batteries.
- Savings in fuel consumption (by eliminating the need to run the main engine)
- Reduced tank engine wear
- Reduced detectability of the tank through noise and heat reduction.

As a result of these positive attributes, the APU has been recommended for various field applications. The Commander-in-Chief-U.S. Army-Europe (CINC USAREUR) has approved an Operational Need Statement which recommends that the Department of the Army initiate the acquisition of the APU for USAREUR. In addition, the U.S. Marine Corps has declared its intention to acquire the same bustle-mounted diesel APU.



For additional information, contact:  
Director, U.S. Army Harry Diamond Laboratories  
Attn: SLCHD-TA-FD, Dr. Carl Campagnuolo  
2800 Powder Mill Road  
Adelphi, MD 20783-1197  
DSN 290-3193 or (301) 394-3193





## AVIATION

### U.S. Army Aviation Systems Command

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## LONGBOW

The LONGBOW program will provide U.S. Army Aviation an adverse weather combat capability, currently a major operational deficiency. The objective is to develop a target acquisition and "fire-and-forget" anti-armor weapon system which is not affected by light rain, fog, dust, smoke, and other battlefield obscurants. Successful demonstration of the LONGBOW system, integrated into the AH-64 Apache, has proven the ability to rapidly detect, classify, and prioritize targets with a mast-mounted, low probability-of-intercept millimeter-wave radar and to acquire, track, and accurately engage the selected target with a "fire-and-forget" millimeter-wave seeker integrated into the HELLFIRE missile. Fielding the LONGBOW system will enable Apache and light helicopter aircraft to detect and engage targets under adverse weather and obscured battlefield conditions and will improve survivability by significantly reducing aircraft exposure time required to acquire and engage these targets.

The LONGBOW Program, integrated into the Apache aircraft, provides adverse weather combat capability.



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For additional information, contact:  
Aviation Applied Technology Directorate (AATD)  
Attn: Jerry Irvine, Public Affairs Officer  
Fort Eustis, VA 23604-5577  
AV 927-3272 or (804) 878-3272



## SOLDIER SUPPORT

**U.S. Army Troop Support Command**  
**U.S. Army Laboratory Command**

### **Nuclear Hardening of Mobile Electric Power Generating Sources**

The Belvoir Research, Development, and Engineering Center (BRDEC) and the Project Manager for Mobile Electric Power (PM-MEP) have worked closely with Harry Diamond Laboratories (HDL) and White Sands Missile Range (WSMR) on a number of nuclear hardening efforts:

**Quiet Reliable Generator (QRG) Sets** were designed without nuclear survivability requirements, but were tested at a Defense Nuclear Agency (DNA) high explosive event with hardening enhancements including a "battle box" developed by the Ballistic Research Laboratory (BRL). The battle box will permit operation of the generator set after a nuclear event if the controls have been damaged.

**Signature-Suppressed Diesel Engine Driven (SSDED) Generator Sets** were designed to survive all nuclear effects. HDL designed overturn protection devices for these generator sets which, when outfitted on the sets, provided a fully-hardened design. These generator sets were successfully tested during two DNA high explosive events.

**Tactical Quiet Generator (TQG) Sets** will be the new family of mobile electric power generating sources for DoD and will be available in 3, 5, 10, 15, 30, and 60 kilowatt sizes and in several different configurations (see photo). Currently in First Article Testing, they are designed to survive only high-altitude electromagnetic pulse effects. The remaining nuclear environments will be addressed in a product improvement program. Experience gained by HDL, BRL, PM-MEP and BRDEC during the QRG and SSDED programs could be applied to TQG sets to meet future product improvement goals.

**For additional information, contact:**  
Project Manager—Mobile Electric Power  
Attn: AMCPM-MEP-T, Bill Merrill  
7500 Backlick Road  
Springfield VA 22150  
DSN 345-3761 or (703) 355-3761

Item Manager—Troop Support Command  
Attn: AMSTR-STP  
DSN 693-9293 or (314) 263-9293

Material Developer—Belvoir RD&E Center  
Attn: STRBE-FG  
DSN 354-5870 or (703) 714-5870

Nuclear Survivability Lab, Harry Diamond Laboratories  
Attn: SLCHD-NW  
DSN 290-3100 or (301) 394-3100





## SOLDIER SUPPORT

U.S. Army Laboratory Command

### High Power Microwave Test and Simulation

Increasingly susceptible electronics, an increase in the number and power of civilian and military emitters, and deficiencies in existing protection have created a new awareness of and need for HPM hardening, and for test/simulation facilities.

**HPM Injection Facility:** Harry Diamond Laboratories' unique 100-kilowatt HPM injection facility provides an economical way to initially explore the effects of HPM on military equipment prior to more expensive target irradiation. By the direct injection technique, one can conduct susceptibility assessment experiments and design HPM protective circuits such as limiters and filters for receiver protection.

Our wide range of source capability coupled with extensive microwave diagnostics and real time data reduction provides one-of-a-kind capability and makes it useful to a broad range of investigators.

The capabilities and special features along with our team of high-power RF specialists are an ideal combination to study semiconductor failure thresholds and damage mechanisms, evaluate hardening techniques and devices, and conduct equipment survivability and vulnerability tests.



Scientists work with sophisticated equipment to develop HPM-hardening methods.



For additional information, contact:  
Director, U.S. Army Harry Diamond Laboratories  
Attn: SLCHD-NW-CS, Lou Jasper  
2800 Powder Mill Road  
Adelphi, MD 20783-1197  
AV 290-1403 or (301) 394-1403  
  
Director, U.S. Army Harry Diamond Laboratories  
Attn: SLCHD-NW-RS, Marc Litz or Bill Lilley  
2800 Powder Mill Road  
Adelphi, MD 20783-1197  
AV 290-3657 or (301) 490-3657

## SOLDIER SUPPORT

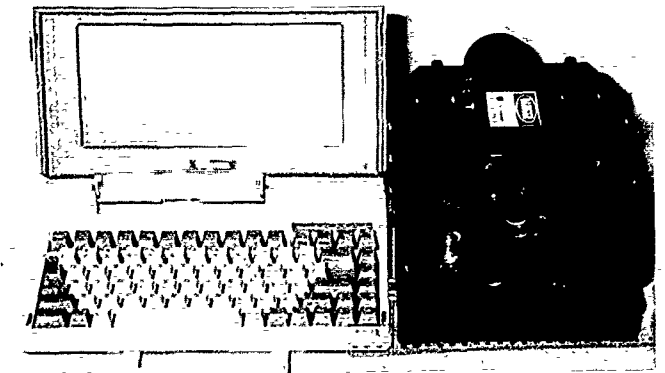
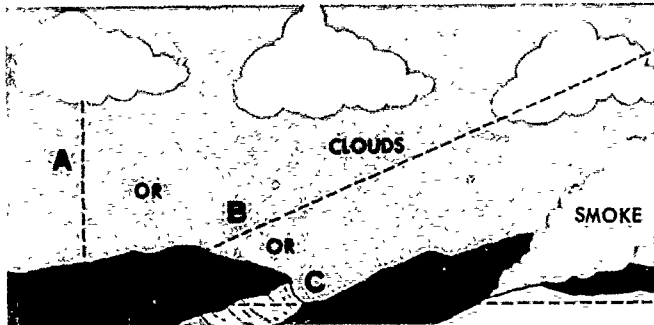


U.S. Army Laboratory Command

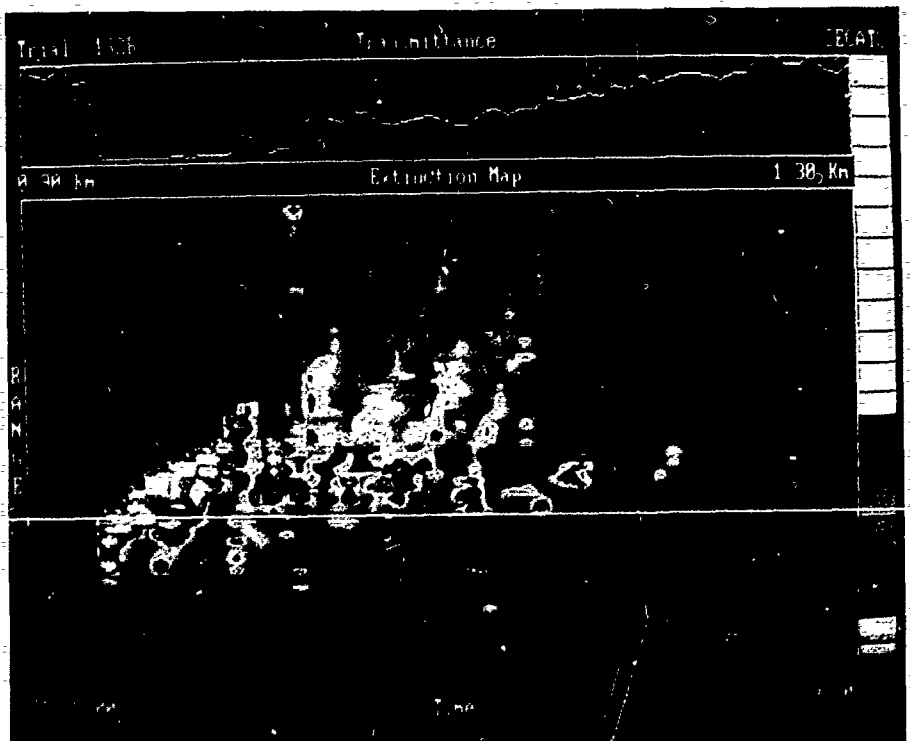
### Visioceilometer

The Visibility and Ceiling Sensor, or "Visioceilometer," is a small, eye safe, portable pulsed laser (LIDAR) that measures visibility, cloud height, and the transmittance of smoke, obscurants and pollutants. It also measures the relative density and changes in obscurant structure over time. Additionally, the visioceilometer can detect solid objects within or on the far side of clouds, smoke, or obscurants. The device, being compact and weighing only 12 pounds, is designed to be used by the individual soldier.

The visioceilometer supports the Program Manager for Smoke and Obscurants (PM-Smoke) in the characterization of battlefield obscuration.



Above, angles used in measuring visibility, clouds, and the transmittance of obscurants. Above right, the Visioceilometer and laptop companion used for visibility and cloud analysis. Right, the computer displays the density map of a cloud.



For additional information, contact:  
U.S. Army Atmospheric Sciences Laboratory  
Attn: SLCAS-AS-1, Mr. Arnold Wade  
White Sands Missile Range, NM 88002-5501  
AV 258-1761 or (505) 678-1761



U.S. Army Laboratory Command

## Mobile Imaging Spectroscopy Laboratory (MISL)

The Mobile Imaging Spectroscopy Laboratory (MISL) is composed of the Target Contrast Characterizer (TCC) and a Fourier Transform Spectrometer (FTS). The MISL characterizes the changes in spectral and spatial propagation of images as a function of atmospheric conditions in real time for weapon system comparison testing and performance modeling. Applications include battlefield selection of optimum weapons for given atmospheric situations. The MISL features:

- Visible, 3-5  $\mu\text{m}$  and 8-12  $\mu\text{m}$  imagery at close-up and engagement (to two kilometers) range
- Field of view matching in the infrared with 6.9X, 13.5X and 17.0X magnification
- Spectral measurements of atmospheric transmission and source and sensor response.

The imagers are remotely controlled and imagery is transferred via a fiber-optic data link. A unique image processor makes possible precise scene registration from the near-field and far-field positions. This allows for direct measurement of the inherent contrast, the contrast transmission, and the atmospheric modulation transfer function.

A mobile imager is remotely controlled and imagery is transferred via a fiber-optic data link.



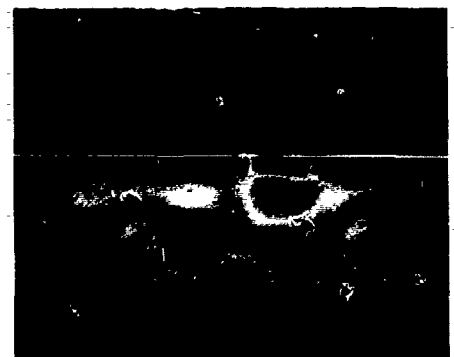
A unique image processor makes possible precise scene registration from near-field and far-field positions.



