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DESCRIPTIVE SUMMARIES OF THE RESEARCH DEVELOPMENT TEST AND EVALUATION, ARMY APPROPRIATION FY 1978, VOLUME I

JANUARY 1977

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Submitted to Congress January 1977

Descriptive Summaries Of The

RESEARCH DEVELOPMENT TEST & EVALUATION
Army Appropriation FY 1978

DEPARTMENT OF THE ARMY DEPUTY CHIEF OF STAFF
FOR RESEARCH DEVELOPMENT AND ACQUISITION
RDTE PROGRAMS AND BUDGET DIVISION

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VOLUME I

DESCRIPTIVE SUMMARIES FOR PROGRAM ELEMENTS

OF THE

RESEARCH, DEVELOPMENT, TEST, AND EVALUATION, ARMY PROGRAM

FY 1978. Volume I.

JANUARY 1977

Department of the Army
Deputy Chief of Staff for Research, Development, and Acquisition

FOREWORD

These volumes have been prepared to provide information on the US Army Research, Development, Test, and Evaluation Program for Congressional Committees during the Fiscal Year 1978 hearings. This information is in addition to the testimony given by US Army witnesses.

These volumes contain a descriptive summary for each program element to be financed during FY 1978 or FY 1979. Descriptive summaries for projects within the program elements to be financed during FY 1978 or FY 1979 for $3.0 million or more appear on buff colored pages immediately following the applicable program element. Where there are several items under development within a project, a separate summary has been provided for each item that exceeds $3.0 million during FY 1978 or FY 1979. A Test and Evaluation Section is provided for all major weapon systems.

There are thirty-nine major weapon systems descriptive summaries appearing in Volumes II and III. Major weapon systems are identified by an asterisk in the Table of Contents. The formats and contents of these volumes are in accordance with guidelines and requirements of the Congressional Committees insofar as possible. Information previously provided in the SAC Data Book is consolidated into these volumes. The SAC Data Book information appears at the beginning of each program element descriptive summary.

A direct comparison of FY 1976, FY 1977, and FY 1977 data in this Program Element Listing with data shown in the Program Element Listing dated January 1976 will reveal significant differences. Many of the differences are attributable to the following factors:

a. A FY 1976 increase of $4.691 million representing additional recoupments from RDTE surcharges on Foreign Military Sales and transfer of reimbursements from prior years.

b. A FY 1977 net reduction of $81.1 million resulting from the following:

(1)	Congressional reduction	- $-95.5 million
(2)	Proposed supplemental for civilian pay raises	- +14.4 million

c. Reclassification to provide greater visibility and contribute to the effective management of the RDTE program such as the following:

(1) The Medical RDTE Program
(2) Combat Support Munitions
(3) Field Artillery Weapons Ammunition Development
(4) Mobility Equipment Technology
(5) Further extension of the Single Program Element Funding Concept.

d. Restructuring of the FY 1976, FY 197T, and FY 1977 programs for comparability to the FY 1978 program structure.

e. Planned RDTE effort to be accomplished at installations operating under the Army Industrial Fund (AIF) will require supplemental funds to cover civilian pay raises included in AIF stabilized rates.

The funding information used in these volumes corresponds to that contained in the President's Budget. Procurement data is shown where applicable for items in engineering or operational development. Military construction data is shown where applicable.

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DE93	WHITE SANDS MISSILE RANGE	1155
DE94	US ARMY ELECTRONIC PROVING GROUND	1159
DE95	COLD REGIONS TEST CENTER	1163

GLOSSARY

PROGRAM ABBREVIATIONS, ACRONYMS, AND POPULAR NAMES

TERM	EXPLANATION	PROGRAM ELEMENT/ PROJECT	PAGE NO.
AAH	Advanced Attack Helicopter	6.42.07.A	724
AFAADS	Advanced Forward Area Air Defense System	6.33.01.A	562
AMPM	Advanced Multipurpose Missile System	6.36.12.A	587
AN/TPQ-37	Artillery Locating Radar	6.47.31.A	984
ARTADS	Army Tactical Data Systems	6.37.23.A	399
BMDSTP	Ballistic Missile Defense Systems Technology Program	6.33.08.A	450
BUSHMASTER (also VRFWS)	Vehicle Rapid Fire Weapon System	6.46.17.A	858
CAAM	Conventional Airfield Attack Missile	6.33.19.A	584
CEFIRE TIGER	Airborne Electronic Countermeasure System AN/ALQ-150	6.47.11.A D906-55	922
CHAPARRAL	Low Altitude Air Defense System	2.37.30.A	482
COMSEC	Communications Security Equipment	3.34.01.A	1040
COPPERHEAD	Cannon Launched Guided Projectile	6.46.21.A	877
CSTA	Combat Surveillance, Target Acquisition	6.27.03.A	137
DARPA	Defense Advanced Research Project Agency	6.27.26.A	206
DRAGON	Medium Antitank Assault Weapon	2.37.27.A	473
DSCS	Defense Satellite Communications System	3.31.42.A D253	545
EW	Electronic Warfare	6.27.15.A	160
		6.37.11.A	623
		6.47.11.A	922
FAMECE	Family of Military Engineering Construction Equipment	6.47.28.A	974
HAWK/HIP	Surface-to-Air Missile (Improved)	2.37.31.A	492
HEL	High Energy Laser Components	6.33.14.A	325
HELLFIRE	Heliborne Missile, Laser Guided	6.43.10.A	781
IFF	Identification Friend or Foe	6.37.06.A	384
ILAW	Improved Light Antitank Weapon	6.46.23.A	883
ILIR	In-House Laboratory Independent Research	6.11.01.A	1
JTIDS	Joint Tactical Information Distribution System	6.37.07.A D137	619
KMR	Kwajalein Missile Range	6.53.01.A	1070
LANCE	Surface to Surface Ballistic Missile System	2.37.33.A	507
MICV	Mechanized Infantry Combat Vehicle	6.46.16.A	852
M60A1 PIP	M60A1 Tank Product Improvement Program	2.37.35.A	516
MSTD	Non-Systems Training Devices Technology	6.27.27.A	209

TERM	EXPLANATION	PROGRAM ELEMENT/ PROJECT	PAGE NO.
OTEA	Operational Test and Evaluation Agency	6.57.12.A	1117
PERSHING II	Surface-to-Surface Nuclear Missile	6.33.11.A	571
REMBASS	Remotely Monitored Battlefield Sensor System	6.37.04.A DK73	609
RPV	Remotely Piloted Vehicles and Drones	6.27.32.A	218
		6.37.25.A	402
SAM-D	Surface-to-Air Missile Development	6.43.07.A	760
SFTS	Synthetic Flight Training System	6.42.04.A D275	704
SHF TDMA	Super High Frequency Time Division Multiple Access	2.80.10.A D113	538
SOTAS	Stand-Off Target Acquisition System	6.47.48.A	1024
STINGER	Shoulder Fired, Forward Area Air Defense Missile	6.43.06.A	753
TACFIRE	Tactical Fire Direction System	2.37.26.A	465
TIME	Test Measurement and Diagnostic Equipment	6.27.79.A	272
TOS	Tactical Operations System	6.37.22.A	690
TOW	Tube Launched, Optically Tracked, Wire Guided (Heavy) Antitank Assault Weapon	2.37.24.A	457
TRADOC	Training and Doctrine Command	6.51.02.A	1066
TRI-TAC	Tri-Service Tactical Communications Program	2.80.10.A	524
UGS	Unattended Ground Sensors	6.47.04.A	905
UTTAS	Utility Tactical Transport Aircraft System (Infantry Squad Carrying Helicopter)	6.42.06.A	711
VEFWS (also BUSHMASTER)	Vehicle Rapid Fire Weapon System	6.46.17.A	858
VTOL	Vertical Take-Off and Landing	6.32.11.A	303
VULCAN	Air Defense Gun Systems	2.37.32.A	502
WWMCCS	Worldwide Military Command and Control Systems	6.37.35.A	453

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FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.01.A

Title In-House Laboratory Independent Research (ILIR)

Category Research

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	12248	3255	14637	14722	17200	Continuing	Not Applicable
A91	In-House Laboratory	12248	3255	14637	14722	17200	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program provides Army RDTE activity directors the opportunity to perform highly promising and innovative research without having to acquire formal approval and subsequent funding. It is one of several measures used to strengthen scientific and engineering competence, improve morale, aid scientific and technical personnel recruitment and retention, and facilitate communication and interaction within the scientific community. Not only does this program provide the resources and interaction with the flexibility to respond quickly to new technical challenges, it also serves as a wellspring for innovative and imaginative ideas, of which the more promising ones progress into development programs. Approximately 550 research and development tasks were pursued in FY 1976 and FY 7T which were representative of prior year programs.

BASIS FOR FY 1978 RDTE REQUEST: Funds are allocated directly to Directors of participating laboratories by the Assistant Secretary of the Army (Research and Development) and are not subject to reallocation by intervening echelons. This allocation is based on a review of the laboratories use of funds and accomplishments during the preceding fiscal year.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The essentially level funding coupled with anticipated cost growth will decrease this in-house program in consonance with Department of Defense policy to increase the ratio of extramural to in-house laboratory efforts.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	450	0	450
(2) Contractor Employees	0	0	0
Total	450	0	450

Budget Activity #1 - Technology Base

Program Element #6.11.01.A Title In-House Laboratory Independent Research (ILIR)

DETAILED BACKGROUND AND DESCRIPTION: This program promotes creativity, innovation, efficiency, improved morale, recruitment/retention of scientists and engineers by providing funds to maintain or increase individual professional competence through original work relevant to assigned military missions.

RELATED ACTIVITIES: The Navy and Air Force have similar programs. Coordination is accomplished through scientific symposia, literature reviews, exchange of research and technology resumes, and Department of Defense subject reviews.

WORK PERFORMED BY: Thirty-eight Army RDTE activities are participating in the FY 1977 ILIR program.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Efforts at the Combat Surveillance and Target Acquisition Laboratory were concentrated upon the effects of tunable polychromatic dye lasers, and significant results have been obtained. Specifically, the important question of the usefulness of dye mixtures for wideband tunability, and the possibility of simultaneous laser action was investigated. The results showed that the polychromatic laser radiation from true dye mixtures has only limited feasibility with presently available dyes. However, simultaneous laser emission, such as blue, green, and orange with a coumarin/rhodamine mixture is possible. The second problem, namely--the development of a single concept appropriate for broadband wavelength tunability in an unstable resonator cavity configuration was successfully solved using a single stage rotary dispersive intercavity filter.

The Communications/Automatic Data Processing Laboratory low profile antenna performance study exemplifies the application of technical creativity to assist in the solution of well known user problems. The need for low profile antennas under combat conditions are well known and documented and in this project, the principal investigator, produced some novel results. An experimental study of one technique of folding a dipole antenna and loading it (using lumped elements on the antenna structure) was investigated and yielded a 30% bandwidth increase and a size reduction of one-half over a conventional half-wave dipole antenna.

The Night Vision Laboratory work on lasers showed that based upon the extensive theoretical foundation developed the previous year, a final laser cavity configuration has been selected, fabricated, and successfully incorporated into the 6.2 program under Program Element 6.27.09.A Night Vision Investigations. The device is a four layer, double heterostructure laser with a 2.3 micrometer cavity, which operates in the fundamental order mode. Hence, it has a very desirable output beam in the plane perpendicular to the junction in order to also control the output beam parallel to the junction by lateral mode selection and/or quenching. A new monolithic processing technique to accurately control sidewall characteristics was developed.

The objective of the interaction of picosecond laser pulses with military systems study at the Natick Research and Development Command is to examine the results of the interactions of picosecond (10^{-12} sec) pulses with molecular systems involved in military materials. A technique to resolve excited state lifetime values for molecular systems found in Army materials has been successfully developed under this task.

Budget Activity #1 - Technology Base

Program Element #6.11.01.A Title In-House Laboratory Independent Research (ILIR)

The objective of Materials and Mechanics Research Center work on hybrid methods applied to three dimensional axially symmetric crack and notch configurations is to extend the hybrid method of solution originally developed for two dimensional crack and notch configurations to the regime of the three dimensional axially symmetric problems. At present, strictly analytical solutions are limited to a few idealized axially symmetric geometries due to the difficulties in finding closed continuous solutions. On the other hand, numerical solutions such as finite elements generally yield unreliable values for the stresses particularly in the regions of chief interest-crack and notch vicinities. By the hybrid method, an effective tool for accurately analyzing the three dimensional axially symmetric problem class can be anticipated based on the previous experience with two dimensional applications of the method.

Optical signal processing work at the Harry Diamond Laboratories included the development of a method by which a variety of reference signals could be stored on a crystal and optically correlated against a "live" signal. Such a device has applications in the field of electronic warfare where it is necessary to correlate complex signatures in real time against a reference. The index of refraction alteration of lithiumniobate in a 10 megahertz delay line having an interaction time of about three microseconds was achieved by introducing a high-intensity laser pulse obtained from the frequency doubling of a neodymium YAG (yttrium-aluminum-garnet) laser during the propagation of a surface acoustic wave. The index of refraction perturbation, which lasted for several hours, was verified both by correlation with a "live" propagation surface acoustic wave, and also by observation of the expected optical diffraction pattern when a laser beam was transmitted through the lithiumniobate.

The goal of the Ballistic Research Laboratory millimeter wave anti-tank beam rider demonstration has been to demonstrate a 140 gigahertz guidance system for use in a "missile" or "shell" in the anti-tank role. Such a system would have important advantages over optical systems. It would be insensitive to smoke countermeasures and muzzle disturbances such as dust, smoke, and flash; and hence it would be highly adaptable to gun launching and to use with high-performance rocket motors needed for supersonic missiles. Also, it would be virtually all-weather. The first tracking radar to operate at 140 gigahertz was built in-house and successfully demonstrated. It used a pulsed IMPATT (Impact Avalanche Transit Time) diode as a transmitter. The missile receiver and signal processing circuitry were also built. Propagation tests through white phosphorus, hexachlorethane and fog oil smoke indicated no attenuation by the smoke.

Recent breakthroughs at the Aviation Research and Development Command Laboratory in the techniques, available for measuring rotor aerodynamically generated noise, have resulted in unique opportunities for major gains in the understanding of rotor noise generation mechanisms and will most certainly result in improved rotor noise specifications, design trade-off information and probably improved noise reduction techniques. The acoustics research program is based on a systematic approach to improve the state-of-the-art in technology for rotor aerodynamic noise. The approach is to make maximum utilization of newly developed rotor noise measurement techniques, combine the unique capabilities of the laser for rotor near in-plane quantitative measurement and test several model rotor blades of different geometric properties to select a configuration that reduces the impulsive noise without significant reductions in the performance.

Budget Activity #1 - Technology Base

Program Element #6.11.01.A Title In-House Laboratory Independent Research (ILIR)

Investigation of magnus surface pressure effects was undertaken at the Chemical Systems Laboratory to develop a means of measuring the pressure distribution acting on the surface of spinning wind tunnel models. The results obtained from this research indicate a technical breakthrough with regard to the aerodynamic analysis of future projectile configurations which are of practical interest to the US Army. A new and unique testing technique evolved.

Pitman-Dunn Laboratory work on interior ballistic analysis of folded ammunition which included an analysis of the performance of folded ammunition during the interior ballistic cycle of 5.56 millimeter (mm) and 30mm folded ammunition, was completed. The folded ammunition concept, where the propellant is along side rather than behind the projectile, required a different approach to analyzing the interior ballistics. Test firings of 5.56mm and 30mm folded ammunition were undertaken utilizing both single and double base propellants. Utilizing a modified interior ballistic computer program, pressure-time records, muzzle velocity and action times of the test data were successfully simulated with excellent accuracy. Using resultant computer output as a data base, the effects of parameter modifications to existing experimental folded cartridges can be predicted.

The Feltman Laboratory project on detection of vapors and laser raman scattering using symmetrical monochromators for explosive vapor detection has resulted in a breakthrough in improving by a factor of about 100 the sensitivity with which explosive vapors can be detected. These two techniques were combined to successfully identify to the Federal Bureau of Investigation, Treasury Department, and New York Police Department the explosive used in the 29 December 1975 bomb explosion that occurred in the Trans World Airlines baggage claim terminal at LaGuardia Airport.