For additional information, contact:  
 U.S. Army Atmospheric Sciences Laboratory  
 Attn: SLCAS-AR, Mr. Wendell Watkins  
 White Sands Missile Range, NM 88002-5501  
 AV 258-4313 or (505) 678-4313



3-5  $\mu\text{m}$  image



8-12  $\mu\text{m}$  image



U.S. Army Laboratory Command

## Enhancing Military Performance by Improving Intelligibility Through Active Noise Reduction

The ability to communicate accurately is a critical factor in the successful completion of many military tasks. Poor communication affects the interpretation of verbal commands leading to misunderstandings, errors, and the increased risk of mission failure.

The Human Engineering Laboratory (HEL), in cooperation with the U.S. Armor School at Fort Knox, Kentucky, and the U.S. Infantry School at Fort Benning, Georgia, has conducted research to quantify, as a function of speech intelligibility, performance measures in the following categories:

- Time to accomplish various aspects of the mission,
- Percent time mission was completed,
- Number of mission errors,
- Gunner accuracy, and
- Navigational errors.

One method of improving speech intelligibility is through the use of phase cancellation technology. HEL has been instrumental in incorporating active noise reduction through phase cancellation in both the DHI32 (tanker) and SPH4 (aviation) helmets. This modification will reduce noise at the operators' ears, resulting in improved communication, reduced hearing loss, and enhanced system performance.



For additional information, contact:  
 Director, U.S. Army Human Engineering Laboratory  
 Attn: SLCHB-BR, Maj. Leslie Peters or  
 Mr. Georges Garinther  
 Aberdeen Proving Ground, MD 21005-5001  
 AV 298-5977 or (301) 278-5977

The use of phase cancellation technology in reducing active noise results in improved communication, reduced hearing loss, and enhanced systems performance.







## SOLDIER SUPPORT

U.S. Army Armament, Munitions and Chemical Command

### Physiological Burden Reduction in Mask Design

Two of the areas most critically in need of improvement for the combat soldier wearing an NBC (Nuclear, Biological and Chemical) respirator are vision and speech communication. The Advanced Protective Systems Integration Laboratory has adapted, modified, and developed physiological techniques to measure peripheral and binocular visual fields, static and dynamic visual and color acuity, and eye-lens and interpupillary distances in order to evaluate various lens configurations in respirator designs. New automated methods of evaluating speech intelligibility, attenuation with distance, direction, and recognition have been developed to evaluate various respirator design concepts including materials, structural shape, and speaker distance from the mouth, for the next generation NBC respirator. Incorporation of these findings has resulted in dramatic improvements in visual and communication capability for the combat soldier when required to function in a chemical environment. Modifying the respirator shape to incorporate the improved visual components has also permitted adding additional capabilities to improve physiological functions that were not possible with older designs.

Various approaches to physiologically enhancing communication in the respirator are also being investigated, including bone conduction through facial bones, using the ear drum to both send and receive messages, and electronic amplification of the voicemitter diaphragm.

These developments will have application in the private sector for those required to wear masks as part of their duties, such as firefighters and hazardous materials workers.

Dramatic improvements have been made in the visual and communication capabilities of NBC respirators.



For additional information, contact:  
Commander, U.S. Army Chemical Research, Development  
and Engineering Center  
Attn: SMCCR-PPI, Dr. Ronald A. Weiss  
Aberdeen Proving Ground, MD 21010-5423  
DSN 584-2313 or (301) 671-2313



## SOLDIER SUPPORT



U.S. Army Laboratory Command

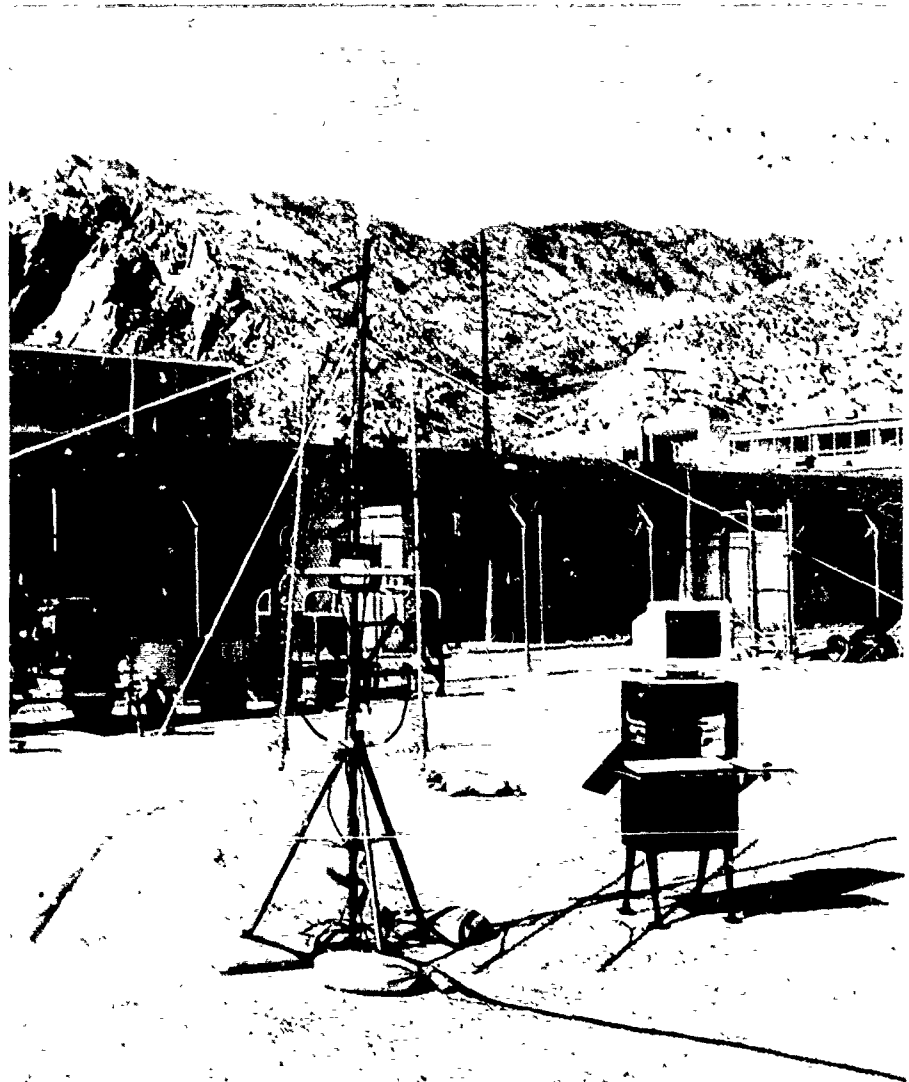
### Portable Meteorological System

The Portable Meteorological System is a lightweight tactical system designed to collect, process, and display weather data. This system has real-time capability to support the U.S. Army in low-intensity conflicts and special contingency operations, as well as weather teams at division level and below.

The system (work station and antenna assembly) receives and processes data from both geostationary and polar orbiting satellites to include direct satellite imagery, and data relayed by either satellite or direct radio (high frequency) transmission.

The Atmospheric Sciences Laboratory is developing Tactical Decision Aids which will be included on the system software, using the data collected to aid battlefield decision makers.

The work station and antenna assembly of the Portable Meteorological System receives data from geostationary and polar orbiting satellites.



For additional information, contact:  
U.S. Army Atmospheric Sciences Laboratory  
Attn: SLCAS, Mr. John Elrick  
White Sands Missile Range, NM 88002-5501  
DSN 258-36C1 or (505) 678-3691



**AMC Field Assistance in Science and Technology**

**Gunmount Recoil Kit for Tank Cannons**

The gunmount recoil kit will significantly reduce the time and costs associated with periodically exercising the recoil mechanisms of the M256/M68 cannons on the M1 and M60 families of tanks, especially those tanks at prepositioned material configuration unit sets (POMCUS) sites and in war reserve. Current doctrine requires the recoil mechanism of all cannons, which have not been fired within a given period of time, to be exercised to lubricate the seals before firing.

Current doctrine prescribes procedures for conducting artificial exercising using either the M3 handpump or the hydraulic boom of the 5-ton wrecker. Both procedures have proved to be costly and have damaged the recoil mechanisms of the cannons. The proposed method is a dependable, fail-safe procedure that significantly reduces labor costs and eliminates the possibility of damaging the recoil mechanism causing a catastrophic failure of the cannon system.

Features of the gunmount recoil kit include:

- Reduced exercise time for 58 tanks from 240 man-hours to 12 man-hours
- Compatibility with both M68 (105mm) and M256 (120mm) tank cannons
- Off-the-shelf components
- Capability of being operated at organizational maintenance.

The gunmount recoil kit for M256/M68 cannons allows exercise of recoil mechanisms while reducing time and cost.