The Avionics laboratory effort on audio and visual inputs as navigation aid in nap-of-the-earth flight represents a novel approach to the presentation of navigation information to aircraft pilots during flight. The Multifunctions Aviation Display concept is used, wherein information such as flight control symbology and navigation maps are presented to one eye of the pilot, permitting him to retain his forward looking view in the other eye. The concept was evaluated by use of a navigation simulator.

The Rodman Laboratory investigation of steel cartridge cases appears to offer a potentially high pay-off as an alternative to brass cartridge cases. Past attempts to use steel or aluminum cases in automatic weapons resulted in a high failure to extract spent cases because of insufficient clearance between the case and the chamber. A nonlinear elastoplastic analysis of the case/chamber interface under firing conditions was made. The critical parameters were identified and guidance for the proper selection of design variables such as material properties, configuration of case and chamber, chamber pressure, and initial clearances was presented. This work represents a major breakthrough in the design of satisfactory non-brass cases.

The Benet Weapons Laboratory study of application of finite element method to plastic analysis of weapon structures is concerned with the solution techniques for rotationally symmetric problems in plasticity. Particular emphasis was given to the finite element method and its application to Army gun tube problems. An exact elastic-plastic solution for rotationally symmetric problem was obtained. The exact solutions are useful for testing the accuracy of the approximation solutions by finite element method.

Budget Activity #1 - Technology Base

Program Element #6.11.01.A Title In-House Laboratory Independent Research (ILIR)

The Missile Research and Development Command concept of the missile, called GROWLAR for Guided Rocket with Laser Radar, was a command guidance round using side thrusters for control and with position and velocity as well as roll attitude determined from a ground based tracking set. The development has proceeded over the past two and one-half years to the point that a laser radar is about 95% complete. The significant achievement of this program has been the results of the simulation which have indicated that the desired objectives can be achieved. It has been shown that the GROWLAR is more effective as well as more economical in terms of ammunition costs and in terms of life cycle costs than a free rocket while achieving accuracies comparable to tube artillery. Long standing major reliability problems in microwave receivers for radar, communications, and countermeasure applications have been significantly impacted by an advance in Schottky radar diode technology completed in FY 76 at the Electronics Technology and Devices Laboratory with a sharpened analysis of the factors which cause premature burnout. The results of this work have impacted on areas relating to Army mission and the microwave semiconductor industry. This information has been used as design considerations for product improvements of existing systems and has also set burnout criteria and protection requirements in new system designs. In addition the program results have been transferred to Electronic Warfare activities where receiver vulnerability to external radio frequency radiation is a prime consideration.

The Atmospheric Sciences Laboratory research on effects of solid and liquid aerosols on infrared radiometric measurements from space was to determine the conditions under which a cloud would approximate a "blackbody" so far as electromagentic radiation is concerned. The results were to show that clouds appear "blacker" in the 11-13 micrometer infrared band and clouds with greater liquid water content require less thickness to attain blackbody properties (thus, maritime cumulus of a given microstructure becomes a blackbody radiator when its thickness reaches about 250 meters, whereas it requires about 550 meters in thickness for a stratus to become a blackbody radiator). These results are fundamental to the interpretation of infrared satellite cloud imagery and permit more accurate information to be deduced from this type of battlefield surveillance.

Real-time video processing studies at the White Sands Missile Range (WSMR) achieved several objectives including: development of important image structure models that have been shown to address problems in identification of various classes of targets in video imagery; development of very fast pattern recognition algorithms for objective identification and tracking; configuration of a "Real-Time" video laboratory to simulate field conditions for providing imagery for developing prototype tracking models; and development of extremely fast special purpose analog-to-digital converter/digital-to-analog converter circuits for live video. Work under this work unit has been well received nationally and is highly relevant to missile/aircraft tracking problems at WSMR and is motivated by these requirements.

Bioengineering Research and Development Laboratory studies on pollutant assessment in fish by measurement of physiological variables lead to less expensive ways of assessing toxicity of pollutants in water either acutely or chronically. Investigation of products and the kinetics of bromine interaction with polyhydric phenols in drinking water can lead to better understanding of bromine as a disinfectant.

Budget Activity #1 - Technology Base

Program Element #6.11.01.A Title In-House Laboratory Independent Research (ILIR)

Letterman Army Institute of Research study of vitamin D, calcium and phosphorous metabolism covers the biochemical, immunological and animal phases of the study of metabolism and utilization of calcium, phosphorous and vitamin D and their interrelationships to other basic body functions. The inadequacy in our knowledge of the metabolism of these three nutrients does hinder preventive and therapeutic measures in soldiers who have disorders such as bone and joint injuries (including stress fractures) periodontal disease and osteoporosis primarily due to post-traumatic immobilization. Greater knowledge of the factors which influence calcium, phosphorous and vitamin D metabolism may lead to prevention of the above conditions or shortening of the time to recovery. This research area has the potential of providing substantial economic savings.

Previous studies at the Institute of Environmental Medicine have suggested that the overfeeding of carbohydrates for a period of one to three weeks resulted in an increase in metabolic heat production thereby lowering the amount of weight gain as compared to overfeeding of the same number of calories of fat. However, these studies were conducted in such a way as not to allow us to be sure that precisely equivalent conditions were maintained between groups. In order to test this hypothesis and determine some of the mechanisms involved, the unique facilities and skills of the Institute in measuring thermogenic responses were coupled with the skills of investigators from the University of Vermont. The results of these studies confirmed the previously suspected difference in thermogenic response between overfeeding of carbohydrates and fat. Further, it has been found that little difference can be detected in the manner in which overweight people and those of normal weight metabolize the calories supplied by carbohydrate or by fat.

At the Institute of Dental Research, a highly successful drug 2,3, dimercaptopropane sodium-sulfonate (DMPS) has been found for the detoxification of mercury taken in by dental personnel. It has been found that some military dental personnel carry body burdens of mercury well above normal levels but not in the clinically toxic range. Since the possible subclinical effects of metallic mercury are unknown it would be desirable to have a drug which can be safely and routinely used in a prophylactic mode to deplete abnormally high body burdens of mercury in dental personnel. The very low toxicity of DMPS and its high efficiency in mercury removal indicate it will be a useful preventive agent against mercury intoxication. DMPS may also find excellent application in the detoxification of other heavy metal poisons.

The study by Walter Reed Army Institute of Research on antigenic components of the cell wall of neisseria meningitidis was designed to analyze the cell surface structure of the meningococcus with emphasis on extracting and purifying the dominant antigens. The goal is to develop candidate vaccines for this disease of military importance. Although effective capsular polysaccharide vaccines for meningococcal groups A and C are now available, group B polysaccharide has thus far been non-immunogenic in humans. These studies demonstrated that human bactericidal antibodies against group B meningococci are reactive with native serotype protein, but not the purified vaccine protein; and with a special high molecular weight form of the B polysaccharide, but not with the bulk of the polysaccharide. Based on these results, a new candidate group B vaccine consisting of high molecular weight group B polysaccharide complexed to serotype II outer membrane protein was prepared for testing in animals and humans.

Budget Activity #1 - Technology Base

Program Element #6.11.01.A Title In-House Laboratory Independent Research (ILIR)

Institute of Surgical Research studies of the effect of variations of temperature and humidity on energy demands of the burned soldier in a controlled metabolic room are considered significant because of the universal importance of metabolic changes in the survival of all injured soldiers. The further studies of thermal regulation have localized the control of post-injury metabolic response to the central nervous system and identified means of reducing the metabolic demands which injury places on burn and other trauma patients. These studies have reconfirmed the clinical observation that extensive thermal injury is the most severe stress to which man is liable.

The host metabolism during rickettsial diseases study by the Institute of Infectious Diseases is concerned with alterations in host metabolism in search of diagnostic and prognostic indices of overwhelmingly severe rickettsial illness as well as indicators of the mode of pathogenesis. This work unit is an essential element in a comprehensive program for defense against biological warfare agents. Measures are made of plasma and tissue levels of trace metals and plasma levels of specific proteins, lipids and amino acids during severe richettsial diseases in animal models. An early increase in the plasma copper concentration, seemingly associated with ceruloplasmin, occurs during model rickettsial spotted fever infections in guinea pigs. The increase occurs before overt illness but when there are microscopic evidence of vasculitis; thus the increase may be related to the vasculitis. Another metabolic sequela which may relate to the vasculitis is the early increase in triglycerides and free fatty acids. The connection may be that the vasculitis elicits a decrease in endothelia cell lipoprotein lipase, an enzyme considered to regulate triglyceride uptake from blood. These findings may prove to be of value in establishing optimal diagnostic and therapeutic indices.

Much of the work at the Cold Regions Research and Engineering Laboratory (CRREL) requires measurement of temperatures underground where thermistors and resistance thermometers probably would be damaged, either during installation, or during subsequent freezing and thawing of the ground. Thermocouples, because of their simplicity and mechanical ruggedness, are ideally suited for this purpose. However, a problem arises when one attempts to measure the temperature-dependent voltage of a thermocouple. Additional junctions are formed where the thermocouple lead wires are connected to the instrument terminals. The voltage developed at these junctions depends on the ambient temperature where the instrument is located and opposes the voltage developed at the measuring junction. During FY 76, a compensator circuit was designed and successfully tested at CRREL which tracks the reference junction voltage within $\pm 0.3^{\circ}$ C over this extended range. As a result, the 26 data collection platforms, which have been installed mostly in Alaska, can now be interfaced reliably with extreme low-temperature data collection devices.

An important finding has been made at the Construction Engineering Research Laboratory on the stress distribution of column steel in the vicinity of the beam-column joint. Under certain loading conditions when the columns above and below the joint are rotated in the same direction, the steel stresses above the joint are influenced significantly by the steel stresses below the joint, for instance, tensile stress may exist in the supposedly compression steel due to transmittal of tensile stress across the joint. This stress condition would influence slightly the ultimate resistance of the column at the critical sections.

Budget Activity #1 - Technology Base

Program Element #6.11.01.A Title In-House Laboratory Independent Research (ILIR)

The object of Topographic Laboratories' work on line-of-sight plotter was to provide tactical field commanders with a rapid means for determining whether a line of sight exists between two ground points using a topographic map to make the determination. A prototype model was designed and fabricated and on the basis of the satisfactory results obtained with this model an improved version of the prototype was fabricated and tested. In-house plotter tests demonstrated that the improved plotter is capable of making line-of-sight determinations which compare favorable to the results obtained with the currently used profile technique and that the plotter is capable of making line-of-sight determinations approximately 33% faster than the profile technique.

The Waterways Experimentation Station recognized that enormous increases in traffic on highways have highlighted the problems of obtaining satisfactory construction materials and performing construction in previously avoided areas. Considering that the strength producing chemical reactions of lime and lime-flyash treatment are highly temperature and time dependent, the objective of this ILIR project was to examine the effects of time, temperature and stabilizer percentage on the strength of soils treated with these additives in anticipation that a maturity rule or criteria could be developed to estimate long-term field strengths based upon short-term elevated temperature curing. Improved criteria and methodologies for mix design procedures for lime and lime-flyash-treated soils have been developed. Adoption of these procedures will reduce times required for assessing the stabilization susceptibility of lime-flyash aggregate mixtures from 28 to 3 days and will provide more accurate estimates of anticipated field strengths with significant economic benefits and military construction applications.

2. FY 1977 Program: Based on the merits of the annual report submitted by each participating activity at the close of each fiscal year, new funding is allocated for the upcoming fiscal year. Directors of individual laboratories or comparable activities assign funds to both new and continuing promising work efforts. The freedom from a rigidly structured program and the resulting autonomy at activity level permit the Directors to effectively use their in-house laboratory independent research funds.

3. FY 1978 and FY 1979 Planned Program: This highly successful program will continue with no change in the basic objectives previously outlined. Changes in emphasis will occur as new ideas and techniques are considered and in accordance with advances in the state-of-the-art. The funding proposed for FY 1979 will permit real growth in this innovative program.

4. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A Title Defense Research Sciences

Category Research Budget Activity #1 - Technology Base

RESOURCES/PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	68498	16990	83247	88809	99984	Continuing	Not Applicable
AF 22	Research in Vehicular Mobility	0	0	500	410	450	Continuing	Not Applicable
AH 42	Research in Materials and Mechanics	1830	475	2092	2100	2196	Continuing	Not Applicable
AH 43	*Research in Ballistics	4965	1346	5922	5760	6400	Continuing	Not Applicable
AH 44	Research in Fluidics, Nuclear Effects and Ordnance Electronics	1725	460	1946	1843	2023	Continuing	Not Applicable
AH 45	*Air Mobility Research	4800	1300	4852	5070	5600	Continuing	Not Applicable
AH 46	Research in Signal Detection and Low Energy Lasers	1079	300	1240	1357	1900	Continuing	Not Applicable
AH 47	Electronic Devices Research	1168	320	1872	1900	2100	Continuing	Not Applicable
AH 48	Electromagnetic Propagation and Antenna Research	619	170	720	900	1050	Continuing	Not Applicable
AH 49	Missile and High Energy Laser Research	530	200	1150	1300	1707	Continuing	Not Applicable
AH 51	Combat Support Research	635	180	700	750	850	Continuing	Not Applicable
AH 52	Research in Support of Equipment for Individual Soldier	1570	500	1847	1715	2157	Continuing	Not Applicable
AH 60	*Research in Large Caliber Armament	3942	1090	4950	5150	6010	Continuing	Not Applicable
AH 61	*Research in Small Caliber Armament	600	192	646	700	710	Continuing	Not Applicable
AH 63	+Research in Electronic Warfare	0	0	0	100	100	Continuing	Not Applicable

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Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
BH 57	*Research in Scientific Problems with Military Applications	19038	3522	23880	27000	30000	Continuing	Not Applicable
BS 01	*Basic Research on Military Injury and Diseases	7170	1804	7782	7923	9210	Continuing	Not Applicable
BS 02	Basic Mechanisms of Recovery from Injury	1207	304	1266	1337	1552	Continuing	Not Applicable
BS 03	*Medical Defense Against Biological Agents	2353	592	2541	2702	3022	Continuing	Not Applicable
BS 04	Identification and Health Effects of Military Pollutants	293	73	350	385	421	Continuing	Not Applicable
BS 05	Military Burn Research	1314	331	1437	1510	1690	Continuing	Not Applicable
BS 06	Combat Dental Materials and Techniques	631	159	690	726	812	Continuing	Not Applicable
BS 07	Helicopter, Combat Crew, and Airborne Medicine	298	75	326	343	380	Continuing	Not Applicable
BS 08	Environmental Stress, Physical Fitness and Medical Factors in Military Performance	1031	259	1127	1184	1325	Continuing	Not Applicable
AT 22	Research in Soil and Rock Mechanics	228	57	310	341	375	Continuing	Not Applicable
AT 23	Basic Research in Military Construction	158	38	240	264	275	Continuing	Not Applicable
AT 24	Research in Snow, Ice and Frozen Ground	1086	362	1424	1557	1665	Continuing	Not Applicable
A31B	*Night Vision Devices Research	3052	950	4777	4830	5200	Continuing	Not Applicabe
B52C	Research in Geodetic, Geographic and Mapping Sciences	1075	248	1328	1518	1535	Continuing	Not Applicable
B53A	*Research in Atmospheric Sciences	2677	780	2900	3625	4023	Continuing	Not Applicable

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Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
A71A	Research in Defensive Systems for CW/BW	1037	290	1130	1400	1600	Continuing	Not Applicable
B74A	Research in Human Engineering	720	210	1086	1199	1290	Continuing	Not Applicable
B74F	Basic Research in Behavioral and Social Sciences	1667	403	2216	1910	2356	Continuing	Not Applicable

* These projects are covered by separate Descriptive Summaries.
o Work previously reported under AH53, AH54, AH55 and AH56 are now reported under these restructured projects.
\+ This is a new project.

BRIEF DESCRIPTION OF ELEMENT: This element supports research in the physical, engineering, environmental, biological-medical and behavioral-social sciences as directly related to the solution of identified Army problems. Each project within the element is associated with a particular Army laboratory or installation.

BASIS FOR FY 1978 RDTE REQUEST: Research will be supported in new and continuing efforts to provide the Army with improved and advanced weapons, with improved support for and care of the individual soldier, and to be responsive to science and technology objectives defined by the Army user.