**For additional information, contact:**

Director, Benet Laboratories

Attn: SMAR-CGB-DC,

Watervliet, NY 12189

DSN 974-4867 or (518) 266-4867

Director, U.S. Army Ballistic Research Laboratory

Attn: SLCBR-SE-B, Maj Curtis L. McCoy

Aberdeen Proving Ground, MD 21005-5066

DSN 298-9075 or (301) 278-9075

Director, U.S. Army Human Engineering Laboratory

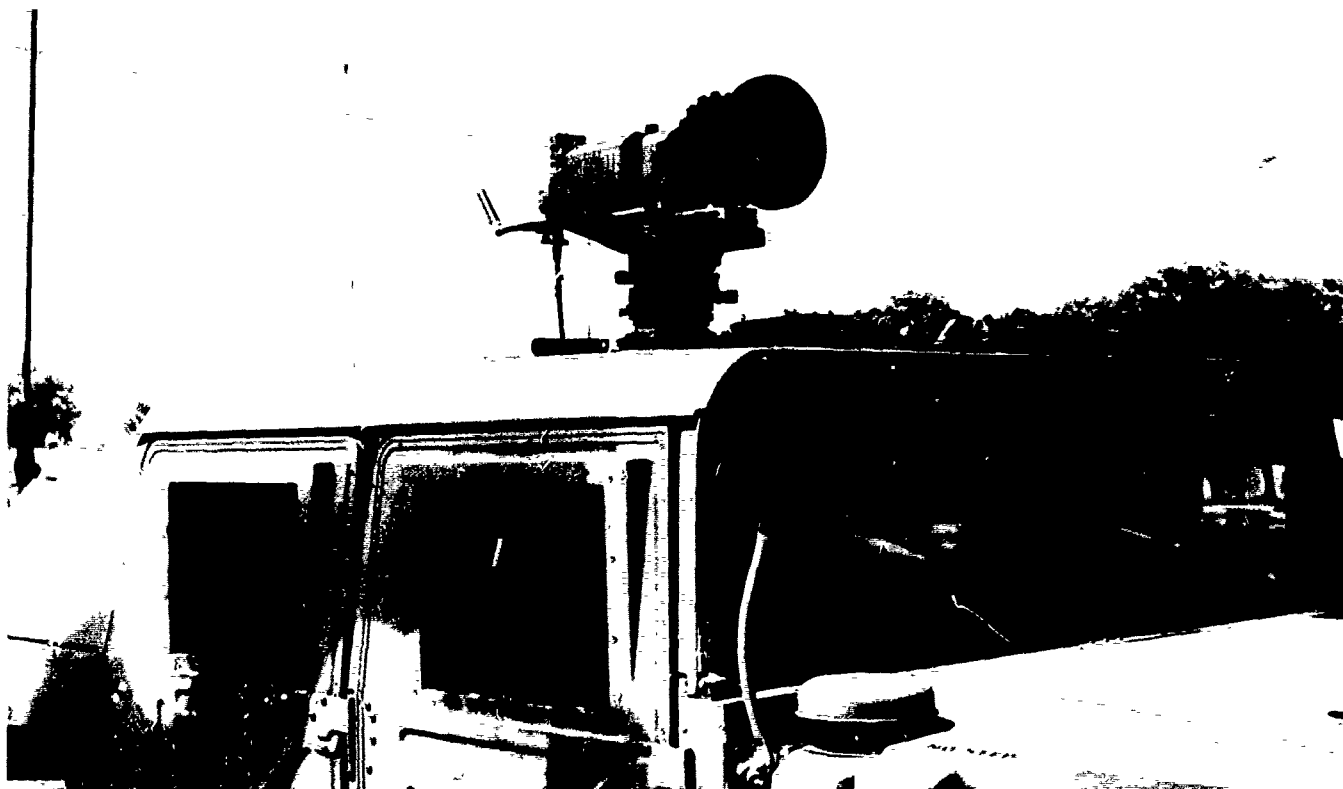
Attn: SLCHE-SS-ED, Mr. Bruce E. Amrein

Aberdeen Proving Ground, MD 21005-5001

DSN 298-5900 or (301) 278-5900

**AMC Field Assistance in Science and Technology****Scout Surveillance (AN/TAS-6 on HMMWV)**

The mounting of the AN/TAS-6 radar on the High Mobility Multipurpose Wheeled Vehicle (HMMWV) addresses a long-standing need to improve the surveillance capability of U.S. Army-Europe (USAREUR) Scouts. Currently, USAREUR Scout surveillance equipment is limited to eight power binoculars which are highly inadequate to meet the needs of USAREUR Scouts. The Communications-Electronics Command Center for Night Vision and Electro-Optics (C2NVEO), conducted a market survey, demonstrated equipment, and conducted troop evaluations of the equipment. As a result of the troop evaluations, it was recommended that USAREUR Scouts be provided the AN/TAS-6. AMC-FAST is currently preparing a decision document for the Commander-in-Chief-USAREUR, requesting that USAREUR be provided 270 AN/TAS-6s for use by USAREUR Scouts. On receipt of the USAREUR request, the Missile Command (MICOM) is prepared to provide on a conditional release, 150 AN/TAS-6s.



The AN/TAS-6 mounted on the HMMWV with 2X extender lens will provide USAREUR Scouts with the capability to greatly improve mission performance

For additional information, contact:  
Director, CECOM Center for Night Vision,  
Electro-Optics  
Attn. AMSEL-RD-NV, Charles Jones  
Fort Belvoir, VA 22060-5677  
AV 354-1811 or (703) 664-1811



**U.S. Army Laboratory Command**

## **Mobility-Portability (MP) Course**

The Human Engineering Laboratory's (HEL) Mobility-Portability (MP) Course has become an Army standard for measuring the effects of soldier load on mobility and physiological functions. The course also provides distribution and method of attachment, interactions among materiel the soldier carries, and durability for fielded and developmental items. The course consists of hard surfaced and wooded march areas and obstacles that require the soldier to run, jump, crawl, climb, and so forth. Objective course data, time and error data, subjective data, and soldier opinions and comments are augmented with real-time physiological data.

Features of the MP course are:

- Interactive system software for information identification, storage, and retrieval
- An integrated system status board for real-time trial status
- Data collection software to compile individual obstacle time, intra-obstacle time, and total elapsed time
- Bio-physical telemetry system for monitoring soldier heart rate, skin and core temperatures with projected growth to include sweat rate and "G" loading.

The Mobility-Portability (MP) course is an obstacle course designed to measure the effects of soldier load on mobility and physiological functions.



For additional information, contact:  
Director, U.S. Army Human Engineering Laboratory  
Attn: SLCHC-CC-LHD, Dave Harrah  
Aberdeen Proving Ground, MD 21005-5001  
AV 298-5926 or (301) 278-5926



## AIR DEFENSE

U.S. Army Missile Command

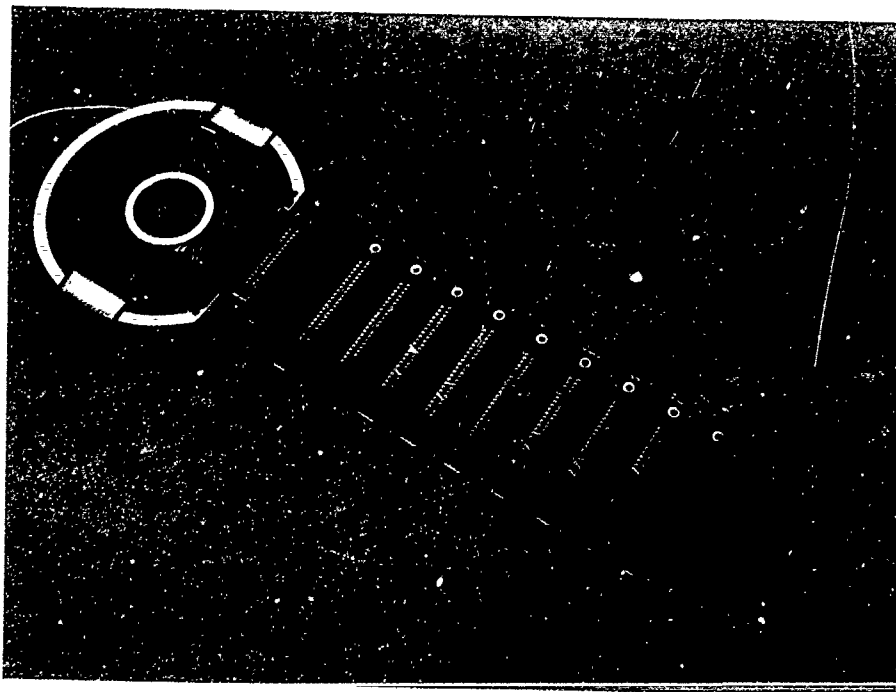
### Manufacturing Technology

The U.S. Army Missile Command's (MICOM) Manufacturing Technology Program conducts research and development of the processes, equipment, and techniques required to produce the advanced technology hardware used in the modern Army's missile systems. Past accomplishments have resulted in both significant savings in military systems' production costs and have spun off to commercial product applications.

The photograph shows the initial results of one of the over one hundred manufacturing technology developments conducted to date. This multilayer rigid-flex printed wiring board shown was produced for the Copperhead Missile using processes, procedures, and material combinations developed by MICOM. The rigid-flex board combines traditional rigid board sections with flexible sections which perform the same function as interconnecting cables without the need for connectors and associated wiring.

Significant cost savings resulted from the rigid-flex effort. The calculated return on investment on the Copperhead Program alone is 160 to 1. Results have also been applied to fabrication of the avionics of the F-15 Eagle, AV8B Harrier, and NASA's Space Shuttle, and to numerous commercial product applications.

The multilayer rigid-flex printed wiring board was produced for the Copperhead missile using processes, procedures, and materials combinations developed by MICOM to withstand the high-g environment of the missile's cannon launch. A significant cost saving resulted from this development and results have also been applied to fabrication of the avionics in the F-15 Eagle, AV-8B Harrier, and NASA's Space Shuttle, as well as to numerous commercial applications.



For additional information, contact:  
Donald E. Dunstone  
U.S. Army Missile Command  
Attn: AMSMI-RD-SE-MT  
Redstone Arsenal, AL 35898-5270  
DSN 746-2140 or (205) 876-2140



**U.S. Army Project Manager for Training Devices**

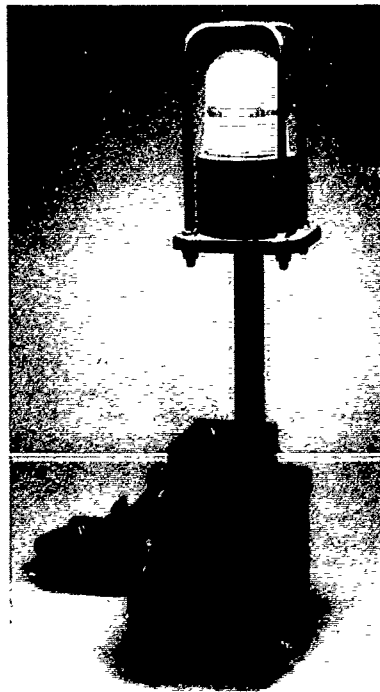
## **Shoot-Through-Obscuration Multiple Integrated Laser Engagement System (STOM)**

The Shoot-Through-Obscuration Multiple Integrated Laser Equipment System (STOM), also called Shoot-Through-Obscuration MILES, is a laser training system being developed to operate with Forward Looking Infrared (FLIR) systems during battlefield exercises where visibility is impaired. The STOM system is capable of ranges in excess of 4 km and can penetrate battlefield obscurants such as fog-oil smoke, dust, and rain.

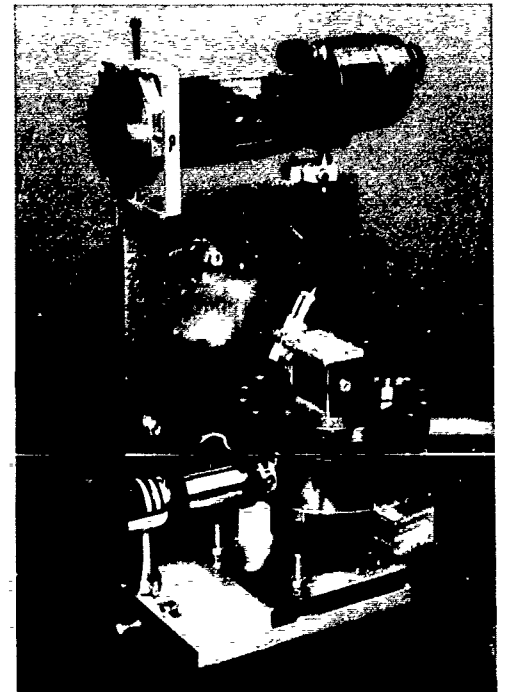
STOM is designed to complement the existing Multiple Integrated Laser Engagement System (MILES). MILES uses eyesafe gallium arsenide semiconductor lasers emitting at 0.904 micrometers to simulate the various weapons being fired. Silicon detectors are placed on various targets to receive the incoming laser hits. With MILES, a gunner firing a laser transmitter can successfully hit whatever he/she can see.

STOM employs a radio frequency (RF) excited CO<sub>2</sub> laser which operates in the center of the FLIR's spectral window at 10.6 micrometers. The laser, which is sealed, non-cooled, and measures less than 6 inches in diameter and less than 2 inches high, delivers 30-watt pulses. The pulse width, which can be as short as 50 microseconds, and the time between pulses are microprocessor-controlled. In addition, the STOM system uses an extremely sensitive, room temperature laser receiver which consists of a pyroelectric detector coupled with a low-noise hybridized preamplifier. This receiver is capable of detecting the 10.6 micrometer STOM laser pulses with irradiance as low as 50 microwatts/cm<sup>2</sup>, using no collecting optics. The STOM system can successfully penetrate natural or manmade obscurants which limit visibility, thereby permitting a gunner using FLIR to engage otherwise obscured targets.

STOM-uncooled CO<sub>2</sub> laser detector assembly (small box) atop MILES independent target system-prototype test setup.



**For additional information, contact:**  
Office of the Project Manager for Training Devices  
Attn: AMCPM-TND-EC, James W. Surhigh  
12350 Research Parkway  
Orlando, FL 32826-3276  
AV 960-4351 or (407) 380-4351



STOM-RF excited CO<sub>2</sub> sealed laser prototype test setup.



U.S. Army Laboratory Command

## Mathematical Model of the Human Auditory System

Modern high performance weapons produce impulses intense enough to affect operational use because of hazards to the ear.

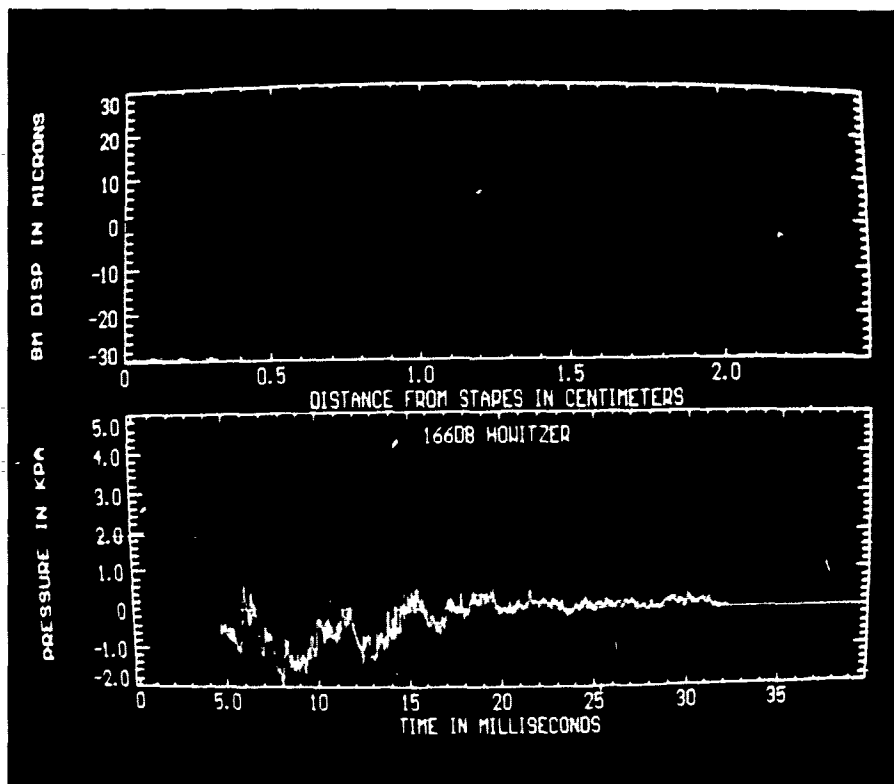
In order to provide physical insight into the functioning of the ear at high intensities, the Human Engineering Laboratory (HEL) has developed a mathematical model consisting of a system of coupled non-linear differential equations or, alternatively, a network of electro-acoustic elements that maintain a conformality with the ear's physiology. Free-field sound pressures drive the model, and values representing displacements, pressures, velocities, etc., can be calculated for structures as far along as the basilar membrane, which is the primary site of damage.

The model includes a nonlinear middle ear at high intensities and calculates hazards within the cochlea based on the mechanical stress at the level of the basilar membrane. For intense sounds, the model ranks hazards appropriately and suggests that damage is the result of factors not previously accounted for and that no standard analytical technique could be expected to succeed. Additionally, it suggests novel means for ameliorating hazard. The basis for much of the model's effectiveness is the non-linear annular ligament of the stapes which effectively peak-clips cochlear input at high levels.

Advantages of the model are that it suggests strategies for reducing hazard without penalizing weapon performance and it provides a basis for a new international standard for impulse noise exposure.

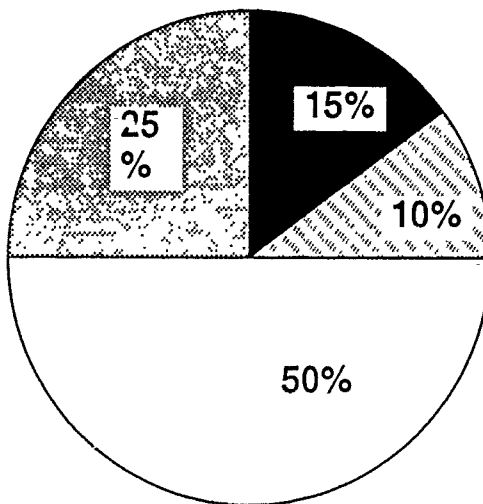


For additional information, contact:  
 Director, U.S. Army Human Engineering Laboratory  
 Attn: SLCHE-BR, Dr. G. Richard Price  
 Aberdeen Proving Ground, MD 21005-5001  
 AV 298-5976 or (301) 278-5976



These graphs show the inner ear's response to Howitzer impulses.





- SUPPORTING CAPABILITIES**
- Facilities and Ranges
  - Modeling and Simulation
  - Assessment Technology
  - Test and Evaluation
  - Special Purpose Equipment and Computers

## SOLDIER SUPPORT



**U.S. Army Laboratory Command**

### **Simulation of Nuclear Blast and Thermal Effects**

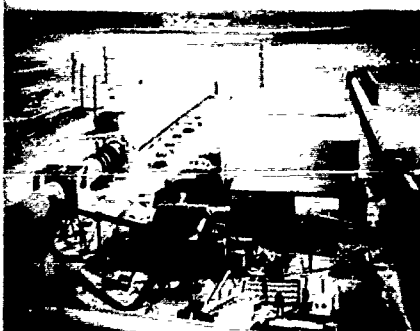
In order to survive the effects of a nuclear explosion, military hardware must be sufficiently hardened against those effects. On the nuclear battlefield, the blast effects of a nuclear explosion will be experienced within a few seconds of the arrival of the thermal pulse. Since heated objects are more susceptible to blast effects, combined thermal/blast effects simulation is required to develop successful hardening measures. Scientists at Harry Diamond Laboratories (HDL), working with others at the Defense Nuclear Agency (DNA), the Ballistic Research Laboratory (BRL), and the Nuclear Effects Directorate (NED) of the Test and Evaluation Command, have developed the capability to meet blast and thermal testing requirements.

Nuclear blast effects can be simulated in a shock tube where compressed gases are suddenly released to produce shock waves. The Army has two shock tubes, 5 feet and 8 feet in diameter, both located at BRL. Nuclear thermal effects can be simulated by either concentrating sunlight with the White Sands Solar Furnace (a part of NED), or using the chemical combustion of aluminum powder in oxygen as a source of thermal radiation at BRL's thermal radiation simulator.

To meet testing requirements over the next 30 years, DNA is building a large combined blast and thermal simulator which will be unique in this country. The requirements for the large blast/thermal simulator have resulted from tri-service test requirements and research projects being conducted at the Laboratory Command (LABCOM). LABCOM has the responsibility for characterizing this facility for DNA and for providing research for product improvement to maintain a state-of-the-art facility. The 8-foot shock tube at BRL is being used as a probative tube to test design concepts and prototypes for the large blast and thermal simulator. The simulator will allow testing of objects the size of a truck with combined blast and thermal environments. This DNA facility will be located at White Sands Missile Range and operated by NED. It is expected to be available by June 1994.



**For additional information, contact:**  
Director, U.S. Army Harry Diamond Laboratories  
Attn: SLCHD-NW-P, Mary Abe  
2800 Powder Mill Road  
Adelphi, MD 20783-1197  
AV 290-2856 or (301) 391-2856



The Army uses the two shock tubes, shown above at BRL, to simulate nuclear blast effects.



BRL's thermal radiation simulator uses the chemical combustion of aluminum powder in oxygen to simulate nuclear thermal radiation.



Nuclear thermal effects can also be simulated by concentrating sunlight, as is done at the White Sands Solar Furnace.



## AVIATION

U.S. Army Test and Evaluation Command

### Moving Target Simulator

The Moving Target Simulator (MTS) is the best place (and in some instances, the only place) to investigate pointing/tracking performance of ordnance delivery, air defense, and fire control systems. The MTS provides testing under controlled repeatable conditions at significant savings in time and personnel, as well as cost savings of \$1.5 million annually compared to field testing.

The MTS is enclosed by a 100-foot radius air-supported, hemispherical dome, the interior wall of which serves as a projection screen. The image of a target is projected by a computer-controlled Beam Steering System (BSS) which maneuvers the target image through unlimited prespecified motion profiles. Visible and thermal targets can be simulated. It presents radar and laser target range returns dynamically, simulating 3-dimensional target motion profiles, to assess air defense tracking and fire control systems.

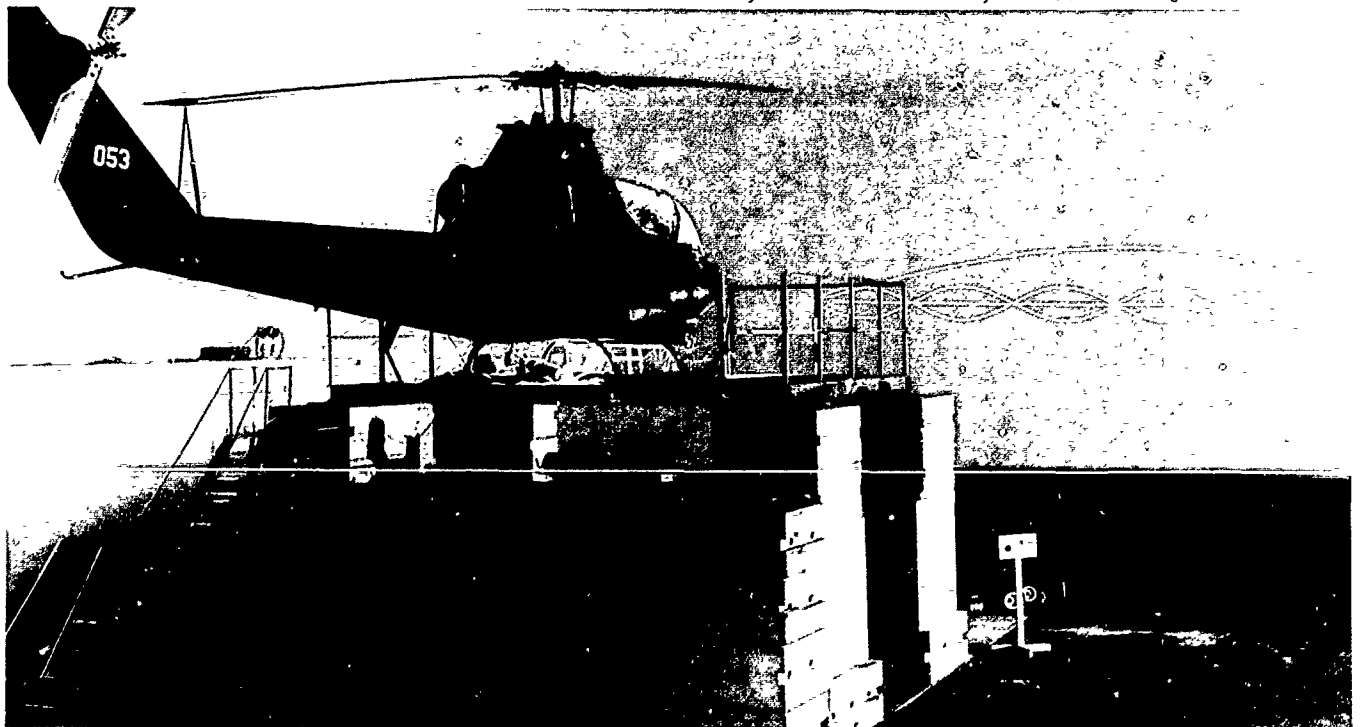
State-of-the-art computers are used for the on-site control, acquisition, and analysis of test data. They provide:

- Near real time throughput of information for the acquisition/decision process,
- Early detection and correction of performance shortcomings,
- Evaluation of performance to "like" test systems.

This functionality is critical to the "test-fix-test" environment because it provides the end-users with the safest, highest performance, and quality equipment.

For additional information, contact:  
U.S. Army Combat Systems Test Activity  
Attn. STECS-EN-EI, J. A. Compton  
Building 436  
Aberdeen Proving Ground, MD 21005  
DSA (AV) 298-7703 or (301) 278-7703

Evaluation of weapon systems against maneuvering targets on open ranges is extremely costly, time consuming, and impossible to replicate. The Moving Target Simulation (MTS) facility eliminates these problems. The MTS is enclosed in a 100-foot radius air supported hemispherical dome whose surface is a screen for laser projected targets (ground vehicles, high performance aircraft and helicopters). A computer precisely controls target movement. This facility has been operational for about seven years and has been extremely successful in reducing test time and costs.