BASIS FOR INCREASE IN FY 1978 OVER FY 1977: The increase is intended to provide funding commensurate with the importance of maintaining a strong technology base, and to compensate for increases in costs of research equipment and personnel.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement) is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	1420	0	1420
(2) Contractor Employees	1500	0	1500
Total	2920	0	2920

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DETAILED BACKGROUND AND DESCRIPTION: This program supports research to gain comprehension, to increase knowledge, and to establish Army technical expertise in the physical and engineering, environmental, biological-medical, and behavioral-social sciences directly related to long term Army needs and to the solution of identified Army problems. It provides a major part of the base for subsequent exploratory and advanced developments in Army related technologies and for new or improved military capabilities in: armor, helicopters, new materials for armor and armaments, small and large caliber weapons and munitions, ordnance electronics, communications, seekers, detectors, surveillance and tracking, propulsion and aerodynamics for missiles, energy conservation, energy conversion, environmental quality, construction, medical and biological sciences, food, clothing, soldier support, night operations, terrain characterization, navigation, and human-weapons integration. Research in the physical and engineering sciences is generally carried out in the laboratories of the Materiel Development and Readiness Command and by contracts with industry and other government agencies from these laboratories. Research on grants or contracts with the academic community is administered by the Army Research Office, an agency of the Materiel Development and Readiness Command. Research involving environmental sciences, military construction, and navigation is carried out in laboratories of the Corps of Engineers and at the Atmospheric Sciences Laboratory of the Army Materiel Development and Readiness Command. Research in the medical-biological area is pursued in several laboratories under the Army Medical Research and Development Command. Research in human behavior and human interaction with weapons systems is carried out at the Human Engineering Laboratory of the Development and Readiness Command and at the Army Research Institute for the Behavioral and Social Sciences.

RELATED ACTIVITIES: The Navy, Air Force, and other Department of Defense agencies, National Aeronautics and Space Administration, National Academy of Sciences/National Academy of Engineering/National Research Council, National Science Foundation, Department of Interior, Energy Research and Development Administration, National Bureau of Standards, US Public Health Service, other government agencies, government agencies of allied nations and the industrial and academic community sponsor related research in some diverse areas of this program element. Coordination to assure no unnecessary duplication is accomplished by Tri-Service reviews; exchange of program data sheets, program documents, research and technology resumes, and technical reports; inter-service/agency liaison; and formal, national and international meetings and symposia. Informal coordination occurs through: visits to governmental, industrial and academic laboratories and installations, and review of the scientific literature. The Army's Defense Research Sciences program is included in the tri-service Technology Coordinating Papers. Additional details on related activities are provided in the individual project descriptive summaries.

WORK PERFORMED BY: During FY 77, approximately 56 percent of the research supported under this program is performed by in-house laboratories and activities. During FY 78, it is planned that approximately 47 percent of this program will be accomplished through contracts and grants. The contract/grant program includes academic institutions, not-for-profit organizations and industrial laboratories. Details on contractors are given in the project and scientific area descriptive summaries. The laboratories/activities responsible for research under this program are the following, listed by major Army developing agencies:

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Army Materiel Development & Readiness Command:

Tank Automotive Research and Development Command, Warren, Michigan
Materials and Mechanics Research Center, Watertown, Massachusetts
Ballistic Research Laboratory, Aberdeen Proving Ground, Maryland
Harry Diamond Laboratories, Adelphi, Maryland
Aviation Research and Development Command, Moffett Field, California
Combat Surveillance and Target Acquisition Laboratory, Fort Monmouth, New Jersey
Electronics Technology and Devices Laboratory, Fort Monmouth, New Jersey
Communications & Automatic Data Processing Laboratory, Fort Monmouth, New Jersey
Electronics Warfare Laboratory, Fort Monmouth, New Jersey
Missile Research, Development and Engineering Laboratory, Redstone Arsenal, Alabama
Mobility Equipment Research and Development Command, Fort Belvoir, Virginia
Natick Research and Development Command, Natick, Massachusetts
Large Caliber Weapon Systems Laboratory, Dover, New Jersey
Benet Weapons Laboratory, Watervliet, New York
Small Caliber Weapon Systems Laboratory, Dover, New Jersey
Army Research Office, Research Triangle Park, North Carolina
Night Vision Laboratory, Fort Belvoir, Virginia

Army Corps of Engineers:

Waterways Experiment Station, Vicksburg, Mississippi
Construction Engineering Research Laboratory, Urbana, Illinois
Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire
Engineer Topographic Laboratories, Fort Belvoir, Virginia

Army Medical Research and Development Command

Walter Reed Army Institute of Research, Washington, D. C.
Letterman Army Institute of Research, Presidio of San Francisco, California
Medical Research Institute of Infectious Diseases, Fort Detrick, Maryland
Medical Bioengineering Research and Development Laboratory, Fort Detrick, Maryland
Institute of Surgical Research, Fort Sam Houston, Texas
Institute of Dental Research, Washington, D. C.
Aeromedical Research Laboratory, Fort Rucker, Alabama
Research Institute of Environmental Medicine, Natick, Massachusetts

Office of the Deputy Chief of Staff for Personnel

Army Research Institute for the Behavioral and Social Sciences, Arlington, Virginia

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Army Materiel Development and Readiness Command:

Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico
Chemical Systems Laboratory, Aberdeen Proving Ground, Maryland
Human Engineering Laboratory, Aberdeen Proving Ground, Maryland

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976 and Prior Accomplishments: Research in materials and mechanics is directed toward the discovery of new and improved materials and toward the design of structurally reliable Army systems. Sophisticated scientific methods were used to prepare and characterize new materials such as silicon nitride, aluminum dodecaboride and complex polymers such as carboranes and polyphosphazenes. New reproducible aluminum bronze superelastic alloys were prepared for applications in springs, gun mounts, and recoil mechanisms. Computer simulations of the forces between atoms in alloys such as titanium and steel are leading to a new understanding of properties and behavior of new alloys with selected impurities. Experiments on wear and erosion of steel gun barrels indicated that hydrogen-water and nitrogen-oxygen products of combustion in simulated gun chambers produced the most severe erosion. Effects of high energy lasers on helicopter components are leading to the development of laser hardened materials. Work on dynamic material response has developed theories and computer models for predicting the "plastic" region of materials. A remarkable list of structurally and ballistically important materials, e.g., aluminum and steels, fit the theories. Project AF 22, Research in Vehicular Mobility is a new start in FY 77. A separate descriptive summary is provided for Research in Ballistics, which supports the Army's weapons development programs. A separate descriptive summary is also provided for Air Mobility Research. This program provides a detailed understanding of aerodynamics of helicopter propulsion and drive train components and basic resource data on helicopter structures. Fluidics research has developed fluid flow analogues of electronic devices such as temperature independent amplifiers, sensors, resistors, transducers, and circuits and systems utilizing these devices. One typical success has been the design of a fluidic flight stabilizer for the UTTAS helicopter. Research in the study of laser interactions with materials has provided information about controlled wavelength shifting and generation of longer wavelength radiation in the millimeter region. This ongoing work will extend the Army's capability in seekers, detectors, designators and imaging devices at night, in inclement weather, and through battlefield smokes and dusts. Research in new materials has included effects of nuclear irradiation which may be encountered on the battlefield causing changes in the properties of electronic components. The technology base for ultra low cost mini-laser rangefinders including new solid state and chemical lasers has been developed, including required improvements in chemical and electrical efficiency by optimization of both composition of laser materials, and the geometry of laser configurations. This capability will extend the life and improve the efficiency of laser operation. Research was extended to development of highly

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sensitive relatively inexpensive, detection systems for carbon dioxide (10.6 micrometer) laser radiation. Theories of solid host-neodymium ion interactions in candidate materials for new lasers have been extended in order to try to control the wavelength and efficiency of neodymium lasers. Research in laser absorbers and reflectors and active filter concepts for the protection of personnel and instruments [illegible] a variety of new effective materials in the ruby (0.693 micrometer) radiation (10.6 micrometer), and carbon dioxide [illegible] spectra. Materials research in electronic devices included studies of semiconductors for use in integrated circuits, magnetic materials for filters and phase shifters in microwave and high frequency wave generation, dielectric electrooptic devices, acoustic beam devices, and basic research in cathode and anode reaction parameters in primary and secondary lithium cells for electrolytic batteries. New materials for lasers include the growth and theory of rare-earth (e.g., neodymium ion) pentaphosphates for new higher efficiency lasers. Investigations of chemical lasers resulted in a working miniaturized model for possible applications as a designator or in communications. Optical fibers were developed which may lead to secure, cost saving, and high information-rate transmitting cables. Work has continued on the development of longer wave length communications links for command posts. Research in communications includes the theory of radiation characteristics of millimeter wave antennas, microstrip antennas and beam forming and beam steering techniques for antennas. Effective, reliable, secure, communications through the electromagnetic noise, absorption and scatter encountered in city dwellings and structures have been characterized to provide communications support for military operations in built-up areas (MOBA). Collection and analysis of ionospheric tilt data has been underway to enable automatic position location to within 50 feet by friendly forces. Research in optoelectronic devices and techniques have resulted in the development of theories of atomic level modulation and modulation efficiency. This work in conjunction with laboratory research in laser modulator materials has shown that difluoroethylene and methanol vapors can be pumped with very low losses. This may lead to new ultraviolet and infrared lasers. Invention disclosure was made for a technique for imaging using a TV image tube to record stationary holographic fringes which are then detected and enhanced using an electron filter to form a super-resolved image on a TV monitor. Theoretical and experimental work on energy utilization and output in gases for high energy lasers has developed to a point where it may be possible to determine conditions which optimize high energy lasers. Research in power supply systems provided the basic technology for fuel cells which can supply electricity by utilizing logistic fuels directly or after prior processing to yield hydrocarbons for use in the cell. The nature of surface catalysis, surface reactions and stability of electrodes in fuel cells has been better characterized by use of Auger and Mossbauer spectroscopy. Light weight, less expensive, high performance electrical conductors have been developed. A separate descriptive summary is provided for Research in Large Caliber Armament (AH 60). This project, which has been restructured from AH 53, AH 54 and part of AH 55 supports the Army's mission as the lead service for R&D in new and improved gun propellants and explosives. Included in this area is the extensive high pressure physics and fracture mechanics research in gun tubes. Research in Small Caliber Armament (AH 61) has been restructured from AH 55 and AH 56. In these projects, research has been conducted in the scientific areas of components, mechanisms, ammunition analysis, stability and control mechanics, and man-weapon interactions related to areas of fire control and small arms technology. Project BH 57 provides for Army sponsorship of research in the academic, not-for-profit, and industrial scientific community to develop new knowledge that contributes to the improvement of Army equipment. This project supports long term research in the physical, engineering, environmental and biological sciences related to long term Army goals. Separate descriptive summaries are provided for this project and for six of its scientific areas. Separate descriptive summaries are also provided for Basic Research on Military Injury and Diseases and for Research in Medical Defense Against Biological Agents. In food research, factors contributing to improvement in military rations have been identified. Flavor stability of food during prolonged storage has been

advanced. Research has demonstrated that glucose extracted from cellulostic materials by unique methods can compete economically with glucose from cornstarch. Fundamental research has led to protection of the soldier from diseases and adverse environments, world wide. Methods for treatment and prevention of shock, trauma and burns were developed. New and improved vaccines and surgical and prosthetic devices have also been developed. For example, an antiserum effective against organisms responsible for endotoxic shock has been shown to be about 80% effective in experimental animals with sepsis. Burn wound healing studies continue to elucidate the factors related to healing and basic mechanisms of healing. Study and definition of the role of lymphocyte cells which are the body's primary defense against fungus infection have been aided by development of assay methods. New methods of bio-assay of insect repellants have been developed and are fully operational. Research in combat dental materials resulted in a new aluminum containing compound to eliminate facing fractures in dental bridgework. Sintered ceramic tooth implants continue to provide high tissue compatibility and tooth stability data. Electroless metal plating was conducted to discover new dramatic preventative and restorative techniques for tooth damage. Aeromedical research has resulted in a new method to evaluate visual constraints of stabilized viewing devices; evaluation of noise hazards related to helicopter and armor operations; intelligibility of the human voice in communications; and evaluation of performance of crews equipped with night vision goggles. Research in military environmental stress led to indicators for judging susceptibility to heat stroke. The threshold of anaerobic metabolism was shown to be a sensitive indicator of physical fitness. Methods for acclimatization to altitude and for increased tissue survival in frostbite cases have been devised. In the areas of soil and rock mechanics, new methods were developed for analyzing and predicting traffic damage to pavements. Penetration of projectiles into dense sands and soil can now be analyzed. Significant increases have been achieved in our knowledge of the behavior, structure, and properties of ice and snow including the complex property of multiple load bearing strength of ice in frozen regions. Research in geodetic and mapping sciences produced new theories and equipment for high speed, high precision imaging and mapping, optical data processing, and pattern recognition. Experiments confirmed theories for radar backscatter analysis and simulated radar signatures. Research in defense systems for chemical and biological warfare has resulted in new improved biological detection, identification and decontamination. Significant progress was made in rapid methods for identification of microorganisms via analysis of their nucleic acids. Remote detection of clouds of microorganisms by lasers has become possible. Theoretical and experimental information basic to evaluation of direct decontamination of airborne microorganisms and chemical agents has been acquired. Mathematical models of the behavior of gas mask protection materials, especially the absorbent fillers, were developed which predict behavior under several different atmospheric conditions. Anti-nerve agent poisoning treatment and prophylaxis have been developed. Medical defense against chemical agents was enhanced by the development of systems permitting studies of the spontaneous reaction of enzymes following nerve gas poisoning. Unique work in the behavioral and social sciences by a small but outstanding group of researchers has resulted in findings on the effects of noise on man, central nervous system functioning, memory and learning ability, perception and relation of eye movement to helicopter pilots performance. A unique device to measure eye movement has been designed to relate accuracy of fire and fire control design. Data from this work has been compiled into a data bank available to design agencies and weapons systems development contractors. Studies of Army performance and training have produced good information on learning and teaching techniques and prediction models for military performance and strategies and techniques for long range career planning and decision making. Other typical accomplishments are given in the project and scientific area descriptive summaries.

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2. FY 1977 Program: The Army's Defense Research Sciences program is a broad and continuing program that exploits new results, theoretical concepts and experimental data. Scientific areas of endeavor are relatively continuing with termination or addition of areas occurring as science advances. The program is modified as appropriate to meet new or changed Army requirements or needs. Details are given in project and scientific area descriptive summaries. Other examples of research efforts follow. Research in Vehicular Mobility (AF 22) is a new project. Research is being conducted in the areas of structural mechanics, component research, and vehicle vulnerability reduction, for both track and wheeled military vehicles. In the investigation of materials with damping characteristics, plates of iron-chromium and iron-cobalt high damping alloys are fabricated into the 1/6 scale model of the armored personnel carrier devised to evaluate candidate new armor material. A relation between stress-deformation-temperature treatment in steel, tungsten and uranium projectiles and strength levels has been combined with results of exploding wire fragmentation tests to obtain better spall criteria in the prediction of metal fragmentation events. Propulsion dynamics studies include development and validation of interior ballistics models and the investigation of parameters leading to stable, reproducible ignition and combustion of liquid propellants. A launch and flight dynamics investigation addresses the gas flow about projectiles and sabots during launch and computation of the Magnus effect tending to cause tumbling of supersonic warheads. Work is in progress on the study of ballistics response of materials and sophisticated computer codes for the analysis of structural response to dynamic high pressure loading. Fluidics research has endeavored to use large scale flow visualization to determine parameters of amplifier operation. A capability is now in hand for establishing design parameters and computer analysis and prediction of fluidics behavior. The physics of laser radiation wavelength tuning and tuned detectors for designator and fuze applications and for laser countermeasures provides proof of feasibility for several optical circuits and equipment. Fundamental efforts continue in the areas of quantum electrodynamics, optoelectronics and electro-physics/chemistry of lasers related to new/advanced system concepts for surveillance, target acquisition, terminal homing, fire control, communications, avionics and optical countermeasures. The high pressure oxidation method for low temperature oxidation of integrated circuit (IC) silicon wafers is being optimized to correlate wafer performance with thermal oxidation parameters in anticipation of scaled up prototype processing. New methods are being sought to better characterize defect and failure mechanisms which affect reliability in beam lead and other IC devices. Theoretical and experimental studies provide basic data for new concepts for improved Army communications and position location systems. This work includes fiber optics, multichannel electromagnetic (EM) transmissions, EM antennas, tactical communications in field and urban combat, ionospheric effects on high frequency direction and position finding, tactical/strategic communications and global navigation satellite signals. Missile related research continues in fast Fourier spectrometry for holographic doppler imaging. An important area of millimeter and submillimeter wave generation and propagation through fogs, smokes and inclement weather is stressed. Basic research in the vibrational-rotational quantum states of molecules of interest in high energy lasers continues to give insight on how to optimize output efficiencies. Target effects and signatures which depend upon scattering, reflection, dispersion, and absorption phenomena are identified and categorized for terminal homing applications. Research in electronic warfare (EW) involves new and novel approaches in stand-off systems which consider adaptive and associative signal processing to simultaneously provide speed of operation and which might match the rate of data collection systems to data handling capacity. EW research also includes factors affecting electronic beam steering to provide hemispherical coverage and determination of polarization phenomena for coherent laser radiating sources and cognitive processes using integrated displays. Research in combat support continues to cover power supplies including those smaller units of interest in fuzing applications as well as more energetic sources including fuel cells and their conductors. Mine detection research has resulted in a sensitive, selective, portable technique for quick detection of hidden TNT.