## SOLDIER SUPPORT

### U.S. Army Test and Evaluation Command

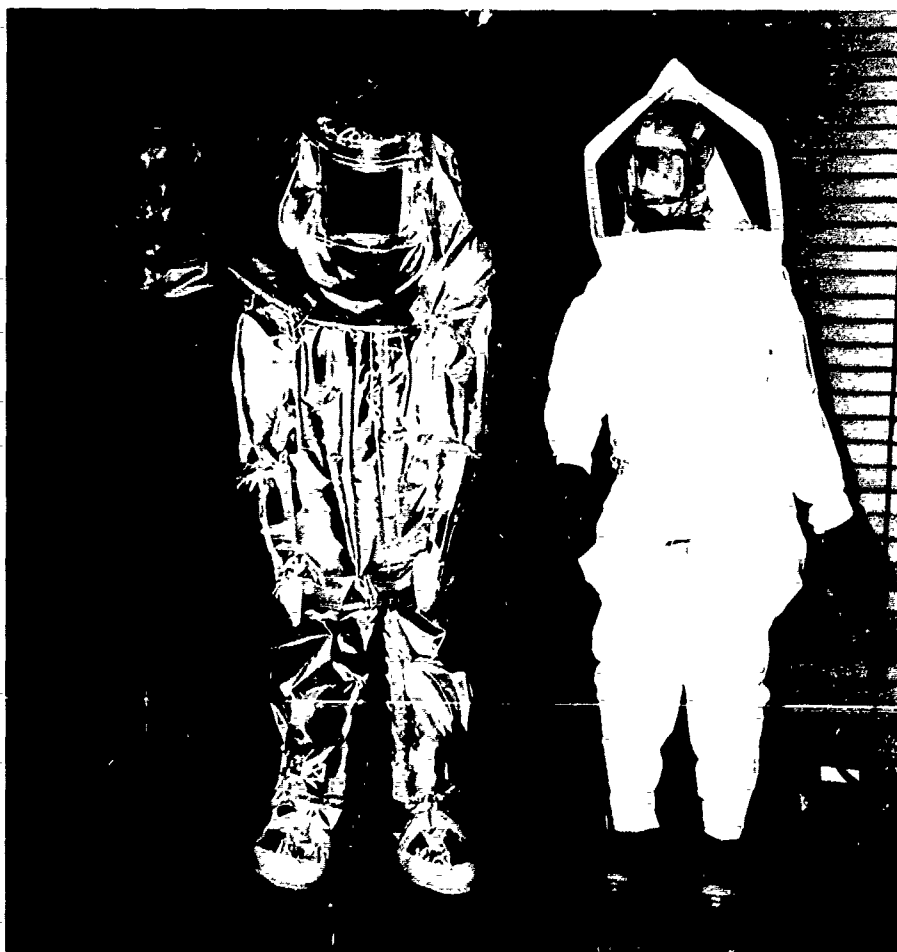
## Robotic Mannequin



"Manny," an articulated robotic mannequin for testing protective clothing in hostile environments, can move, perspire, and breathe like a human. Manny's unique sampling system can detect penetration of the clothing by hazardous environments.

"Manny" is an articulated robotic mannequin designed to be equivalent to a 75th percentile human male, i.e., 5'11", 165 lbs. Manny was developed for the Army's Dugway Proving Ground in Utah, by the Battelle Pacific Northwest Laboratory. The mannequin will test protective clothing worn by soldiers when in hazardous environments. It has features not normally associated with robots, such as body temperature, perspiration, and simulated breathing. Piezoelectric chemical sensors are attached to the surface of the skin, to provide real-time data as to the garment's effectiveness to resist penetration by the contaminating environment.

The articulated mannequin will replace the present static mannequin and provide a more realistic dynamic clothing testing capability. The mannequin with its fully automated control and real-time data acquisition systems allows for safe, cost-effective testing of protective clothing. Significant dollar and manpower savings are anticipated as critical agent penetration data will be available up front to make acquisition decisions, by discovering deficiencies early on that might delay, stop, or escalate the cost of a protective clothing development. As a result of the realistic testing "Manny" provides, the soldier will be provided protective clothing which will allow him to carry out his assigned mission in a safe and effective manner.



For additional information, contact:  
Charles E. DeWitt  
STEDP-MT-D-I  
Dugway Proving Ground  
Dugway, Utah 84022  
AV 789-5311 or (801) 831-5311



U.S. Army Laboratory Command

## Electronic Warfare Threat Emulators of RF Self-Screening Jamming Systems and Electro-Optical Countermeasures Systems

In conducting the independent electronic warfare vulnerability assessment of U.S. Army air defense weapon systems, the Vulnerability Assessment Laboratory (VAL) subjects the system under investigation to realistic battlefield countermeasure conditions. In performing this function, countermeasure systems similar to the ones depicted are used in field experiments.

UH-60 Blackhawk helicopters, carrying Radio Frequency (RF) self-screening jammers (also called RF electronic countermeasures pods) on the inboard wing stations and self-protecting chaff/flare pods on the outboard wing stations, are used to evaluate the RF and electro-optical components of U.S. Army air defense weapon systems. The RF self-screening jammers, packed with sophisticated electronics, are capable of generating signals to investigate the effects of several different deceptive jamming techniques. The chaff/flare systems are certified to be carried by several fixed-wing, rotary-wing, and subscale targets. They can be configured for multiple scenarios—chaff only, flares only, or a combination of the two.

Subjecting the air defense weapon system to a hostile ECM environment under field conditions clearly establishes weapon system performance deficiencies. VAL is dedicated to identifying weaknesses, as well as recommending improvements, to produce U.S. Army weapon systems capable of defeating the most sophisticated enemy.



For additional information, contact:  
Gilberto Mares  
Air Defense and Space Systems Vulnerability Division  
Vulnerability Assessment Laboratory  
AV 258-6130 or (505) 678-6130

UH-60 Blackhawk helicopter, carrying RF self-screening jammers on the inboard wing stations and self-protecting chaff/flare pods on the outboard wing stations.





# FIRE SUPPORT

## U.S. Army Laboratory Command

### Human Factors Howitzer Test Bed

The Human Factors Howitzer Test Bed demonstrates advanced technology concepts in the areas of simplified fire control, ammunition handling, command and control, and crew life support and protective systems on a single platform. The overall program analyzes the interface between the soldier and his increasingly complex weaponry.

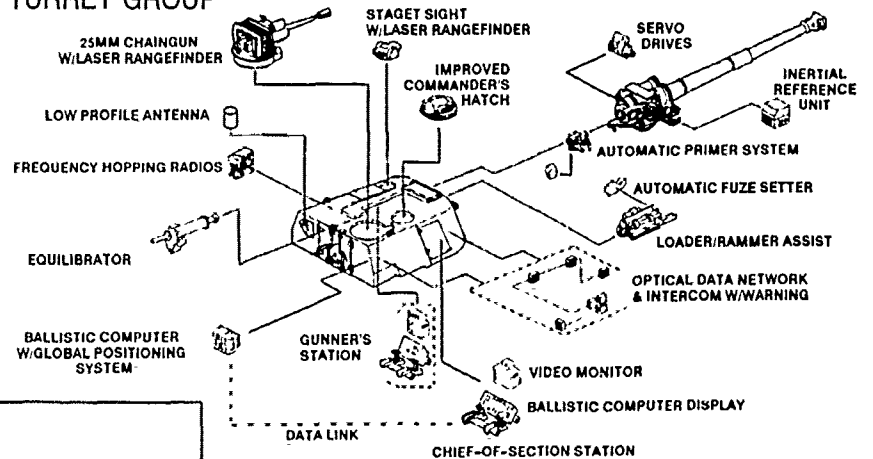
The test bed will provide more responsive and accurate indirect fire support, with fewer crew members. Each of the components incorporated into the concept was selected for its ability to increase the capability of the firing platform while reducing or simplifying crew tasks.

The completed vehicle will be demonstrated in a concept evaluation program and the results will influence the design of the Advanced Field Artillery System.

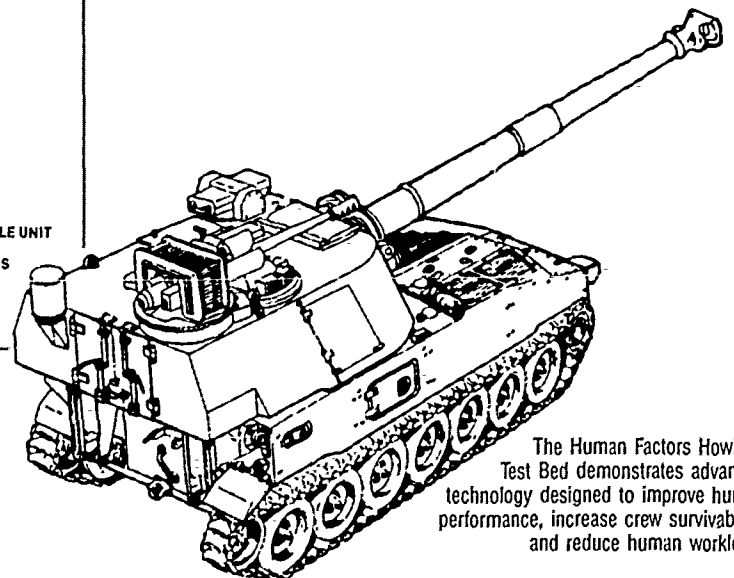
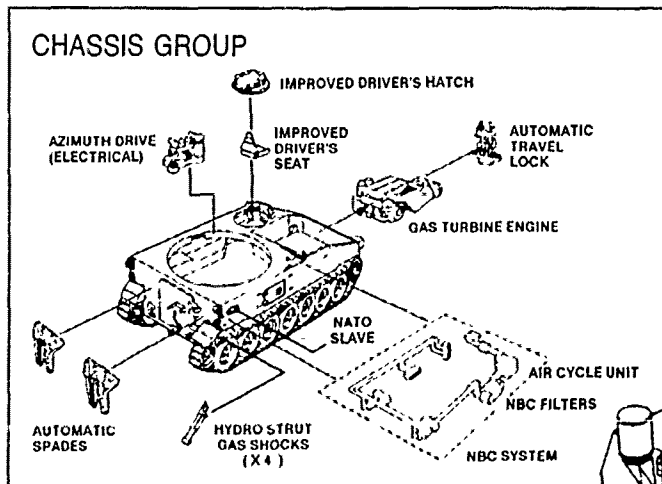


For additional information, contact:  
Director, U.S. Army Human Engineering Laboratory  
Attn: SLCHE-FT, Mr. William Dousa  
Aberdeen Proving Ground, MD 21005-5001  
AV 298-5886 or (301) 278-5886

#### TURRET GROUP



#### CHASSIS GROUP



The Human Factors Howitzer Test Bed demonstrates advanced technology designed to improve human performance, increase crew survivability, and reduce human workload.



## SOLDIER SUPPORT

U.S. Army Troop Support Command

### Army Field Feeding System (AFFS)

The Army Field Feeding System (AFFS) is designed to provide three nutritious meals a day to soldiers, under a variety of climatic and field conditions. The system meets stringent requirements for short setup and quick response times, low reliance on manpower, easy transportability, low dependence on fuel and water, and adaptability to different levels of troop consolidation.