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Soldier support research continues to provide guidelines for food, nutrition, food analysis, and food composition. Methods and equipment have been designed for the analysis and diagnosis of foods with the objectives being to assess wholesomeness, carbohydrate chemistry, flavor factors, microorganisms and microbial toxins in foods, spoilage of rations, food acceptance criteria and food choice and habits. Research in Large Caliber Armament (AH 60) is a restructured program (formerly AH 53, AH 54, and part of AH 55) described in a separate descriptive summary. Research in Small Caliber Armament (AH 61) which has been reconstituted from AH 55 and AH 56 includes: propagation of lasers of fire control interest through dust, smoke, and all-weather conditions; control theory; linear and non-linear systems analysis; hybrid computer modelling for increased capability in fire control sighting and tracking; signal processing techniques; sensor/computer interfaces to increase response and accuracy of present systems; and theory and experiments to develop stabilized sights and weapons platforms. Extensive accounts of supported fundamental research efforts under BH 57 are given in separate descriptive summaries. In medical research the action and pathogenesis of skin diseases are studied in order to better design treatment or prevention of fungal infection which is so prevalent in early and prolonged military operations. The identification of health effects of military pollutants in water and air at or below detection limits of available instrumentation is accomplished by bio-assay systems. Alternatives to current practices in toxicity testing are being reexamined to replace more time consuming and costly tests. In vitro studies to measure human response to trace organics in water continue. Military burn research includes studies on: the efficiency of antisera against negative gram sepsis; amino acid sequencing of proteinosis substances responsible for depressed immunocompetence and "shock lung syndrome"; the basic mechanism of back-diffusion of hydrogen ions leading to stress ulcer formation; and host-parasite interactions following burns directed toward causes of decreased opsonization. Electroless metal plating, ceramic coatings for high quality lower cost prosthetic appliances, dental restorative materials for field use, and effects of laser beams on oral tissues for restorative techniques have continued. The ability to solder base metals is a major achievement which points out the potential of establishing new, inexpensive prosthetic techniques. Research in psychomotor performance in helicopter operations continued together with studies of psychophysiology of vision and psychoacoustics. Effective use of night vision goggles and elimination of other air and ground problems due to faulty visual perception are stressed. Acclimatization to prolonged hypoxia are studied. Also, the current programs include frostbite treatment and thermographic techniques for evaluation of frostbite. Research in soil and rocks is concerned with: criteria for evaluating liquifaction susceptibility of soils, soil density monitoring techniques by gamma radiation, earth penetration modeling and experiments and evaluation of the use of bor-grid systems in pavements and foundations. Starting in FY 77 fundamental research conducted previously under N52A is included in Project AT 24, Research in Snow, Ice and Frozen Ground. This project is directed at generating exploitable knowledge applicable to winter warfare such as winter camouflage, winter mobility, ice adhesion on helicopters, and operability of transport and weapons systems. Research in mapping sciences includes efforts to confirm a new numerical method for more precise determination of deflections-of-the-vertical. Development and demonstration of experimental methods for high speed parallel array sensing of aerial imagery, and research leading to automated feature extraction systems are underway. Biological defense efforts are in agent detection, rapid identification and decontamination. The chemical warfare defense research addresses medical effects of agents, medical defense, advanced concepts for detection and analysis of trace amounts of agents, and air purification techniques. The main areas of the behavioral and social sciences are human performance in detecting targets in combat and cross sensory interactions. A tentative model has been developed which is useful as a predictive device to estimate human performance in command and control or similar settings. Exploitation of the eye movement oculometer will evaluate pilot performance and ability to detect camouflage. New criteria are evolving for evaluation of effectiveness of training programs such as computer aided testing for

qualification, classification and assignment; cost-effective models for career gaming; motivation and productivity of women in traditionally-male oriented jobs and institutions; factors in military manpower retention; factors in adjusting to first full-time job; variables influencing retention and transfer of training; interactive effects of individual performance on group proficiency; and patterns of career progression in comparable Army and civilian jobs.

3. FY 1978 Planned Program: Research will be supported in both continuing and new relevant efforts to provide the Army with information useful for advanced equipment and with improved support for and care of the individual soldier, and to be responsive to needs and requirements. Details of the planned program are described in project and scientific area descriptive summaries. Other examples of proposed research topics and efforts are the following. The objective of the terrain characterization program is to characterize random terrain profiles as they relate to predictions of vehicle performance. Efforts will continue to emphasize inherent differences between track and wheeled systems. Vehicle responses to curves will be compared directly. The mathematical definition of the mobility index will be subjected to a sensitivity analysis to insure adequate resolution and ranking of vehicle systems with respect to operability in different conditions or cross country. An Army area of emphasis will be to conduct research on the physical and chemical aspects of gun barrel wear and erosion coupled with a program on coatings and liners designed to increase gun barrel life. Silicon nitride characterization will be expanded to include new nitrides and oxynitrides for possible use in gun liners for large caliber weapons, for bearings and other high temperature applications. Substantial progress will have been made on the tensile fracture criterion so that emphasis will at first be on adiabatic shear and gross plastic deformation failure criteria with the longer range goal of obtaining a universal criterion. Each of the scientific areas of the ballistics research program will be pursued to obtain a data base for advanced weapons technologies. Details are provided in a separate descriptive summary. Advances in fluidics will continue to be in the direction of design and specification of new components and circuits for a wide variety of proposed applications such as integrated system packaging, interfacing precision control valves, angular accelerometers, and matching fluidic to electronic amplifiers. Laminar digital device modelling will be developed for cutting flow consumption and power required in digital fluidic networks. Acousto-optic interaction in piezoelectric materials will be studied to develop a device which can perform real time correlation for large interaction times to maximize the signal to noise response and the large time bandwidth product and dynamic range. Another Army area of emphasis will be the study of millimeter (mm) and submillimeter (smm) waves in combat conditions, in adverse weather and smoke and dust environments to improve operational capabilities. Sources and detectors for mm and smm frequencies, propagation attenuation backscatter through the atmosphere, componentry and factors influencing imaging will be studied. The Army User community has placed a high priority on this capability. The technology base for mini-rangefinders will be extended to the 1-5 micrometer region. New compounds will be prepared in order to obtain information about crystal structure stoichiometry and laser action. Compact infrared lasers in the 3 to 4 micrometer region will be actively pursued. The effort in long wavelength laser technology will concentrate on optimization of the geometry of hydrogen cyanide type lasers, finalization of a practical structure for transversely excited carbon dioxide laser pumped cell attachments and other methods to enhance infrared emission. Unstable resonator geometries will be extended to include active gain cavity loading, and applied to the reduction of components. Integrated components such as lead salt diodes will be assessed as local oscillators for developing a highly sensitive and reliable detection system for carbon dioxide laser radiation. Other material properties which affect frequency shifting, absorption and emission of laser input or output radiation in order to control frequency and intensity

of laser radiation including absorbers and reflectors and broad and narrow band active filter concepts will be extended and analyzed. Low temperature processing by the pressure oxidation method will be advanced to actual fabrication of devices for full evaluation. Proton enhanced diffusion a high precision radiation processing method, will be advanced to include all required dopants in a silicon host. Such a process may eliminate imprecise chemical methods. Results of charge defect analyses in metal on silicon structures will be correlated with electrical performance/reliability deficiencies in integrated circuit, metal on silicon devices labelled and diagnosed by highly sophisticated instrumentation and techniques. New, high speed electron-beam resist polymers will be evaluated for circuit writing speed, optical exposure and differential solvent development procedures. Reliability physics and failure mechanisms research will continue in order to understand the root causes of failure due to materials degradation. Materials for high frequency (microwave) filter applications and ferrite phase shifters will be optimized for device specification. The main emphasis of all antenna research will be to improve affordability and reliability of secure, mobile jam-proof and fast communications for patrols and armor especially for operations in built-up areas. Research in photochemistry of propellants, aerodynamics of turbulent shear field, advanced propulsion materials such as boranes and carboranes by laser accelerated synthesis and improved simulation models will be continued for improved free rocket systems. Doppler enhanced resolution, sub-millimeter propagation in all-weather and smoke, target properties and imaging, infrared effects of surface roughness and laser induced luminescence will be studied as a basis for information in development of terminal homing systems. High energy laser related fundamental research will be conducted in the areas of excitation mechanisms and energy transfer mechanisms in gases and gas mixtures, with emphasis on hydrogen-deuterium fluoride and carbon dioxide lasers. Superradiance will be examined for high intensity short pulse generation pertinent to Army laser missions. Work on fuel cells will continue with emphasis on lower cost longer life electrodes, increased performance and efficiency, and enhanced fuel tolerance and utilization. Catalyst surface structure studies will provide increased knowledge of electrocatalytic processes leading to the development of catalysts for direct oxidation of hydrocarbons in fuel cells. Research in support of high electrical conductivity materials will continue. Night vision devices research will continue in uncooled low cost thermal imaging, extrinsic silicon detectors, atmospheric optics, target signatures and detection in the 1-2 micrometer range. Details are supplied in a separate descriptive summary. A new program initiated in Research in Electronic Warfare (AH 63), to be conducted by the Electronic Warfare Laboratory, will include: supporting research in systems theory for sensor concepts; pattern recognition; adaptive and associative signal processing; detection modulation theory for receivers, and antennas; propagation theory; characterization of new devices; control theory; and electronic warfare related electrooptics. Research in Support Equipment for the individual soldier will continue to investigate purification and immobilization of microbial toxins and their antibodies for development of rapid assay techniques and the examination of survival growth of food-bound space forming pathogens. Details in Research in Large Caliber Armament are supplied in a separate descriptive summary. In the Small Caliber Armament project, sighting and tracking research will be performed for the determination of effective and acceptable image processing techniques and generation of fast computer algorithms to accomplish such processing. The effects of obscurants on the performance of fire control systems and methods for improvements of fire control systems for ranging and tracking capabilities in smokes and reduced lighting will be examined. Josephson weak link detectors for millimeter and submillimeter, microwave imaging and tracking systems and improved optical elements may lead to better aiming capability at night and in foul weather. In the medical and biological sciences recent indications are that interactions of certain drugs (antimalarials) and essential vitamins and minerals are potentiating factors of gastrointestinal disturbances. This possibility and the effects which are related to military performance will be studied. Evaluation of selected exogenous and endogenous substances to include hormones will be thoroughly studied as to potentiation of wound healing.

Studies will be initiated to evaluate loss of blood supply and sepsis in wounds as they affect the hemodynamic picture and endocrine system in shock states. Alternatives other than animal species will be critically evaluated for use in toxicity testing. Comparative toxological/physiological studies have the potential for reducing the time and therefore the costs of toxicity testing. Maxillofacial studies with biodegradable ceramics for hard tissue avulsive wound replacement will now move into high scientific levels of clinical testing. Evaluation of this technique will be lengthy (3 to 5 years) but promises revolutionary replacement and treatment of maxillofacial wounds. A clinical phase for electroless metal deposition for restorative and preventative fixtures will begin for better material characterization. Helicopter and airborne medicine will reflect increased emphasis on improving soldier performance and eliminating health hazards. Research in military environmental stress is to be extended to adaption to extreme climates at the organ and cellular levels. Studies of peritoneal dialysis and arteriovenous shunting for internal cooling of the blood for treatment of heat injury will be continued. Research will be continued to devise a simple screening technique to determine the sensitivity of individuals to the hypoxia of high altitude environments and to determine the individuals who have a greater susceptibility to cold injury. Studies on the use of periotoneal dialysis and arteriovenous shunt for the internal rewarming of patients suffering from deep hypothermia will be continued. Non-destructive procedures for soil and rock assay by neutron and gamma radiation will be finalized. A reliable calculational method will be devised for predicting penetration of warheads in several geological environments. Laboratory and field experiments on the use of industrial waste as construction materials will be conducted. Geodetic and mapping scientists will develop theory for reducing gradiometry data; confirm the use of hybrid systems for optical data processing; demonstrate storage capabilities for new image recording materials; and complete their analysis of sensors applicable to line-of-communication identification. New research efforts in the chemical warfare/biological defense area are planned in the long term study of the effects of nerve agents on the blood components of the neuron. The effects of candidate antidotes for nerve gas poisoning will be studied along with improvements in chemical pattern recognition techniques which are important for substantially reducing costly toxicological procedures tests. FY 78 research effort in behavioral sciences will be devoted towards: specification of loss of field performance such as in night patrols, and reconnaissance patrols, due to temporary or specified degree of permanent hearing loss of soldiers in various combat scenarios; development of a position paper on the optimum mix of auditory and visual display systems in complex Army material items; delineating those Army material operational tasks which can be performed equally well by female soldiers and/or those tasks where female soldiers excel. Plans are to develop technology and methodology base for improvement of unit performance, provide support for enhancing operator/user performance in military systems and contexts, and to develop organizational effectiveness techniques ultimately applicable to military situations.

4. FY 1979 Planned Program: Research in vehicular mobility will continue to explore new and futuristic concepts of combat vehicles especially in the areas of structural mechanics, vehicle dynamics, components, and vehicle vulnerability reduction. The program for materials and mechanics will be focussed on quantifying the non-linear aspects of post-buckling behavior of ceramics. It is anticipated that when valid criteria for these failure modes are available, the structural efficiency of composites can be increased

by at least 25%; emphasis will be placed on generalized 3 dimensional structures and large deformation elastic-plastic stress analysis methods will be developed for application to metal forming processes. Research on mixed-mode fracture will continue in addition to work on criteria for fracture of more ductile materials. Investigations to remove technical barriers related to areas of ballistics will continue. Greatest importance will be placed upon those efforts directly in support of concepts which enhance ballistic effectiveness. Basic fluidics research will continue to evolve algorithms and criteria for design of temperature independent components for power supply conditioning and temperature compensated sensor/amplifier packages for low cost use at high and cryogenic temperatures. Research will continue on effects and nuclear hardening concepts for dielectrics and electronic components. Lithium-organic electrolyte systems will be studied to evolve stable, more effective electrolyte/electrode systems for fuzing. Advanced concepts for ordnance devices, such as proximity fuzes will be explored in the light of the advancing state-of-the-art in electronics, optics, electrooptics and structure of matter. It is expected that we will make a vital contribution to the Army's technology base in the area of sub-millimeter and millimeter waves including sources, propagation and scattering and detection related to imaging. This will significantly enhance operational capabilities in battlefield and inclement weather environments. Research in lasers will continue to stress new methods of obtaining high purity crystals and high concentration of laser ions in host lattices and matrices, for higher efficiency and lower cost lasers. Techniques for wavelength agility, new Q-switching materials, and scaling laws for higher power operation will be investigated. Objectives of this research is to develop lasers for ranging, designation and surveillance with wavelength variability, and the required ancillary equipment. Emphasis will be on integrated heterodyne receivers long wavelength lasers and laser radar hybrid, detection. Advanced materials and concepts for electronic components and devices will be sought for secure communications, compact data processing equipment, and tactical surveillance equipment and systems. New and diversified diagnostic techniques for eliminating defects and improving processes at the atomic level, new processing technologies based upon chemical kinetics and radiation physics will continue to be discovered and applied along with theory for electron behavior in solids of interest. Theoretical and experimental studies will be continued to provide new concepts and basic data for improved Army communications. Missile related research will include optoelectronics and quantum optics in connection with laser modulators and doppler spread imaging, studies of energy transfer in gases of high energy laser interest, aerodynamics, propulsion, electro-optical properties (reflection, scattering, luminescence) of surfaces which control terminal homing to targets, and simulation studies for distributed hybrid computers. Electronic warfare related research in material sciences, electronics, and computer simulation will also be conducted. Combat and soldier support directed research will extend to power supplies and transmission studies of interaction of materiel with environment in all terrains. Food research will examine factors governing growth of microbial toxins in foods, spoilage potential of rations, diet and menu optimization, metabolic consequences of free glycerol, and other long range requirements of the military services. Clothing, soldier equipment, and materials including the personal armor program for comfortable, lightweight inconspicuous clothing and vests will be improved. New research in Large Caliber Armament is outlined in a separate descriptive summary. Research in Small Caliber Armament will generate and exploit a technology base in: fire control technology including lasers, sighting and tracking, systems analysis, hybrid computer modelling, gun tracking and pointing; and design of small and cannon caliber projectiles. Contract/Grant research will continue as outlined in several separate descriptive summaries to maintain significant research in promising areas and to initiate new thrusts. Planned research in healing and recovery from injury includes studies to enhance the longevity for the storage of blood. Continuation