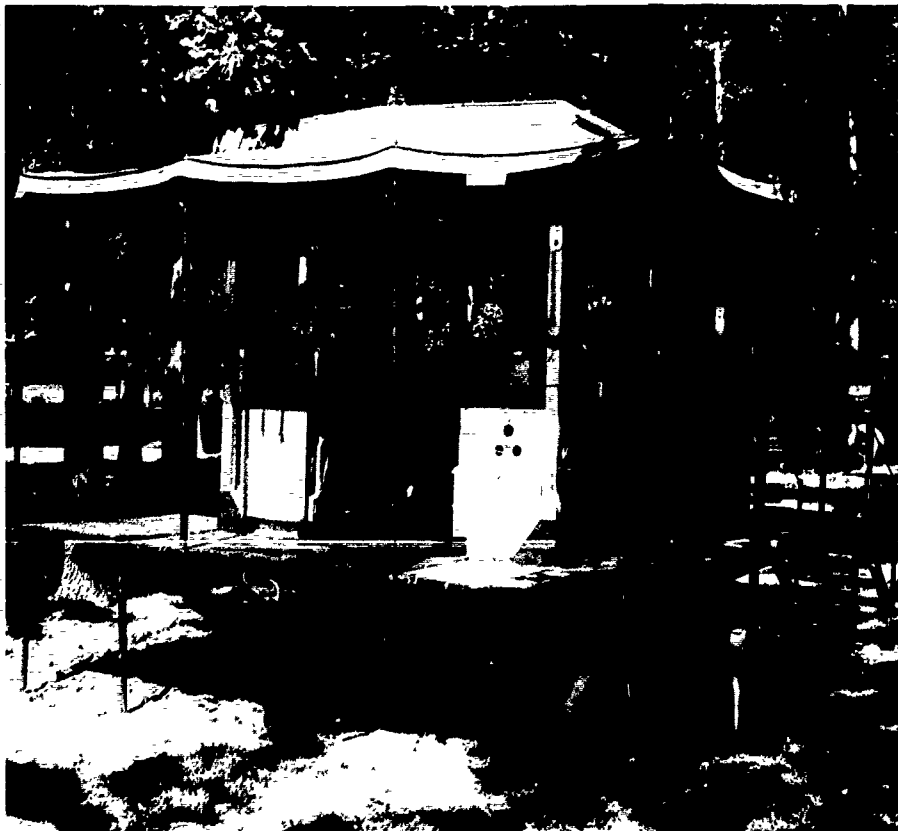
Equipment incorporates:

- Materials and engineering technologies in order to maintain operability of equipment in severe cold and hot weather
- Sanitation and material concepts to protect foods during preparation, serving, and distribution, and to sanitize food service equipment more efficiently and effectively
- Technology for efficient, lightweight, and compact refrigeration/freezing for delivery/storage of perishable food items
- Heat transfer technologies for the efficient utilization of chemical or electrical energy in heating and warming foods
- System design and configuration concepts that optimize space, equipment and manpower utilization and that maximize versatility, adaptability, efficiency, and effectiveness
- Technology to reduce weight and volume of both equipment and associated shelters.

For additional information, contact  
U.S. Army Natick Research, Development and  
Engineering Center  
Attn: STRNC-W, Mr. David Saren  
Natick, MA 01760-5000  
DSN 256-5184 or (508) 651-5184



The Mobil Kitchen Trailer is a completely self-contained field kitchen. The versatility of this system allows four cooks to prepare A-Ration meals from scratch or to heat and serve Tray Ration meals for up to 300 soldiers in the field. The system is currently the central core of the Army Field Feeding System (AFFS), which is designed to ensure that soldiers receive three nutritious meals per day.





## INTELLIGENCE AND ELECTRONIC WARFARE

**U.S. Army Communications-Electronics Command**

### **TRIPHAMMER Intelligence and Electronic Warfare Processor (IEW-P)**

The TRIPHAMMER Intelligence and Electronic Warfare Processor (IEW-P) is a non-system specific prototype developed to demonstrate the feasibility of collecting, correlating, and displaying data from multiple sensor types to more effectively provide combat information to the battlefield commander. By minimizing redundant information and correlating multiple source data, the overall battlefield intelligence product can be improved while simultaneously reducing dependence on active sensors. This results in enhanced sensor survivability and possible reduction in sensor numbers and overall costs.

The IEW-P incorporates commercial-off-the-shelf hardware and software, U.S. Army non-developmental items (NDI), and Command and Communications Signal Warfare (C<sup>2</sup>SW) mission-specific software. This approach provides exceptional flexibility and allows for evolutionary growth while greatly reducing the development time as well as the overall project cost.

The command and communications signal warfare (C<sup>2</sup>SW) IEW-P uses icons to represent sensed and correlated targets, and includes digital terrain/evaluation data.



For additional information, contact:  
Commander, U.S. Army Communications-Electronics  
Command Center for SW  
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Fort Monmouth, NJ 07753  
DSN 229-7096 or (201) 349-7103





## SOLDIER SUPPORT

U.S. Army Test and Evaluation Command

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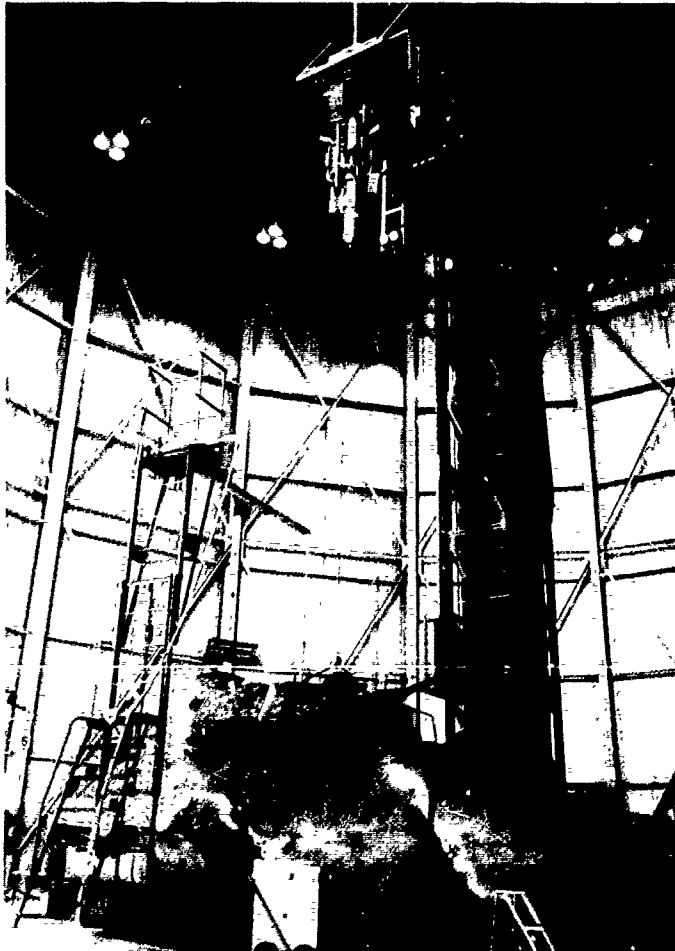
### Coping with the Nuclear Threat: Radiation Shielding

A major component of the nuclear threat involves initial nuclear radiation (INR) which consists of neutrons and gamma radiation. INR is very penetrating. Neutrons can easily penetrate heavy armor and can be a deadly threat to armored vehicle crews. INR can also produce both permanent and transient damage to electronic, optical, and other subsystems and components.

The Army Pulse Radiation Facility (APRF) at the Combat Systems Test Activity, Aberdeen Proving Ground, produces an INR test environment with a high degree of realism. Measurements are made on full size armored and non-armored vehicles and anthropomorphic phantoms to determine radiation shielding, protection factors, and personnel exposures; and hence determine methods to reduce vulnerability in a nuclear environment.

The concept of combined armor embodies another practical method to reduce armored vehicle crew vulnerability. Combined armor is the selective addition of certain material at specific locations, which provides increased protection against both conventional threats and radiation. This has been adopted by several NATO countries and is verified by tests such as those at the APRF.

Armored vehicle radiation test at the Army Pulse Radiation Facility (APRF) assesses radiation effects to reduce crew vulnerability.



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For additional information, contact:  
Director, Nuclear Effects Directorate  
Attn: Dr. A. H. Kazi  
Aberdeen Proving Ground  
Aberdeen, MD 21005-5059  
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## INTELLIGENCE AND ELECTRONIC WARFARE



U.S. Army Laboratory Command

### Electronic Warfare Threat Emulators for Electro-Optical Countermeasure Systems

The Vulnerability Assessment Laboratory has developed threat electro-optical countermeasure (EOCM) systems and devices to emulate current and postulated threats for missile firings and acquisition/tracking experiments.

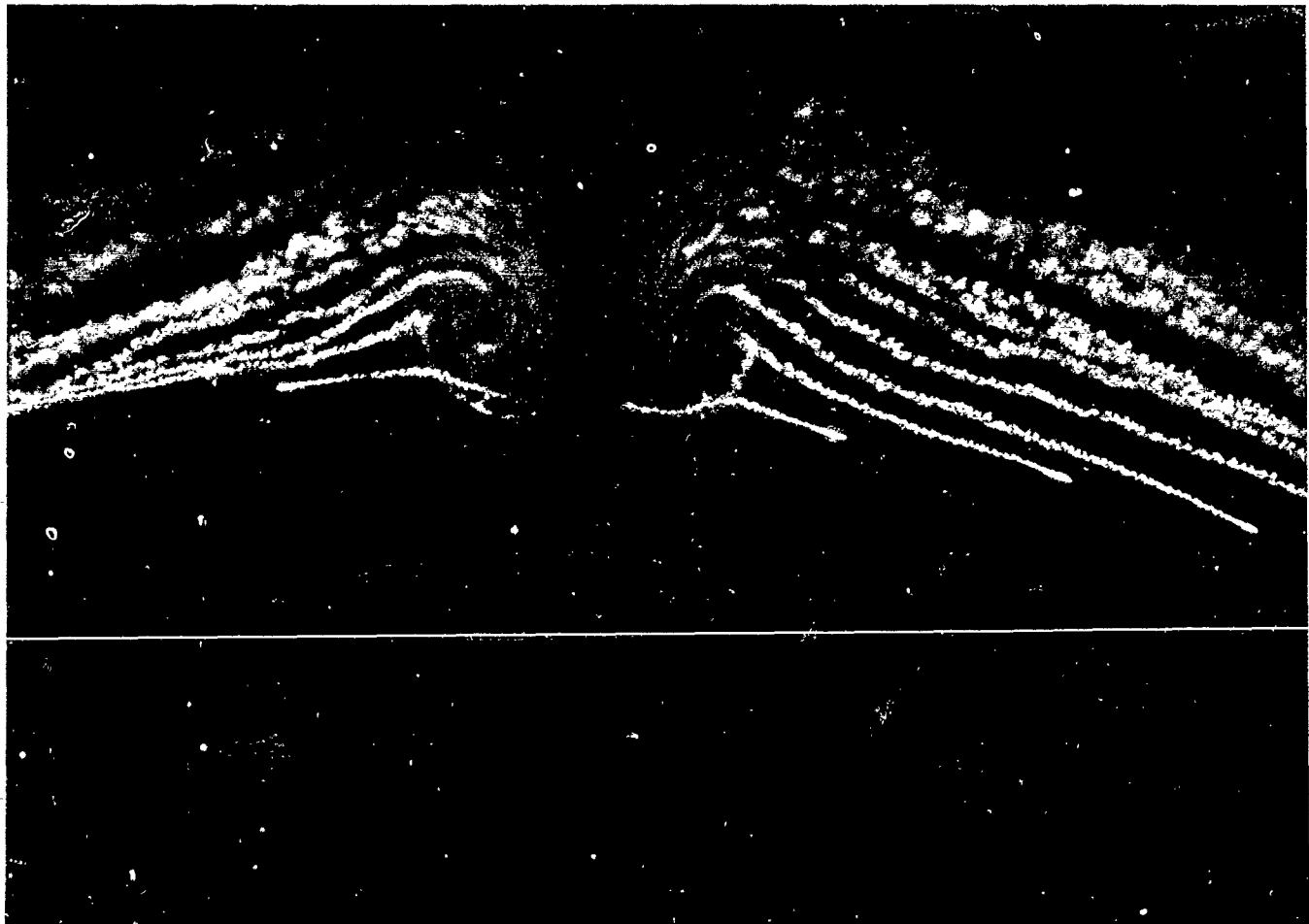
EOCM systems are currently certified on several fixed-wing, rotary-wing, and subscale targets, and can be controlled remotely if desired. They can be configured for multiple run scenarios, can fire flares in any direction over a large range of rates, and can be adapted to many different types of flares.

Additionally, infrared (IR) and ultraviolet (UV) jammers are available when test objectives require them. EOCM devices are also developed for tests and experiments involving laser systems.



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Vulnerability Assessment Laboratory  
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This helicopter has been fitted with electro-optical countermeasure systems and devices for acquisition/tracking experiments.





## AVIATION

U.S. Army Test and Evaluation Command

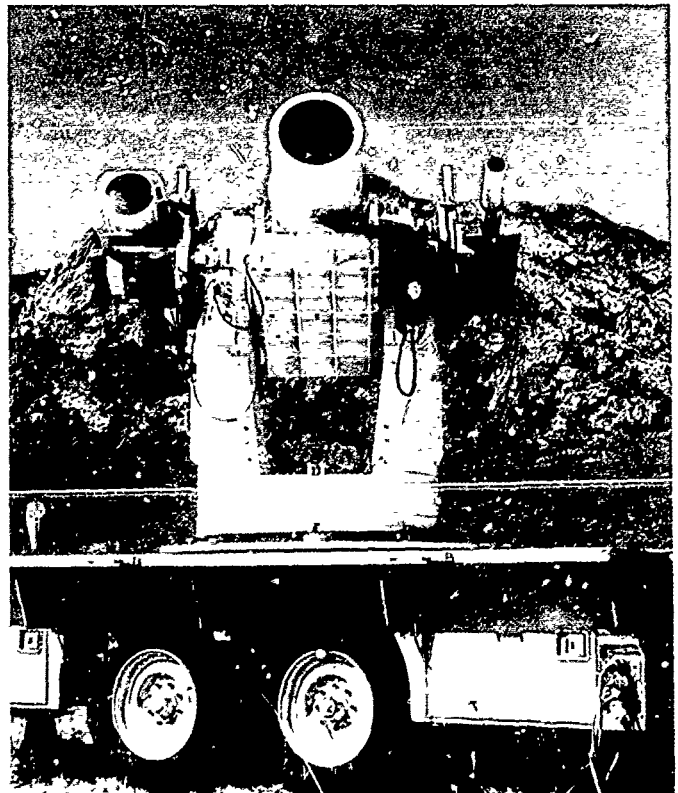
### Remote Instrument Control System (RICS)

The kinetic energy missile (KEM) being developed as an anti-tank weapon for use by the U.S. Army achieves an exceptional high velocity during its flight and has presented a unique challenge for providing the optical instrumentation that is required during the KEM test program at White Sands. A fully automated high performance Launch Area Theodolite (LAT) mobile tracking mount has been developed by White Sands to provide precise trajectory data throughout the KEM flight as well as detailed photographic imagery on a scale never before achieved for a target moving at such high rates. The eight LAT tracking mounts are spaced along the KEM flight path at a standoff distance of only 4000 feet. The LAT mounts are equipped with a conventional video sensor, a forward looking infrared (FLIR) sensor, a high speed 35-mm film camera, and an in-house developed automatic video tracker. The LAT mounts are operated under full remote control from a remote location by a Remote Instrumentation Control System (RICS). The combination of LAT mounts and RICS vans have been networked together into a real-time control system that provides a very powerful new capability for use within the missile test community. This optical instrumentation development has been carried out as an in-house effort using individual items built by industry along with Government-developed items and controlled by software developed at White Sands.

The Remote Instrument Control System (RICS) operates optical tracking instruments for anti-tank weapons.



The LAT tracking mount provides precise data for missile tracking. It is operated from the RICS.



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U.S. Army Laboratory Command

## EW Vulnerability of Weapons and Command, Control, Communication, and Intelligence (C<sup>3</sup>I) Systems

The mission of the U.S. Army Vulnerability Assessment Laboratory (VAL) is to conduct independent assessments of the vulnerability of Army weapons and C<sup>3</sup>I systems to hostile electronic warfare (EW). VAL also provides electronic countermeasures (ECCM) recommendations and technical expertise to assist Army decision makers and developers in eliminating or reducing those vulnerabilities.

A complete vulnerability assessment requires detailed threat assessment, theoretical analyses, laboratory investigations, computer simulations, and field investigations. Threat assessments define and quantify the current and projected EW systems, waveforms, and doctrine utilized by adversaries. Theoretical analyses are conducted in an effort to predict weapon system performance against the defined threat as well as new electronic countermeasures (ECM) techniques being developed from emerging technologies.

In the laboratory, actual weapon system hardware is used to investigate performance against a wide variety of countermeasures. These investigations also serve to validate theoretical results. Computer simulations are developed when actual hardware is unavailable or impractical to investigate in a laboratory setting.

Finally, field investigations are performed in order to validate previous investigations or demonstrate performance that cannot be tested in the laboratory or modeled on the computer. In order to accomplish this field testing, threat level ECM devices are developed, fielded, and certified by VAL.



For additional information, contact:  
Special Projects Office  
Attn: Thomas Reader  
Vulnerability Assessment Laboratory  
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Field investigations are conducted to demonstrate performance.



Testing of Apache AH-64 Helicopter in the Special Electromagnetic Interference Vulnerability Assessment Facility (SEMIVAF).



## AVIATION

### U.S. Army Test and Evaluation Command

## Trial Before Combat

The U.S. Army Aviation Development Test Activity (USAAVNDTA) plans, conducts, evaluates, and reports on technical testing of aviation materiel (aircraft, aircraft components, aircraft subsystems, and aviation-related support equipment) and exploitation of foreign materiel. USAAVNDTA has one of nearly every type of aircraft in the active Army inventory and has the ability and expertise to configure these aircraft to meet nearly any testing requirement. The Activity's instrumentation includes sophisticated devices for in-flight recording of all aspects of aircraft performance, and an engine test facility that allows repeatable static testing of engines at a low cost.

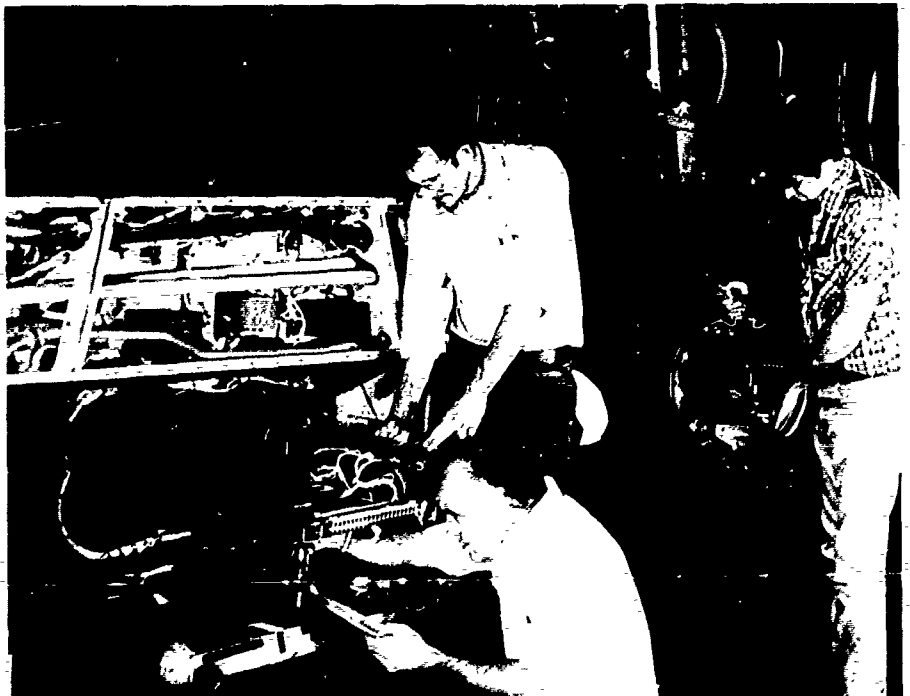
In accomplishing its mission, USAAVNDTA operates the Aviation Technical Test Center (ATTC). The ATTC is responsible for:

(1) planning, conducting, analyzing, and reporting results of aviation systems tests to include all installed subsystems and related aviation support equipment; (2) conducting airworthiness qualification flight tests of air vehicles developed and/or procured as integrated systems and for the airworthiness evaluations of those vehicles proposed or considered for Army application or incorporating advanced concepts having potential military applications; (3) test operations in support of exploratory research and advanced development programs related to aviation technology, and in support of foreign materiel exploitations; and (4) testing of aviation systems and aviation-related support equipment for non-Army Government agencies and private industry.

For additional information, contact:  
U.S. Army Aviation Development Test Activity  
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Fort Rucker, Alabama 36362-5276  
AV 558-8087 or (205) 255-8087



An AH-64 Apache helicopter undergoing flight testing of its armament systems. During the technical test phase, aircraft are highly instrumented to ensure that all needed data is collected from the aircraft, armament, and fire control systems.



Aircraft maintenance and instrumentation technicians are installing various instrumentation packages in an attack aircraft prior to technical flight testing.



## ROBOTICS

### U.S. Army Armament Munitions and Chemical Command

## Explosive Ordnance Disposal Automated Information and Expert Retrieval System

The Explosive Ordnance Disposal (EOD) Automated Information and Expert Retrieval System (AIRES) provides on-site assistance to improve the efficiency and effectiveness of the soldier-technician during the identification and "render safe" procedures for unexploded ordnance.

The system features:

- Expert systems software for information
- Optical disk data storage
- Flat panel display for graphics and text data presentation
- Touch interaction for operator input

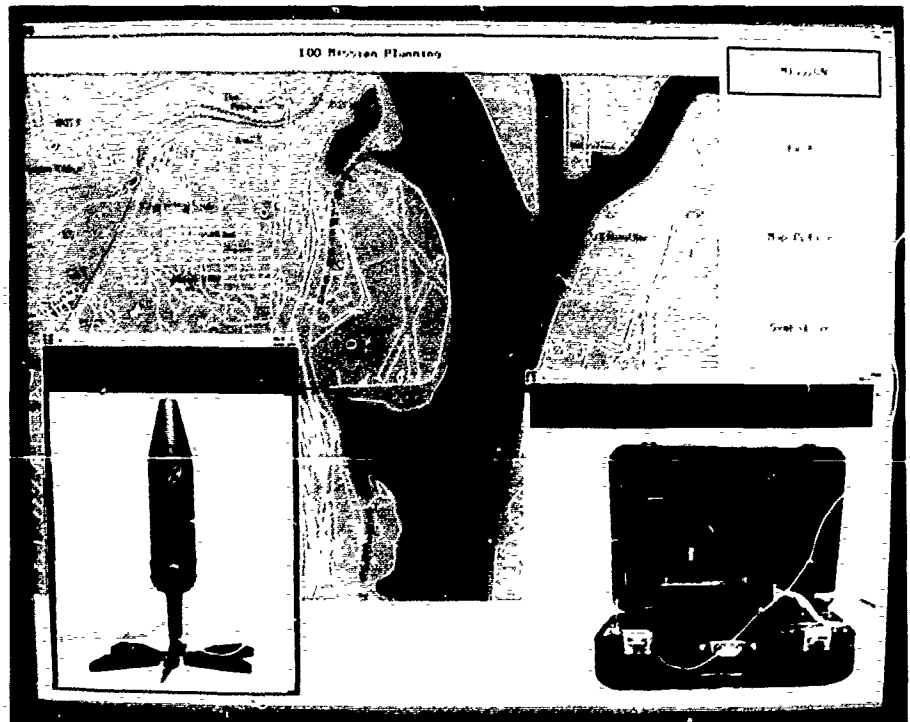
Advances in the state-of-the-art for these technologies have made it possible to effectively access large, complex data bases in the tactical environment. The hardware and software techniques used in this prototype system apply to a wide range of diagnostic and prognostic problems in the tactical environment. Further improvements to AIRES are being demonstrated in the areas of:

- RF communications (SINGARS)
- Electronic security
- Video capture of "first seen" ordnance in digital format
- Video display and transmission
- Munition characteristic examination and operation sequence
- Terrain mapping

Explosive Ordnance Disposal (EOD) Automated Information Retrieval and Expert System (AIRES) aids EOD technicians during identification and "render safe" procedures for unexploded ordnance.