of surgical studies of mechanisms of shock and recovery from trauma, and developing methods to improve wound healing is planned. The identification of health effects of military pollutants will require research on less time consuming and less costly toxicological testing. Emphasis will be placed on determining organs, tissues or physiological processes which are targets for toxic materials. Military burn research will include development of antisera for clinical studies concerning protection against shock, lung and decreased immunocompetence post-trauma. Clinical trials of antisera against sepsis will be completed. Development will proceed on opsonization enhancing factors. Combat dental related work on new materials and with biodegradable ceramics for avulsive wound replacement will now enter long range (3-5 year) evaluation, promising revolutionary treatment of torn-away wounds. Electroless metal techniques to reduce field dental emergencies will move into full clinical testing. Research will be continued in the areas of helicopter tactical aeromedical evacuations; helicopter combat crew and airborne visual requirements; helicopter vibration effects on musculoskeletal physiology; stress/disease/injury states of the acoustical environment affecting helicopter combat crew and airborne effectiveness/performance. Studies of peritoneal dialysis and arteriovenous shunting as methods of internal cooling for treatment of heat injury and internal rewarming for treatment of deep hypothermia will be continued. Research on the adaption to environmental extremes at the cellular, organic and organismic levels also will be continued. Continuation of studies to develop and refine simple screening techniques to determine an individual's susceptibility to cold injury and acute mountain sickness is anticipated. Testing for durability of industrial wastes as construction materials will be completed. Soil and rock studies will seek a physically reasonable model of dynamic friction effects at soil/structure interfaces. New research will be initiated in the areas of engineering geology and soil and rock mechanics. Fabrication of an experimental automated feature extraction system; a comprehensive assessment of state-of the-art in mapping instrumentation; and an analysis of sensors applicable to camouflage detection will be completed. Research in CW/BW defensive systems will include a long term study of: red blood cells and plasma cholinesterase; mechanism of action of carbamate compounds in motor muscle at the cellular level; antidotes for nerve gas poisoning; and visual acuity in animals and humans. The Human Engineering Laboratory will continue to derive new information on the behavior of man upon which to base predictions of man's performance when using military equipment under all types of field conditions and environments. FY 1979 plans in Army performance and training include a sizeable step-up in organizational development and organizational effectiveness research to produce knowledge and methodologies enabling 6.2 and 6.3 efforts to address team entity, or group cohesiveness concepts, also job satisfaction, morale and productivity techniques and models. Successful leads of the FY 1978 program will be continued where transfer to 6.2 and 6.3 programs is not yet warranted.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A

Title Defense Research Sciences

Project #AH43

Title Research in Ballistics

Category Research

Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: This project supports the Army's weapon development program and consists of research critical to understanding the processes involved in the functioning of a weapon, e.g., the chemical kinetics under conditions of high temperature and high pressure in explosives and propellants; the fluid dynamics and heat transfer involved in combustion, detonation and incendiary processes; the aerodynamics of shells and rockets; and the continuum mechanics controlling explosive-metal interactions. This research is conducted in the scientific areas of: propulsion dynamics; launch and flight dynamics; warhead dynamics and mechanics, and blast and kinetic energy projectile mechanisms and effects; ballistic protection; mathematical analysis; and system statistics and decision theory. This project is a continuing integrated effort to provide the fundamental scientific and engineering base necessary to advance the various weapons technologies. This work is relevant to the entire spectrum of weapon systems ranging from small arms to large missiles and their warheads.

RELATED ACTIVITIES: Related research is performed by the Navy, Air Force and the National Aeronautics and Space Administration. Coordination is accomplished by program reviews, exchange of program data sheets, research and technology resumes, technical reports, and liaison and attendance at scientific meetings and conferences. At Department of Defense level, coordination is achieved through program reviews sponsored annually by the Office of the Director of Defense Research and Engineering. Broader, multinational coordination is achieved through joint participation of Australia, Canada, United Kingdom and the United States in The Technical Cooperation Program, and participation in the North Atlantic Treaty Organization Advisory Group on Aerospace Research and Development. Data exchange agreements exist on various aspects of ballistics research with both the Federal Republic of Germany and France. This project is planned and executed in close coordination with Project AH60, Research in Large Caliber Armament, Project AH61, Research in Small Caliber Armament, and Project AH80, Ballistics Technology.

WORK PERFORMED BY: Approximately 84 percent of this program will be accomplished in-house at the Ballistic Research Laboratory, Aberdeen Proving Ground, MD. The remainder of the program will be accomplished through contracted efforts with universities, industry and government agencies. Contracts of more than $25,000 each are planned for: Johns Hopkins University, Baltimore, MD; Los Alamos Scientific Laboratory, Los Alamos, NM; New Mexico Institute of Mining, Socorro, NM; Princeton University, Princeton, NJ; Stanford Research Institute, Palo Alto, CA; System, Science and Software, La Jolla, CA; Dyna East, Wynnewood, PA; Mathematical Applications Group, Inc., Elmsford, NY; Honeywell, Inc., Minneapolis, Minn; and Marvaland, Inc., Westminster, MD. Six additional contracts are expected to total about $355,000. In FY 76, the Army Research Office (ARC) funded more than $700,000 in contracts to give direct support to the Research in Ballistics program under Project BH57, Research in Scientific Problems with Military Applications. ARO's contracts with universities and private corporations will continue to be a vital supplement to the Research in Ballistics program.

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #AH43 Title Research in Ballistics

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Characterized the thermal decomposition of a promising liquid propellant at atmospheric pressure and developed a mathematical model for ignition and combustion of this propellant. An improved thermal jacket for tank gun tubes was designed and tested indicating a reduction in variable bias due to solar heating. The gas-dynamical model of muzzle flow was experimentally verified in predicting blast interaction with emerging projectiles. The effect of an asymmetric muzzle device on the dispersion of a projectile was measured. Improvements were made in the basic empirical penetration models used to predict the interaction of kinetic energy projectiles striking armor. Work was initiated on techniques to provide a spherically converging detonation from novel waveshaping configurations. Simplified mathematical models for use in tank design trade-off studies were evaluated. Heat transfer measurements and radioactive tracer techniques were used to improve the fundamental understanding of gun tube erosion mechanisms and to assess the efficiency of wear-reducing additives. A theoretical algorithm was developed that correctly predicts the stability of liquid-filled projectiles during rotational acceleration. Chemical studies showed that small amounts of halon mixed with diesel oil had the ability to improve the performance of diesel oil by enhancing ignition and at the same time to extinguish simulated-combat-induced fuel fires by preventing sustained combustion in vented chambers. Advances in the understanding of the behavior of high density metals subject to high dynamic stresses will lead to the development of improved anti-armor penetrators. The ground work was laid for a 5-year chemical kinetics program; work began on a flow reactor system for neutral species detection, and assembly of computer codes to study gas-phase chemistry of neutral species, and assess applications to Army problems. With the goal of measuring the temperature of shaped charge jets under dynamic conditions, a technique to determine the temperature of an event whose duration is approximately one-millionth of a second was demonstrated.

2. FY 1977 Program: Fundamental investigations of the technical barriers related to the various scientific areas of this project are continuing. Propulsion dynamics studies include the development and validation of interior ballistic models and the investigation of parameters leading to the stable reproducible ignition and combustion of liquid propellants. Launch and flight dynamics investigations address the problem of muzzle gas flow about the projectile and sabot during launch, and the computation of the Magnus effect on supersonic projectiles. Efforts in warhead mechanics involve studies of the sensitivity of explosives as well as fundamental studies of shaped charge and fragmentation warheads to include waveshaping techniques. Work continues on the ballistic response of materials and sophisticated computer codes for the analysis of structural response to dynamic high-pressure loading. This should lead to design improvements in both armor and kinetic energy penetrators to defeat armor. Sample stochastic system models are being developed to analyze the performance and survivability of selected weapon systems and to establish the general structure of stochastic models.

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #AH43 Title Research in Ballistics

3. FY 1978 Planned Program: Major efforts in each of the scientific areas of the ballistics research program will be pursued. In the propulsion area, a ballistic evaluation of molded propellants will be completed. Additional emphasis will be placed on work to improve understanding of the mechanisms involved in wear and erosion of gun tubes. This will include thermal and radioisotope techniques to measure, respectively, heat transfer to and erosion of gun barrels. The results of this effort will contribute to high velocity gun programs as well as to existing systems. Launch and flight dynamics investigations will continue in muzzle device modeling, understanding turbulent boundary layer development, and modeling projectile aerodynamics. In warhead dynamics emphasis will be placed on formation phenomena and physical properties of shaped charge jets. The focus in the kinetic energy projectile/armor will be on improved understanding of penetrator-target interactions leading to a greater capability to model the process and predict the effect of design changes. This work will be applicable to both munition and armor items. The mathematical analysis efforts will treat such topics as stochastic performance and survivability models and numerical codes. Statistical model development and decision and predictive algorithms will be developed in the systems statistics area. The small decrease in FY 1978 funding is related to achieving overall balance between in-house and extramural work in the Army's research program.

4. FY 1979 Planned Program: Fundamental investigations of the technical barriers related to the various scientific areas of this project will continue. Greatest emphasis will be given to those efforts which are directly in support of concepts having a potential for greater effectiveness. The planned increase in funding in FY 79 will allow for a small amount of real growth in the level of effort. This will permit greater emphasis in attacking such pacing problems as gun tube life, penetration mechanics and ignition and combustion of liquid propellants.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	4965	1346	5922	5760	6400	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A **Title** Defense Research Sciences

Project #AH45 **Title** Air Mobility Research

Category Research **Budget Activity** #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: This project supports research to advance the state-of-the-art in rotary-wing aerodynamics, structures, propulsion, and mathematical models. The objective is to expand the technologies in those areas which are most likely to produce improvements in operational effectiveness, safety, survivability and life cycle costs of Army aircraft. Aerodynamics research will address basic fluid mechanics, airfoils, acoustics, dynamics, control and flight simulation. Structures research will address advanced metal and composite aircraft components. Fatigue and fracture characteristics of these materials will be investigated and fracture control procedures and techniques will be developed. Propulsion research will be directed at small engine technology and will consider improvements in internal aerodynamics of combinations of compressors, combustors, and turbines, and increasing turbine operating temperatures. Mathematical modeling research will develop mathematical techniques applicable to problems peculiar to rotary-wing aircraft.

RELATED ACTIVITIES: This project supports the Army's aeronautical research program conducted in joint participation with the National Aeronautics and Space Administration (NASA) in accordance with the agreement between NASA and the Army. Related research is performed by the Navy, Air Force, and the Department of Transportation. Coordination to eliminate undesirable duplication within the Department of Defense is accomplished by program and topical reviews; through the exchange of program data sheets, research and technology resumes, and technical reports; and by inter-service liaison and visits. Broader coordination, including international coordination and cooperation, is accomplished by participation in the Quadripartite Standardization Program, The Technical Cooperation Program, NASA Research and Technology Committees, and the North Atlantic Treaty Organization Advisory Group on Aerospace Research and Development. The program supported under this project is closely related to, and planned in conjunction with, the scientific program of contracts and grants with industry and academic institutions that is implemented by the Army Research Office under project 1T161102BH57, Research in Scientific Problems with Military Applications, and the technology program supported under element 6.22.09.A, Aeronautical Technology.

WORK PERFORMED BY: Approximately 60 percent of this program is accomplished in-house at the Benet Weapons Laboratory, Watervliet, NY; and by laboratories of the Army Aviation Research and Development Command located at Moffett Field, CA; Hampton, VA; and Cleveland, OH. The following contractors have contracts or grants of $36,000 or more: Dynamic Engineering Group, Newport News, VA; ADVEK, Newport News, VA; McDonnell Douglas, Long Beach, CA; Sikorsky Aircraft, Stratford, CT; Bell Helicopter Company, Ft. Worth, TX; Boeing Vertol Company, Philadelphia, PA; DATACOM, Incorporated, Ft. Walton Beach, FL; Creare, Incorporated, Hanover, NJ; United Technology Research Center, East Hartford, CT; and MacNeal Schwendler Corporation, Los Angeles, CA. The remaining contract program involves eight contractors for a total of $135,000.

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #AH45 Title Air Mobility Research

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Fluid dynamics research led to the first detailed understanding of the variations in the pressure distribution on a helicopter rotor blade during forward flight. This revealed, for the first time, the distinction between lift stall and moment stall and explained why this dynamic phenomenon is not apparent from conventional static airflow tests. This phenomenon is the driving mechanism for stall flutter and is important with regard to rotor control loads and stability. Follow-on investigations showed that retreating blade stall originates in the turbulent boundary layer on practical rotor blade shapes, even though much of the vorticity that induces large transitory loads emanates from the leading-edge region. An in-flight far-field acoustic measurement technique was developed and used to gather acoustic directivity data on a UH-1H Huey helicopter experiencing blade slap. More recent experiments using a YO-3A quiet airplane in place of the OV-10 used previously for the in-flight far-field acoustic measurements have been completed. The new system allows for substantial separation of microphones to provide triangulation data on noise sources and provides a 15 db reduction in background noise from that of the already good OV-10 levels. A mathematical dynamic performance model of a heavily-loaded, single-rotor helicopter operating in ground effect was developed that has had a major impact on the training of helicopter pilots. A significant finding from materials research is a marked advance in coatings for superalloys for operation at high temperatures, typically used on the turbine airfoils of small engines. Consolidation processes for improving toughness of ceramic compounds were developed. Polymers for low cost, lightweight compressors were developed. A three-dimensional, finite-element stress analysis program has been demonstrated for turbine discs and blades. This improved analytical capability can guide designers in developing higher temperature, longer life turbines. Laminates made up of titanium and aluminum explosively bonded were fatigue tested. These show increased fracture toughness, damage tolerance, and fatigue performance over plate material of either alloy because of compressive residual stresses generated.

2. FY 1977 Program: Theoretical and experimental research is directed toward understanding the important aerodynamic mechanisms contributing to the dynamic loads of rotors. Of primary concern is the development of fundamental knowledge of main rotor blade dynamic stall and means of delaying such so as to increase forward-speed performance, improve agility, increase main rotor and control system reliability, and reduce operational maintenance costs. The far-field solution is being incorporated into a general, three-dimensional, steady, transonic code in order to determine blade acoustics simultaneously with loading. The unsteady, three-dimensional transonic code is being extended to include variable blade geometries Testing of fully instrumented blades will begin. Rotary-wing dynamic research is being continued with emphasis on improving hingeless rotor aeroelastic and dynamic design technology. An experiment to examine the flap-lag-torsion stability of elastic blades in hover is being initiated with the Rotor Dynamic Model. Experimental acoustic techniques are being refined to help quantify impulsive and broadband noise-generating mechanisms. Structural and aerodynamic design and analysis tools are being developed for high-pressure ratio stages that will lead toward reducing the number of components required in future engines. Combustor research is being continued, and the configurations receiving immediate attention include the through-flow and reverse-flow types. Fundamental design criteria are being developed for gears, bearings, seals, lubrication, and shafting, and will be applied to advanced drive trains and engines. Research effort is

devoted to providing materials with extended usage properties, and development of alloying, dispersion, strengthening, powder metallurgy, and a variety of fabrication and processing techniques. The dynamic behavior of composite material structures is being investigated. Research in structural analysis as well as in material applications is being continued.