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Picatinny Arsenal, NJ 07801-5000  
DSN 890-2188 or (201) 724-2188

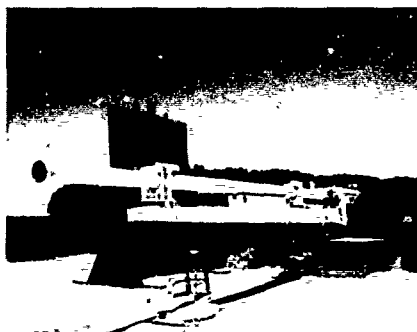




## U.S. Army Test and Evaluation Command

### Live Fire Vulnerability and Lethality Testing

This newly developed launching system uses compressed gas to fire missiles at weapons during testing.



The Depleted-Uranium (DU) Containment Fixture (SUPERBOX) is a state-of-the-art, environmentally safe, fixture for explosive testing involving DU materials.

Live fire testing is some of the most highly visible testing presently being conducted within the military development community. Unfortunately, there are many misconceptions about the purpose, requirements, and overall nature of live fire testing. US Army Combat Systems Test Activity has been a key player in the development and conduct of DOD live fire testing. It conducts live fire lethality and vulnerability testing for the Army, Navy and Marines, and can therefore present DOD universal lessons learned, joint service utilization of unique facilities, and DOD wide value of the live fire testing program.

USACSTA evaluates the performance of military weapon systems against maneuvering targets; however, performing these tests on open ranges is costly and time consuming and accurate control of target motion is difficult. The Moving Target Simulation facility has been developed to overcome these problems. It can simulate weapons expected on a modern battlefield, such as ground vehicles, high performance aircraft, and helicopters. The simulator is enclosed in a 100-foot radius air-supported hemispherical dome. The inside surface serves as a projection screen, where a laser beam steering system allows projection of line drawings or images of targets and movement of those targets under precise computer control. The facility has operated for about seven years and has been extremely successful in reducing test time and costs.

Live Fire Vulnerability and Lethality testing, conducted by the U.S. Army Test and Evaluation Command (TECOM) at Aberdeen Proving Ground, MD, provides a unique opportunity to evaluate system vulnerability/lethality in as realistic an environment as possible.



For additional information, contact:  
Kersey Jones, USACSTA  
Palmer L. Paules, USACSTA  
Aberdeen Proving Ground, MD

## INTELLIGENCE AND ELECTRONIC WARFARE



### U.S. Army Laboratory Command

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## Big Crow

The Big Crow, an extensively modified NKC-135A based electronic warfare (EW) flying laboratory, is the most versatile resource in the free world for airborne EW research and development. It is capable of autonomous EW test support, calibrated instrumentation, and real-time analysis. The Big Crow's primary mission is to emulate EW threat environments for conducting EW vulnerability assessments of various Department of Defense weapon systems.

The Big Crow aircraft is equipped with a suite of electronic equipment that is easily reconfigurable, permitting great flexibility in mission capability. The EW equipment can also be dismantled from the aircraft and used in various ground-based experiments at different sites. The Big Crow has the capability to carry aloft entire missile systems or subsystems, either within the space available in the radomes or externally-mounted under the wings.

The Big Crow can generate various modulation schemes which include barrage noise, spot noise, cross-polarized pulsed-wave and continuous-wave, and deception signals.

Its EW repertoire contains features such as communication jamming, stand-off/escort self-screening/self-screening jamming, chaff environments, radar jamming, data-link jamming, and electronic support measures.

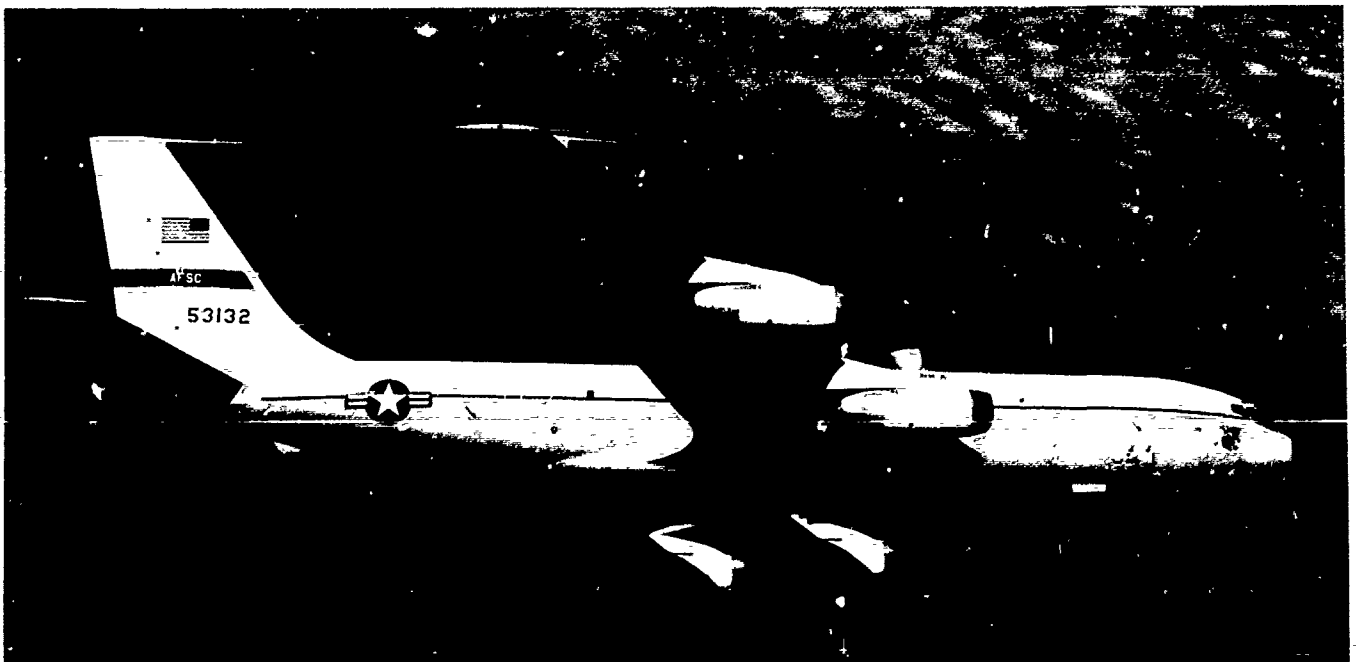
As a result of being recently upgraded with an inflight refueling capability, the Big Crow can support customers requiring jamming and signal intercept processing information over extended periods.



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For additional information, contact:  
Chief, Vulnerability Assessment Laboratory  
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The Big Crow flying laboratory is capable of autonomous support of a wide range of EW activities.





## ARMORED SYSTEMS



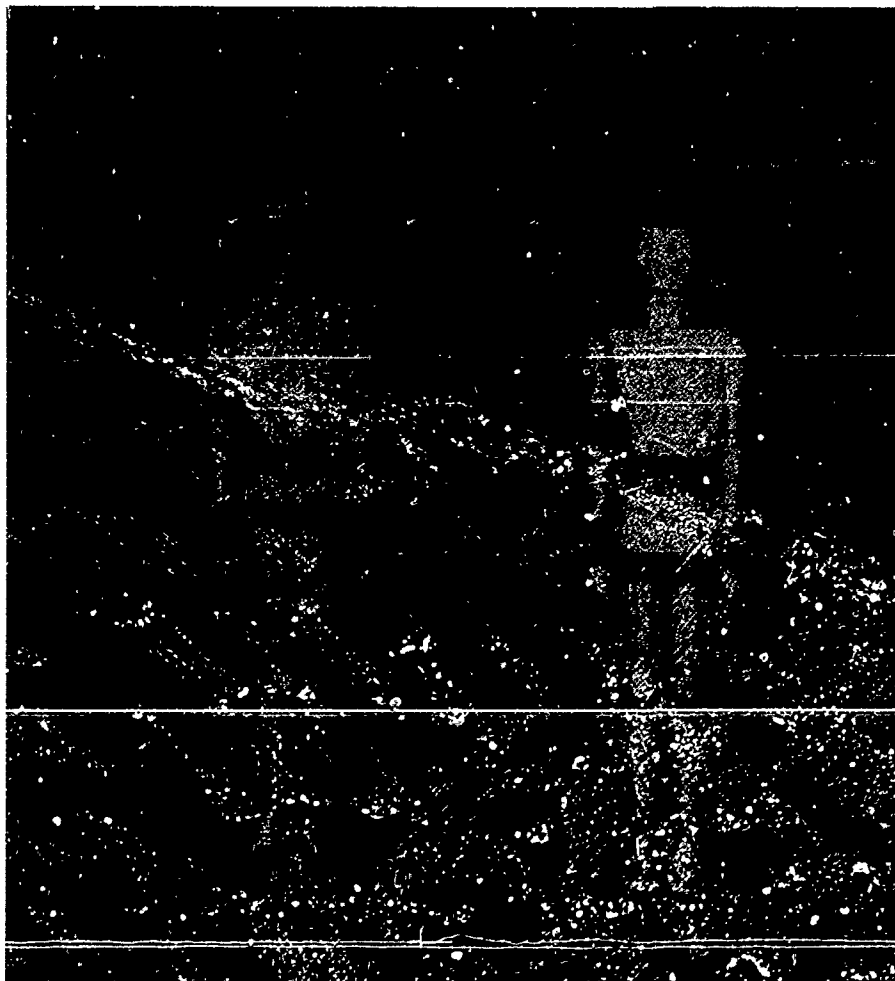
U.S. Army Laboratory Command

### Human Figure Performance Modeling (JACK)

Created by the Computer Graphics Research Laboratory at the University of Pennsylvania with funding and guidance from the U.S. Army Human Engineering Laboratory (HEL), the Army Research Office (ARO), and other Government and private sponsors, JACK is a three dimensional Computer-Aided Engineering (CAE) and human figure performance model. JACK will be used to perform human factors evaluations and analyses on Computer-Aided Design (CAD) drawings generated by developers for the Government's research and development centers. Proposed equipment designs can be evaluated from the soldier-machine interface point of view before a prototype is built and design options are restricted.

Currently JACK is a fully articulated human body model with anthropometric sizing controlled by a spread-sheet-like program, multiple position and orientation goals, and various body display graphics. JACK includes menu-driven interaction with command macros, view analysis and real-time motion playback. Future improvements will include incorporation of current Army anthropometric data into the model database, natural language user interface, clothing restraints, and human locomotion.

Human figure performance model, JACK, will be used in Computer Aided Design (CAD) drawings to evaluate proposed equipment designs before the actual prototype is built.



For additional information, contact:  
Director, U.S. Army Human Engineering Laboratory  
Attn SLCHE-CC LHD, Ms Brenda Thein  
Aberdeen Proving Ground, MD 21005-5001  
AV 298-5945 or (301) 278-5945



## SOLDIER SUPPORT

U.S. Army Laboratory Command

### Small Arms/Soldier Performance Firing Range

The Human Engineering Laboratory's (HEL) Small Arms/Soldier Performance Firing Range is a state-of-the-art facility for examining soldier weapon performance. It consists of multiple stationary and moving targets which are controlled by a computer-equipped command and control center. The firing range permits the engagement of targets at a wide variety of distances, target exposure times, and angles.

The range features four firing lanes with target exposures from 25 to 550 meters, and three targets at each distance in each lane. There are also three moving targets per lane—at 80, 130, and 180 meters—and pneumatically operated target mechanisms.

The command and control center is computer-equipped and is capable of presenting programmed arrays of targets at any distance, time interval, or sequence. It can also present a different target scenario in each lane simultaneously.

The computer system has a software package that records and reduces range events to include targets presented, target time, target hits, shots fired, time of shot, etc., as well as an acoustic measurement system which provides horizontal and vertical coordinates of a hit or a near miss on a target.

Through the use of the Small Arms/Soldier Performance Firing Range, HEL can closely examine soldier weapon performance to determine the most effective small arms technologies of the future.



For additional information, contact:  
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