3. FY 1978 Planned Program: Theoretical and experimental research will continue directed toward understanding the aerodynamic mechanisms contributing to the dynamic loads of rotors. Airfoil research will emphasize optimization of parameters based on criteria developed for segmental mission analysis with a goal of minimum compromise over the entire mission profile of a specific helicopter. Aeroelastic stability analyses of hingeless rotors will continue. The flap-lag-torsion stability of elastic blades in forward flight will be examined through extensive parametric variation. An experiment to examine the flap-lag-torsion stability of elastic blades in hover will be continued. Work will continue in the area of improving impulsive noise measurements. The investigation of fatigue failure mechanisms in composite laminates will continue and inspection of the boron-epoxy reinforced tail cone will continue to determine degradation during service. The application of higher strength and lighter weight materials, with long life properties, to the design of hot combustor and turbine components will be investigated to alleviate thermal fatigue problems and improve engine life. The application of modern mathematical techniques to the solution of aeronautical problems will continue. The increase in the funding of this project will permit continuing approximately the same level of effort.

4. FY 1979 Planned Program: The same major areas of effort will be continued. New advances and techniques resulting from earlier investigations will be exploited and program emphasis will reflect changes in the state-of-the-art. In unsteady aerodynamic research, emphasis will be placed on developing the capability to include these phenomena in the airfoil/rotor design cycle through pure analytical and/or empirical methods. Ultimately both lift and unsteadiness will be considered in transonic flow analysis. Evaluation of cyclic shear response of unidirectional composites will continue with the scope expanded to include an assessment of cyclic frequency and mean stress effects. The funding increase will support a continuation of the current program and permit some real growth in the aerodynamic part of this important aeronautical research program.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	4800	1300	4852	5070	5600	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A — Title Defense Research Sciences

Project #AH60 — Title Research in Large Caliber Armament

Category Research — Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: This project supports the Army's armament development programs in scientific areas of unique Army need for fundamental understanding as a basis for sound future development. It consists of research in the following scientific areas: energetic materials (explosives, propellants, and pyrotechnics); ultra-high pressure physics; and physics for armament (failure and reliability, advanced structural analysis, and gun mechanism analysis and control theory). In energetic materials, the thrust is toward developing new materials, understanding their behavior in ignition and initiation, combustion and detonation, their effects and their degradation to permit safer, more efficient and effective development, manufacture, use and disposal of munitions. The remainder of the effort is devoted to developing understanding of unique problems in armaments to permit the design of longer life, safer and more efficient gun tubes, recoil mechanisms and mounts.

RELATED ACTIVITIES: Related research is performed by the Navy, Air Force, National Aeronautics and Space Administration and the Energy Research and Development Agency. Coordination is accomplished by program reviews, exchange of program data sheets, research and technology resumes, technical reports, and liaison and attendance at scientific meetings and conferences. At Department of Defense level, coordination is achieved through active participation in Joint Technical Coordinating Groups and program reviews sponsored annually by the Office of the Director of Defense Research and Engineering. Broader, multinational coordination is achieved through joint participation of Australia, Canada, United Kingdom and the United States in The Technical Cooperation Program, and participation in the North Atlantic Treaty Organization Advisory Group on Aerospace Research and Development. Data exchange agreements exist on various aspects of the program. This project is closely coordinated with Project AH43, Research in Ballistics; Project AH61, Research in Small Caliber Armament; and the related exploratory development elements. This project has been restructured to support the Large Caliber Weapon Systems Laboratory in the new Armament Research and Development Command. It includes work previously reported under Project AH53, Research in Energetic Materials, Project AH54, Research in High Pressure Material Synthesis, and portions of Project AH55, Research in Weapons and Firepower. The objectives of this project are also supported by contracts and grants placed by the Army Research Office under Project HH57, Research in Scientific Problems with Military Applications.

WORK PERFORMED BY: Approximately 62% of this project is accomplished in-house at the Large Caliber Weapon Systems Laboratory at Dover, New Jersey and Watervliet, New York and the Ballistic Research Laboratory, Aberdeen Proving Ground, Maryland. The remainder is accomplished on contracts and grants. Contracts of more than $25,000 each are planned for: General Electric Company, Schenectady, New York; National Bureau of Standards, Washington, DC; Lawrence Livermore Laboratories, Livermore, California; J. B. Lilly Company, Minola, New York; Kared, Inc., Santa Monica, California; and Halo Beam Lasers, Inc., Paramus, New Jersey. Twelve additional contracts are planned totaling approximately $450,000.

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #AH60 Title Research in Large Caliber Armament

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: This program established and maintains the in-house competence for fundamental understanding of the properties and behavior of energetic materials. New techniques were evolved to determine the parameters controlling pyrotechnic, propellant and explosive decomposition. New instrumentation has provided new experimental data which makes it possible to verify or discard old theories and which guides the development of new and/or improved models and analyses. An example is that methods for identification of explosive impurities were established which are sufficiently accurate to distinguish the source of manufacture by region and plant. Extensive work in high pressure experimental physics and fracture mechanics motivated to understand phenomena happening during firing in a gun tube has led to important capabilities in fundamental physics as well as detailed results on gun tube phenomena. Static pressures in excess of 400 Kbar have been generated, and several new transition phases in bismuth have been discovered. A new technique for measurement of sound velocity in materials under ultra high pressures has been developed. A finite element approach to prediction of structural response of a moving mass in a long hollow cylinder was successfully developed.

2. FY 1977 Program: In the energetic materials area, research is devoted to: the discovery of new routes for the synthesis of existing explosives and of new compounds with improved properties; advanced detection techniques for explosives and propellants; ignition and initiation studies; and combustion and deflagration investigations. Emphasis is being placed on understanding the role of propellants in gun barrel erosion and the role of free radicals in initiation of explosives. Under the ultra high pressure physics area, studies of argon and hydrogen at 400-500 Kbar pressures are being completed. The experimental results for hydrogen will permit refinement of the theoretically predicted transition pressure for the metallic state. Efforts will continue to synthesize superhard materials and to study high strength/low optical absorption materials for possible laser window applications. In the physics for armament area, emphasis continues on research to gain understanding of the mechanisms of gun tube erosion and fatigue. Using a recently developed appearance potential spectroscopy technique, surfaces are being characterized to shed light on means for improving coating adhesion and, in particular, to explain the reason for adhesion variation as a function of base alloy content. A stochastic probabilistic model is being developed which will likely result in enhanced reliability of sample analysis of such components as gun tubes rather than depending strictly on classical statistical approaches. The work in advanced structural analysis addresses the problem of a single integral equation for three dimensional fracture mechanics involving various crack geometries and dispersion hardening of gun tube materials. Gun mechanism analysis and control theory is developing analytical procedures that can be used for initial design of a mechanism that will perform a set of required functions and to serve as a tool for the evaluation of the performance of a mechanism.

3. FY 1978 Planned Program: Major efforts in the energetic materials program will continue to permit prompt and thorough exploitation of new results to include: the synthesis and characterization of energetic materials, their decomposition products and residues; investigation of fundamental properties of energetic materials; study of propellant ignition mechanisms, and explosive initiation methods; characterization of propellant combustion and deflagration with emphasis on the low vulnerability

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project [illegible] Title Research in Large Caliber Armament

(nitramine) compounds; studies of reaction mechanisms in pyrotechnic mixtures; and continued studies of the theory of non-ideal and heterogeneous detonations to advance the utility of cheap, available commercial explosives and to characterize fuel-air explosives. The ultra high pressure physics work will include coupling a new one megabar system with a cryogenic sample chamber. Techniques will be developed and applied for critical field (Meissner) measurements to establish superconductivity under high pressure. High pressure synthesis of high purity polycrystalline alkaline halides with low optical absorption will be continued. The failure and reliability work will address plating mechanisms and new techniques to further surface characterization specifically as pertains to coating adhesion phenomena. A second life limiting process, that of erosion and wear, will be examined for potential development of a probabilistic model that may eventually formulate the basis for design criteria. The advanced structural analysis efforts will include extending the singular integral equation for three dimensional fracture mechanics problems to the multi-crack body and crack bifurcation problems. Definition of the mechanism of recoverable plastic deformation and the direction for strengthening and/or application to high strength materials will be completed. The gun mechanisms work will include investigations of new approaches and designs of recoil components and sensitivity studies for an accurate deterministic model of large caliber weapons which accounts for small variations in operational conditions and manufacturing tolerances. Studies will be undertaken to identify improvements in weapon control techniques based on modern control theory and technological advancements. The increase in funding planned for FY 1978 will partially offset the estimated effect of cost growth allowing for an approximately constant level of effort.

4. FY 1979 Planned Program: Significant efforts in each of the scientific areas will continue to permit early exploitation of new results. The planned funding increase in FY 1979 will provide real growth in the level of effort of this project. This will allow increased emphasis on important problem areas such as gun tube wear and erosion, mechanisms of explosive initiation, combustion of low vulnerability propellants, and application of ultra high pressure techniques to improve understanding of material properties under high loading conditions.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	3942	1090	4950	5150	6010	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A

Title Defense Research Sciences

Project #AH60

Title Research in LargeCaliber Armament

Scientific Area 01

Title Energetic Materials

Category Research

Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: The overall objective of this scientific area is to develop the theory of energetic materials and the knowledge of their behavior that is required for advances in technology and munitions development. This research will lead to a fundamental understanding of the functioning of military explosives, propellants and pyrotechnics through the conduct of both theoretical and experimental investigations. Research is conducted in the areas of preparation, characterization and properties; ignition and initiation; combustion and deflagration; detonation; and energetic effects. This research provides the fundamental characterization technology necessary to achieve new explosives and gun propellants and to provide significant improvements in handling and effectiveness of Army ammunition and explosive warheads. It is relevant to all munition systems and demolition devices as well as the associated manufacturing and loading technology. In addition, it provides a basis for assistance to both military and civilian agencies regarding transportation of explosives, hazard evaluation and various law enforcement applications.

RELATED ACTIVITIES: Related research is performed by the Navy and Air Force as well as the Energy Research and Development Administration (ERDA). Coordination is achieved by program reviews, exchange of program data sheets, research and technology resumes and technical reports and by active participation in scientific conferences and meetings. The explosives research of the three Services is formally coordinated through the Joint Services Explosives Program which also includes input by the ERDA laboratories. It was established by the Joint Logistics Commanders and is described in a document entitled "Joint Agreement on Services Explosive Program, Revision 4", dated 31 October 1976. Within the Department of Defense, the Army has the lead responsibility for explosives and pyrotechnics research. Broader multinational coordination is achieved by participation with Australia, Canada, and the United Kingdom in The Technical Cooperation Program and by data exchange agreements with France, Germany, the Netherlands, and Sweden. Related extramural research is conducted through the Army Research Office, under Project BH57, Research in Scientific Problems with Military Applications. This scientific area is closely related to and planned in conjunction with the exploratory development work supported under Program Element 6.26.03.A, Large Caliber and Nuclear Technology. Work in this area was previously supported under Project AH53, Research in Energetic Materials.

WORK PERFORMED BY: Approximately 85 percent of this program is accomplished in-house at the Large Caliber Weapon Systems Laboratory, Dover, NJ, and the Ballistic Research Laboratory, Aberdeen Proving Ground, MD. The remainder of the program is performed under contract with: National Bureau of Standards, Gaithersburg, MD; Lawrence Livermore Laboratory, Livermore, CA; J. B. Lilly Co, Minola, NY; Karad, Inc, Santa Monica, CA; Halo Beam Laser, Inc, Paramus, NY; and the National Academy of Science, Washington, DC. Eleven additional contracts are planned totaling approximately $80,000.

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #AH60 Title Research in Large Caliber Armament

Scientific Area 01 Title Energetic Materials

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: The program has established the leading in-house competence in the Department of Defense for basic understanding of the behavior and properties of energetic materials. The methodology for analysis and prediction of performance has been advanced by improved understanding of atomic and molecular structure. New techniques were evolved to determine effects of impurities and structural changes upon the behavior of explosives. Specific examples of accomplishments are: it was discovered that water affects structure and forms a rectifying electrical contact which may be important in electrical initiation; photoelectric initiation of lead azide explosives was achieved, and this may make remote fuzing by light possible; a high pressure laser spectroscopic technique was developed to provide a new approach to understanding explosive behavior; methods for very accurate identification of explosive impurities were established thus providing the capability to distinguish the source of manufacture by region and plant; and using laser instrumentation to study propellant surfaces resulted in determination of igniter energy outputs required for ignition. The effect of ammonium nitrate phase transitions on the dimensional stability of the new cost effective Amatex explosive fills for shells and bombs was determined. An improved mathematical model of the interaction of fuel droplets in the propagation of fuel-air explosives (FAE) was developed. The deflagration to detonation transition in these FAE compositions was predicted to be smooth. Transient species in the decomposition of TNT were tentatively identified and their lifetimes were measured. The effect of sub-detonation shocks in explosives were studied, and the presence of free radicals was detected. The addition of methylammonium nitrate and other additives permitted the attainment of performance comparable to Composition B in the cheaper ammonium nitrate explosive compositions. Additional insights were obtained into the vapor phase oxidation of magnesium which is important to pyrotechnic development. The continuing study of black powder revealed that sulphur does not affect the ignition temperature and that the flame propagation behavior of the composition does not occur via radiation. An ignition bibliography was completed and the importance of pressure on the ignition of M30 propellant was demonstrated. Kinetic parameters for nitrocellulose and nitramine propellants were determined.

2. FY 1977 Program: Preparation, properties and characterization research is devoted to the discovery of new routes for the synthesis of explosives and of new compounds with improved properties. Advanced techniques to detect and analyze explosives and propellants in liquid and solid media and in the atmosphere are being explored. In the ignition and initiation area, studies are continuing on the effect of heating rate on explosive pyrolysis determined by mass spectrometry and infrared matrix isolation techniques. The radiative ignition and "cook-off" properties of both standard and low vulnerability propellants is being studied. The development of a model of the thermo-mechanical response of energetics to pressure pulses is being initiated, and the role of free radicals in modifying initiation thresholds is being investigated in support of requirements for low vulnerability and premature insensitive compositions. The effects of particle size and percent nitration is being determined for various propellants. Fuel-air explosive detonation studies are assessing the advantages of solid fuels and solid or liquid

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #AH60 Title Research in Large Caliber Armament

Scientific Area 01 Title Energetic Materials

oxidizers. Work is continuing on ammonium nitrate explosives by exploring techniques suitable for assessing improvements in performance. A new thrust is the investigations of new techniques and conduct of model experiments to determine the role of propellants in gun tube erosion. The capability to describe and determine the mechanism of gun flash in the visable and infrared is being developed.

3. FY 1978 Planned Program: Major investigations in the various aspects of the energetic materials program will continue to make possible the prompt exploitation of new results. Emphasis will be placed on: the synthesis and characterization of energetic materials, their decomposition products and residues; investigations of fundamental properties of energetic materials; the study of propellent ignition mechanisms and improved methods of initiation of explosives; characterization of propellant combustion and deflagration with focus on the low vulnerability (nitramine) compounds; studies of fundamental reaction mechanisms in pyrotechnic mixtures leading to improved flares and illuminants; and continued studies of the theory on non-ideal and heterogeneous detonations to advance the utility of less expensive, available commercial explosives and to characterize fuel-air explosives. Research in support of the Joint Services Explosives Program will continue. Investigation of propellant-barrel interactions will be expanded. The small planned increase in funding in FY 1978 will help to offset the effect of cost growth on the work performed under this scientific area.

4. FY 1979 Planned Program: Substantial research efforts will continue in FY 1979 generally along the lines indicated for FY 1978. Continued emphasis is expected in such areas as characterization and synthesis improvements of new and existing explosives, mechanisms of ignition and combustion of propellants, and improved understanding of the reactions of various pyrotechnic compounds. The planned funding increase in FY 1979 will provide a modest level of real growth. This will be used to expand efforts in such thrust areas as: characterizing improved low vulnerability propellants and low cost ammonium nitrate-based explosives; obtaining a fundamental understanding of the role of propellants in the erosion of gun tubes; and addressing the role of free radicals in the initiation of explosives leading to the possibility of tailoring shock sensitivity by the use of small quantities of additives. This area will continue to support the Joint Services Explosives Program.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	3108	840	3782	3840	4200	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A

Title Defense Research Sciences

Project #BH57

Title Research in Scientific Problems with Military Applications

Category Research

Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: This project supports research to increase knowledge in mathematics and the physical, engineering, environmental, and biological sciences directly related to explicitly stated long-term national security needs and to the solution of identified military problems. It provides part of the base for subsequent exploratory and advanced developments in Defense-related technologies and of new or improved military functional capabilities in areas such as communications, detection, tracking, surveillance, weapons, munitions, aircraft, missiles, propulsion, land vehicles, guidance and control, navigation, energy conversion, materials, armor, structures, military construction, and personnel support.

Investigations in physics, chemistry and mathematics provide for systematic advance in the acquisition of new knowledge in the areas described in separate descriptive summaries for these scientific areas under this project. Research in electronics, information, materials, mechanics, energy conservation and aeronautical sciences provides technology to achieve significant improvements in performance and effectiveness of Army equipment. This research supports technologies described in the separate descriptive summaries for these scientific areas under this project.

The geosciences investigations in the atmospheric and terrestrial areas include atmospheric sensing and probing, cloud and aerosol physics, small scale atmospheric processes, upper atmosphere research, military geographic analyses, geodetic positioning and geophysical properties of the earth. This program provides the technology to meet the Army's needs for accurate artillery fire and for adapting Army vehicles and military construction to the natural environment, improved mapping and navigation, improved trafficability and mobility, and operating in the severe desert-polar-tropical regions of the world. Biological sciences research in such areas as biochemistry and biophysics provides the input to applied research directed toward the maintenance of the well-being of the soldier and the development of an adequate chemical and biological weapons defense capability.

This project is divided into scientific areas as follows: 01-Atmospheric and Terrestrial Sciences; 02-Biological Sciences; 03-Communications Engineering and Electronics; 04-Materials; 05-Mathematics; 06-Mechanics and Aeronautics; 07-Physics, and 08-Chemistry. These broad groupings of research derive from the strong need of the Army to participate in and sponsor work in the scientific community for the development of new knowledge that contributes to the improvement of Army equipment.

RELATED ACTIVITIES: The Navy, Air Force, National Aeronautics and Space Administration, Energy Research and Development Administration, National Science Foundation, Department of Interior, National Bureau of Standards, US Public Health Service, other government agencies, government agencies of allied nations, and the industrial community conduct related research. Coordination to assure

no unnecessary duplication is accomplished by program reviews; exchange of program data sheets, research and technology resumes and technical reports; interservice and interagency liaison; and attendance and participation of representatives at annual reviews sponsored by the Office of the Director of Defense Research and Engineering. Coordination occurs through sponsorship of meetings and conferences, attendance at professional and scientific society meetings and review of scientific literature.

WORK PERFORMED BY: This program of grants and contracts with academic and not-for-profit institutions and industrial laboratories is managed by the US Army Research Office, Research Triangle Park, NC. The top ten grantees and contractors are: University of Wisconsin, Madison, WI; Massachusetts Institute of Technology, Cambridge, MA; University of California, Berkeley, CA; University of Southern California, Los Angeles, CA; Stanford University, Stanford, CA; Stanford Research Institute, Menlo Park, CA; University of Illinois, Champaign-Urbana, IL; Princeton University, Princeton, NJ; Pennsylvania State University, University Park, PA; and Cornell University, Ithaca, NY. There are in addition 175 grantees and contractors. The value of the additional grants and contracts is $13,700,000.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Accomplishments are reported separately in six scientific area Descriptive Summaries. Other examples follow: High resolution lidar (laser radar) has been demonstrated to be potentially superior to current field systems for determining wind conditions in the lower few thousand feet of the atmosphere, and has application to adjustment of rocket and cannon fire, fog formation and dissipation, and transport of gases. A new technique for designing radar signal waveforms was discovered which will provide more accurate information about the target. A capability for remotely observing atmospheric motions in nearly real time has been achieved. The techniques show promise for incorporation in the Army Automated Meteorological System. New semiconducting materials have been developed, and the main required physical principles have been demonstrated, which are expected to make available detectors of long wavelength infrared radiation with sensitivity close to that available for detection of visible light. Research on the structure and properties of aluminum-columbium-chromium-nickel alloys has contributed knowledge necessary to allow scale-up and control of processes for the production of a new family of turbine blades and vanes. A new numerical scheme has been demonstrated for study of fracture and fatigue processes in gun tubes.

2. FY 1977 Program: Research efforts relevant to the Army's mission are being supported in the areas partially listed below to provide the Army with the most advanced equipment and to be responsive to its changing needs: atmospheric sensing and probing, cloud and aerosol physics, small-scale atmospheric processes for investigation of mesoscale weather conditions, military geographic analysis, and geophysics for application to engineering problems; food and ration research, protection of material from biodegradation, protection and rehabilitation of environmental quality, defense against chemical and biological weapons, chemistry of

surfaces and interfaces for air filtration and skin decontamination, and atmospheric chemistry; electronic materials and principles for better device performance and reliability while decreasing costs, antennae and detection of radiation; capability to design and simulate integrated circuits in order to optimize design without expensive cut-and-try fabrications; signal processing and related systems for fast, accurate, reliable and efficient transmission of information, new ideas for man-machine interfacing, microprocessors and distributed processing systems, and research in communications-related computer systems; applied mathematical analysis for such problems as heat transfer in weapons, understanding and development of efficient and accurate numerical analysis schemes, development and analysis of statistical techniques for the interpretation of field data, and operations research in logistics problems; solid mechanics applied to design of helicopters, weapons, vehicles and other Army materiel; fluid mechanics oriented toward the development of technology for Army weapons which involve air vehicles or liquid working fluids, engines and fuels, degradation, reactivity, new methods of synthesis and processing, and new concepts for testing and analysis of ceramic, polymeric and metallic materials for military applications; and the discovery and exploration of new physics concepts, phenomena and techniques for improvement of military weapons, equipment and practices.

3. FY 1978 Planned Program: The FY 1978 program will be a continuation of the work described in Section 2, above. The tendency will be continued to emphasize work of high scientific merit with both short and long-term potential for impact on Army technology. In addition to the work described in the Descriptive Summaries for six of the scientific areas of this project, research emphasis will be placed on carefully selected thrust areas in the atmospheric, biological and terrestrial sciences. The increase in funds from FY 1977 to FY 1978 is based both on continuing Army requirements for research and Department of Defense policy to provide a real increase in the Army's extramural research program.

4. FY 1979 Planned Program: The FY 1979 program will be based on a continuation of the work described in the foregoing sections, maintaining flexibility to initiate new thrusts as promising scientific areas and corresponding Army needs become evident. The increased funding in FY 1979 will provide additional support of relevant research contracts and grants with the scientific community.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	19038	3522	23880	27000	30000	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A

Title Defense Research Sciences

Project #BH57

Title Research in Scientific Problems with Military Applications

Scientific Area 03

Title Communications Engineering and Electronics

Category Research

Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: This task contributes to the electronics and communications science and technology base through exploration of novel phenomena and generation of new concepts. The objective is to solve critical Army problems related to exploratory development where progress has been inhibited by a lack of understanding of fundamentals or a scarcity of basic data. Research to obtain fundamental information is performed in the areas of signal generation, transmission, reception and processing; computer systems and sciences, and communication theory; and solid state electronics to include semiconductors, superconductors, magnetics and dielectrics, circuitry and networks. Work under this task has application to a wide variety of exploratory development efforts contributing to the solution of such science and technology related problems as communications, command and control; surveillance, target acquisition and night observation and intelligence and electronic warfare. Current emphasis is on the following six areas: physical electronics; electron devices; antennas and electromagnetic detection; circuits, networks, and related systems; signal processing, communications and related systems; and computers and information processing. The effort provides for coupling between academic and military scientific communities and complements the efforts of in-house Army scientists to provide a basis for follow-on exploratory development. Included is the Army portion of the support for the Joint Services Electronics Program, planned and funded jointly by the Army, Navy, and Air Force.

RELATED ACTIVITIES: This program is related to parts of the following projects in Program Element 6.11.02.A: A315, Night Vision Devices Research; AH47, Electronic Devices Research; AH48, Electromagnetic Propagation and Antenna Research; AH44, Research in Fluidics, Nuclear Effects and Ordnance Electronics; AH43, Research in Ballistics; and AH51, Combat Support Research. Close coordination is maintained with the Navy, Air Force, Defense Advanced Research Projects Agency, the National Aeronautics and Space Administration, and the National Science Foundation.

WORK PERFORMED BY: This program in managed by the US Army Research Office, Research Triangle Park, NC. The top ten contractors are: Massachusetts Institute of Technology, Cambridge, MA; University of Illinois, Urbana, IL; Columbia University, New York, NY; Stamford University, Stamford, CA; Varian Associates, Palo Alto, CA; University of California, Berkeley, CA; University of Southern California, Los Angeles, CA; Georgia Institute of Technology, Atlanta, GA; California Institute of Technology, Pasadena, CA; and Case-Western Reserve University, Cleveland, OH. The total number of additional contractors is 29; the total dollar value of these contracts is $1,300,000.

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #BH57 Title Research in Scientific Problems with Military Applications

Scientific Area 03 Title Communications Engineering and Electronics

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976 and Prior Accomplishments: Significant progress made in advancing the state-of-the-art of electronic devices are: the use of interdigital transducers in surface acoustic wave technology for radar signal processing; the development of a gallium phosphide light-emitting diode for photocathode calibration in surveillance systems; the passivation of gallium arsenide devices for high frequency integrated circuits; the understanding of impurity doping of, and contacting on, gallium arsenide; near-infrared field assisted hot electron photocathode with record sensitivity; and the completion and worldwide application of computer-aided integrated circuit design program for integrated circuit modelling. In the field of information processing, research has led to: development of design procedures for auto- and cross-correlation signal sets for use in radar systems; a novel theory predicting heterojunction discontinuities of importance to photocathode, injection laser and other semiconductor devices; the first growth and characterization of high quality epitaxial indium phosphide films to be used in extremely high frequency devices; and completion of a theory for analysis of electromagnetic ray propagation for optical and microwave acquisition and surveillance systems.

2. FY 1977 Program: Cooperation with Army laboratories was further enhanced. Increasing emphasis is placed on long-range research projects. Block funding has been implemented at three schools: Georgia Institute of Technology; California Institute of Technology; and Stanford University. In technical areas, major emphasis is on finding new techniques and tools to solve problems in multidimensional signal processing concerned with data compression, transmission and reception. Work in computer sciences is directed to finding improved techniques for man-machine interfacing, new ideas for the use of microprocessors and distributed processing systems, and new approaches to communications-related computer systems. Work is closely coordinated through the integrated software research and development program of the Army. In solid state electronics research, particular attention is being devoted to finding new electronic materials and new applications of physical laws in order to develop novel generators, detectors, and signal processors that will operate at radar bands and onto the millimeter wave region. Under the Joint Services Electronics Program, Harvard University, Massachusetts Institute of Technology, Polytechnic Institute of New York, Columbia University, the University of Illinois, the University of Texas, the University of California at Berkeley, the University of Southern California and Stanford University receive block funding based on favorable review of proposals by selected tri-Service committees. The increase in funds in FY 1977 is to provide additional support of relevant research contracts/grants with the scientific community in this scientific area.

3. FY 1978 Planned Program: Much of the current electronics program will be continued. Research effort will be extended to generate new technology and better understanding of phenomena in the areas of small, active antennas, surfaces and interfaces in solid state electronics, semiconductor devices for high-power pulsed radar applications, computer-aided design of hybrid integrated circuits and integrated circuit process modelling and simulation. The program will be kept flexible and dynamic in order to be

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

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Scientific Area 03 Title Communications Engineering and Electronics

responsive to Army needs. The Joint Services Electronics Program will be continued. The increase of the Army Research Office budget from FY 1977 to FY 1978 is based both on continuing Army requirements for research and Department of Defense policy to provide for a real expansion of the extramural research effort in communications and electronics. In order to improve the operational capabilities of the Army at an acceptable cost of material, it is desirable to intensify the exploitation of scientific advances and novel engineering concepts.

4. FY 1979 Planned Program: About thirty percent of the presently active program will be scrutinized for renewal with emphasis on those thrusts which will bear on the science and technology base of the 1980's and beyond. Investment strategy will be guided by presently existing program thrusts and modifications implemented to assure most efficient pay-off for the dollars invested. A proper balance between short and long range programs will be maintained.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	4023	564	4860	5330	6100	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A Title Defense Research Sciences

Project #BH57 Title Research in Scientific Problems with Military Applications

Scientific Area 04 Title Materials

Category Research Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: This scientific area contributes to materials for mobility, firepower, communication and control, and personnel protection for the Army through exploration of novel phenomena and generation of new understanding of the processing, structure, properties, degradation, and protection of materials. Research to obtain fundamental knowledge is performed in the areas of mechanical behavior of materials (e.g. strengthening, fracture, embrittlement, erosion and wear); degradation and reactivity of materials (e. g. corrosion, oxidation, and decomposition under radiation); effects of structure, defects and chemical composition upon physical and chemical properties of materials (e.g. effect of defects on electronic, optical and magnetic properties, relation between chemical composition and the microstructure of special alloy steels, and structure and properties of the new amorphous metal alloys); new methods of synthesis and processing of materials to improve properties and reliability in service (e.g. intercalation of graphite to improve its electronic and optical properties, and curing of concrete under carbon dioxide atmosphere to decrease the curing time necessary to reach maximum strength); and new concepts in testing and analysis of materials (e.g. optical probing of acoustic emission waves to detect the onset of fatigue in alloys, and novel modeling of magnetic field interactions with material defects). The work is accomplished through grants and contracts which are awarded to universities, private industry and non-profit laboratories for research of high potential relevance to Army problems. The effort includes coupling among the academic, private and government-wide sectors to bring all of the available research and development resources to bear on Army needs. This program complements the Army in-house programs to provide a science base for the existing and future technologies of interest to the Army.

RELATED ACTIVITIES: This program is coupled with and related to in-house laboratory work in the following projects in Program Element 6.11.02.A: AH42, Research in Materials and Mechanics; AH43, Research in Ballistics; AH60, Research in Large Caliber Armaments; AH61, Research in Small Caliber Armaments; and AH47, Electronic Devices Research. Close coordination is maintained with the Air Force, Navy, Defense Advanced Research Projects Agency, National Aeronautics and Space Administration, National Science Foundation, and the Energy Research and Development Administration.

WORK PERFORMED BY: This program is managed by the US Army Research Office, Research Triangle Park, NC with all work being performed under contract or grant. The top ten contractors are: University of Illinois, Urbana, IL; Massachusetts Institute of Technology, Cambridge, MA; University of Pennsylvania, Philadelphia, PA; Battelle Memorial Institute, Columbus, OH; Lehigh University, Bethlehem, PA; Colorado School of Mines, Golden, CO; University of Washington, Seattle, WA; University of Connecticut, Storrs, CT; Rensselaer Polytechnic Institute, Troy, NY; and Michigan Technological University, Houghton, MI. There are 37 additional contractors representing a total dollar value of $920,000.

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #BH57 Title Research in Scientific Problems with Military Applications

Scientific Area 04 Title Materials

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Examples of significant accomplishments are: improved understanding of the nature of defects, impurities, annealing and doping behavior of ion implanted silicon (relevant to silicon devices and in particular radiation damage in electronic components); invention of a device to assess protective coatings against corrosion, and to predict the oxidation and pitting of steels; oxide coatings to improve the protection of nickel-based superalloy turbine components against degradation by sulfur attack; discovery and improvement of rare earth cobalt (samarium cobalt and related alloys) permanent magnets which are the most powerful to date (used in Patriot missiles, utility and attack helicopters, and Air Force and Navy aircraft); improved understanding of the mechanism to change brittle gray cast iron to ductile cast iron by control of the chemical composition (alloying); and development of a new analytical technique for prediction of dynamic crack propagation in high strength steels which could lead to improved design criteria for the Army's armored vehicles. Discovery of the mechanism of stress-corrosion failure in high strength, weldable aluminum-zinc-magnesium alloys for application in M113 Armored Personnel Carriers, extruded bridge structures, and helicopters; discovery of the influence of thermomechemical treatment on the fracture of polymers of potential value in the processing of polymers and polymer-matrix composites to avoid environmental stress crazing and to increase impact strength for such Army components as helicopter canopies, helicopter rotor blades, and missile motor cases; and development of a technique to study the kinetics of the recombination of halogen atoms on solid surfaces (relevant to the design of catalytic tubes for hydrogen flouride and hydrogen chloride lasers, to the selection of container materials for these gases, and to the diagnosis of the performance of gas dynamic laser systems employing the hydrogen plus flourine reaction).

2. FY 1977 Program : Several topics have been identified as thrust areas within the program due to their importance as Army needs, their timeliness and their potential for large payoff. These thrust areas include structure, strength and fracture mechanisms in polymers and polymer-based composites (structure-processing-property relationships are being studied much more intensively in order to provide efficient and reliable polymeric and polymer-matrix composite materials); behavior of materials under high rates of energy impingement, e.g. pulsed laser interactions with alloys, and influence of materials structure on response to dynamic loading and shock; erosion of gun tubes, missile components, and turbines by hot gases and particulates; tailoring of properties through structural control in new alloys, compounds, and other materials which have unusual properties which may serve as the base for future electronic, magnetic, and optical devices, e.g. intercalated graphite, ion-implanted semiconductors, and amorphous splat-cooled alloys; novel techniques for the analysis and characterizaiton of materials to ensure reproducible structure and properties for the Army's materials; and fretting and wear of materials (one of the key problems in helicopter failure).

3. FY 1978 Planned Program: This program will address a balanced scope with major thrusts and emphasis changing to reflect the Army's requirements and the advance of science into new areas of relevance to the Army's anticipated future needs. For example, future trends in the mechanical behavior of materials will be to studies of strengthening and failure at higher temperatures under

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #BH57 Title Research in Scientific Problems with Military Applications

Scientific Area 04 Title Materials

more complex loading conditions, at higher loading rates, and in more complex materials. In the degradation and reactivity of materials, trends will be to studies of novel protective coatings to protect materials from aggressive environments, degrading of materials under combined effects of temperature, stress, abrasion, and more complex chemical environments. New techniques will be sought to characterize the structure (including defects) of novel materials, e.g. the amorphous magnetic alloys. Exploration will continue for new techniques to provide materials with unique properties, to reproducibly produce materials with reliable performance and to reduce the cost of processing materials. The fundamental aim of this program of research on materials is to discover the relationships between the composition, structure and properties of materials. The correlative aim is to master the principles whereby a desirable structure and composition may be dependably and repetitively produced at the minimum cost. Thus, the planned program for FY 1978 will be to maintain a science base for the Army's current and future materials needs which is a combination of work units having both short and long-range objectives. Areas of current interest will be brought to fruition, and emerging areas of potential long-range payoff will be exploited. Coupling with programs of the Army laboratories will continue. The planned increase in funding for FY 1978 will provide for a real expansion of the extramural research in materials in consonance with Department of Defense policy.

4. FY 1979 Planned Program: The program for FY 1979 is planned along the same guidelines as those of FY 1978, i.e., maturation of the existing topic areas and initiation of work units which show promise for future Army technology. Those work units which are advanced to the position that they are ready for exploratory development will be coordinated with the Army laboratories. The budget increases will be used to expand the program into areas which are not now being adequately funded. Areas which now can be identified as being of high potential for program expansion include increased emphasis on processing of novel materials (especially electronic, magnetic and optical materials), novel concepts in testing and analysis (special emphasis on composite materials, joining of materials, improved properties and reliability of weldings, and adhesive bonding), predictive methodology for performance of materials at high temperatures, and the role of surface reactions and their kinetics upon deterioration of materials (and its prevention).

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	1912	455	3000	3430	3800	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A

Title Defense Research Sciences

Project #BH57

Title Research in Scientific Problems with Military Applications

Scientific Area 05

Title Mathematics

Category Research

Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: Objectives of this task are twofold. (1) Support the acquisition and systematic advancement of fundamental knowledge in mathematical sciences relevant to future Army needs as well as those needs inherent in its present operations. Some of this knowledge will be applicable to such work as field and laboratory testing, mechanical design, fluid flow and information handling. This phase of the program is directed toward providing the mathematical foundations for treatment of both short- and long-range problems of interest to the Army. (2) Dissemination to Army installations of research results obtained in the above program, coupled with advice and assistance, constitutes the other phase of the mathematics program. For example, to promote communication among Army scientists, there is a continuing program of three annual Army-wide conferences. In addition, visits are made to Army installations by the investigators to brief personnel on recent mathematical developments. A training program has been developed which emphasizes the presentation of mathematical techniques with Army utility. Mathematical results of foreign researchers are considered.

RELATED ACTIVITIES: The Navy, Air Force, National Science Foundation and other government agencies and industrial groups conduct related research in the mathematical sciences areas. Coordination to assure no unnecessary duplication is accomplished by periodic interagency meetings, program reviews, exchange of program data sheets and technical reports, and attendance and participation of representatives at annual reviews sponsored by the Office of the Director of Defense Research and Engineering. Coordination also occurs through sponsorship of meetings and conferences, attendance at professional and scientific society meetings and review of the scientific literature.

WORK PERFORMED BY: This program of grants and contracts is managed by the US Army Research Office, Research Triangle Park, NC. The top ten grantees and contractors are: University of Wisconsin, Madison, WI; University of California, Berkeley, CA; University of Florida, Gainesville, FL; Stanford University, Stanford, CA; Brown University, Providence, RI; University of Southern California, Los Angeles, CA; University of Texas, Austin, TX; Georgia Institute of Technology, Atlanta, GA; Cornell University, Ithaca, NY; and Carnegie-Mellon University, Pittsburgh, PA. There are in addition 50 grantees and contractors. The value of the additional grants and contracts is $1,200,000.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #BH57 Title Research in Scientific Problems with Military Applications

Scientific Area 05 Title Mathematics

1. FY 197T, FY 1976, and Prior Accomplishments: Buckling of a shell or a structure under load and the onset of instabilities in viscous flows or nonlinear chemical reactions, both of interest to ballistics research, are examples of the phenomena of bifurcation or branching. A comprehensive bifurcation theory has been developed which clarifies previously obscure data on buckling of plates and shells. The question of how to determine the effect of change in pay on Army recruiting or how to determine the impact of new policy directives on inventory levels in an inventory research office is related to situations where data exhibit complicated dependencies and seasonal variations. An efficient statistical procedure has been developed that takes into account effects of such interventions on an operating system. An efficient procedure has been developed for an optimum utilization of test range resources for missile and aircraft testing under realistic limitations on the quantities and types of instruments and their accuracies. In a class of problems exemplified by the flow between rotating cylinders, it has been believed that transition to turbulence takes place through a large number of successive instabilities. The calculations and numerical procedure developed towards understanding this phenomenon have proved to be useful in the analysis of stability of liquid filled shells. New numerical schemes have been developed which employ an extra parameter to control certain characteristics of the solution. Such least squares procedures are found to be useful in collocation methods for computing surface flaws that arise in the study of fracture and fatigue processes of gun tubes as well as in thick walled cylinders. A recurring problem in the quality assurance offices of commodity laboratories is the estimation of the reliability of extremely complex weapon systems. An efficient statistical procedure has been developed which solves the problem for several cases of interest.

2. FY 1977 Program: Research efforts relevant to the Army's mission are being supported in the five subareas of applied analysis, numerical analysis, operations research, statistics and probability, and computer science. The program does not cover the total spectrum of mathematical research in any subarea. Rather, it is concentrated on those topics that appear to have impact on relevant Army problems in some reasonable time frame. For example, the mathematical research topics supported under this program are motivated by consideration of problems in aerodynamics, communications systems, heat transfer in weapons and other structures, gun barrel erosion, chemical kinetics and combustion, structural analysis and penetration mechanics, guidance and control of missiles, testing and evaluation of complex weapon systems, and methodology for effectively treating Army operations research and logistics problems arising in design, development, distribution and support of weapon systems. Emphasis is being placed on numerical treatment of large-scale systems, mathematical modeling of processes too complicated for the usual analytic treatment, stochastic processes, and validation of simulation techniques.

3. FY 1978 Planned Program: In addition to pursuing the major directions in the present program, emphasis in FY 1978 will be placed on the solution of time-dependent problems in fluid dynamics and aerodynamics, and on robust statistical methods in reliability and life testing. The increase in the mathematics program from FY 1977 to FY 1978 is based both on continuing Army

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #BH57 Title Research in Scientific Problems with Military Applications

Scientific Area 05 Title Mathematics

requirements for mathematical research and Department of Defense policy to provide a real expansion in extramural research.

4. FY 1979 Planned Program: In order to improve the operational capabilities of the Army at an acceptable cost of materiel, it is desirable to intensify the exploitation of scientific advances and novel engineering concepts. Mathematically, this means it is important to take advantage of recent theoretical developments by encouraging their incorporation in mathematical software. Thus, in FY 1979, greater emphasis and increased funding will be given to research efforts operating at the interface between computer science and the other mathematical subareas, and concerned with the development of high quality mathematical software.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	3060	424	3620	3935	4300	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A Title Defense Research Sciences

Project #BH57 Title Research in Scientific Problems with Military Applications

Scientific Area 06 Title Mechanics and Aeronautics

Category Research Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: This task covers the fields of solid mechanics, fluid mechanics and power generation and has the objective of establishing a scientific base from which engineering design improvement can be generated. Such a scientific base is required for increasing performance and reliability while reducing cost and maintenance requirements of weapons, armor, propulsion devices, and ground and air mobility. Current Army trends such as missile maneuverability, kinetic energy penetrators, nap-of-the-earth helicopter operations, and multi-purpose engine fuels are recognized in carrying out this research program. Major thrust areas responding to these needs are in fuel conservation, tribology (wear and lubrication), helicopter noise reduction, rotor aerodynamics, missile control, ballistics, structural mechanics, impact penetration mechanics, and propellants.

RELATED ACTIVITIES: This scientific area is related to the following projects in Program Element 6.11.02.A: AF22, Research in Vehicular Mobility; AH42, Research in Materials and Mechanics; AH43, Research in Ballistics; AH44, Research in Fluidics, Nuclear Effects and Ordnance Electronics; AH45, Air Mobility Research; AH49, Missile and High Energy Laser Research; AH51, Combat Support Research; AH60, Research in Large Caliber Armaments; and AH61, Research in Small Caliber Armaments. Joint participation in conference sponsorship with other Defense services and other government agencies is undertaken, such as: biennial meeting of the Heat Transfer and Fluid Mechanics Institute; Three Dimensional Stress Analysis Meeting; and Symposium on Turbulent Shear Flows. These joint programs are directly coordinated with other Department of Defense (DOD) agencies regarding technical value and relevance to their respective mission responsibilities. Army and other DOD scientists participate in and attend these meetings at no fee and several copies of the proceedings are received for internal Army library distribution. In addition, timely workshops addressing specialized technical topics are jointly sponsored with Army laboratories, such as: Fuels and Materials for Army Engines of the Future; Impact and Penetration; and Engine and Fuels Conservation Research Meeting. Apportionment reviews of the DOD programs in materials, mechanics, structures and aerodynamics are participated in annually, during which this mechanics/aeronautics program of the Army Research Office is presented and reviewed along with those of the Navy and Air Force. The Army Research Office technical staff makes annual assessment studies of the 6.1 programs at Army laboratories. These reviews provide a forum for direct exchange of technical information on topics of common interest, the progress of the state-of-the-art in specialized technological areas and identification of research results with possible application to Army problems.

WORK PERFORMED BY: This program of grants and contracts is managed by the U. S. Army Research Office, Research Triangle Park, NC. The ten top contractors are: Princeton University, Princeton, NJ; University of Illinois, Urbana, IL; Massachusetts Institute of Technology, Cambridge, MA; University of Mississippi, Oxford, MS; Polytechnic Institute of New York, Brooklyn, NY; Systems,

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #BH57 Title Research in Scientific Problems with Military Applications

Scientific Area 06 Title Mechanics and Aeronautics

Science and Software, La Jolla, CA; University of Virginia, Charlottesville, VA; Iowa State University, Ames, IA; Arnold Research Organization, Tullahoma, TN; and University of Wisconsin, Madison, WI. There are 43 additional contractors having contracts totaling $1,100,000.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: It has been shown that the emission of electrons from ball bearing surfaces can be used to demonstrate that an increase of exoelectron production is a precursor to the failure of the bearing due to surface fatigue. This method can be adapted to screen out early failure of ball bearings. Results obtained from research on packed beds of granular propellants can be applied directly to the interpretation and prediction of the interior (gun tube) ballistics of weapon systems. An efficient computational technique for optimal rotor suspension system design (helicopters and turbine shafts) was developed. A new experimental technique has been developed for making accurate quantitative studies of plastic deformation of laminated composite materials under loads. This research investigation together with the companion theoretical work for the prediction of composite material response will be useful in determination of fatigue limits of composite structures. A magnetic suspension and balance system for both spinning and coning projectiles has been developed that is extremely useful in providing interference free force and moment measurements of various projectile configurations. By means of asymptotic methods in applied mathematics, simple analytical formulas for ignition time and for its dependence on incident radiant energy flux, on pressure and on temperature have been derived and applied to both solid and gaseous fuels. Such knowledge is useful in both devising and understanding more efficient ignition concepts.

2. FY 1977 Program: Program thrusts in the solid mechanics field are in the areas of fatigue and fracture, shock, vibration, wave propagation, surface mechanics and composites. Increased emphasis on the true nature or phenomena of fatigue and fracture mechanics is necessary to predict more accurately the behavior of Army materiel. The effects of external forces of a deterministic or random nature including shock loads on materials and structures is being studied as well as the vibration of structural components and the noise resulting therefrom. The surface mechanics effort embraces lubrication, friction, and wear which are all basic to many Army applications; for example: vehicle design, maintenance and gun mechanisms. Particular attention is being paid to composites as a means of optimizing material properties and dispersion of undesirable waves in structures. Program thrusts in fluid mechanics are in the areas of aerodynamics, aeroacoustics, ballistics and missile aerodynamics. Forces and moments produced on a flight vehicle due to its passage through the air must be understood and predictable if increased performance, lower cost, greater reliability and increased safety are to be designed into the operational configuration. The reduction of rotor generated noise and the understanding of the effects of absorption, reflection, refraction and focusing due to terrain shape are important to successful nap-of-the-earth operations. Research on both internal and external ballistics of shells is supported to provide

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

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Scientific Area 06 Title Mechanics and Aeronautics

the necessary information for designing longer range and more accurate projectiles. Research in missile aerodynamics is supported to provide the advanced technology for designing highly maneuverable and stable missiles. Program thrusts in the field of power generation are concentrated in the areas of energy and fuel conservation, and propellants. Vehicle engines and the fuels necessary to energize these engines must be understood if better performance, greater reliability, safety, lower maintenance, and more efficient fuel usage can be obtained for ground vehicles and Army aircraft propulsion systems. The Army requires continuing and progressive research in the broad field of propellants, both for the launching and propulsion of missiles, rockets, and projectiles.

3. FY 1978 Planned Program: The planned research program for FY 1978 will largely be a continuation of the program thrusts described in item 2, above. However, certain new trends can be discerned and funding increases are planned to support needed research in these areas. For example, more basic knowledge in wave propagation, particularly three-dimensional large amplitude motion, is required in such areas as fuze design and shock loading. Because of the ever present need for more advanced firepower, increasing emphasis will be placed on supporting research in ballistics for both projectiles and missiles. Such studies will concentrate on high angle of attack aerodynamics, missile component interference effects, plume-body and plume-launcher effects, transonic flows, magnus effects and muzzle flows. In response to the Army needs for more efficient engines for air and ground vehicles, research on engine design, combustion and fuel conservation will be given increased emphasis. Stratified charge implementation to spark-ignition internal combustion and diesel-type engines will be considered. New starts in all of these areas are planned.

4. FY 1979 Planned Program: The major thrust areas described in items 2 and 3 will be supported. In addition, the increased funding will support those areas where more knowledge is required. For example, in the area of wear and corrosion, more knowledge is needed particularly for gun barrel design and helicopter gearing. Better understanding of the mechanisms governing impact and penetration for kinetic energy penetrators, piercing of armor plate and soil penetration, is needed. Concepts will be sought for in situ crack detection in metals and polymers in order that safety measures can be taken in helicopter and weapon structures. Studies directed toward attaining multi-fuel capacity for innovative multi-cycle internal combustion engines as well as for gas turbine types will be expanded. Increased knowledge of mechanisms of base drag reduction for application to both projectiles and missiles is needed. New starts in these areas of research are planned.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	2293	487	3000	3430	3900	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A

Title Defense Research Sciences

Project #BH57

Title Research in Scientific Problems with Military Applications

Scientific Area 07

Title Physics

Category Research

Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: The objective of this task is the discovery of new physics concepts, phenomena, techniques and data that are expected to improve Army weapons, equipment, and practices. The physics program impacts Army capabilities in target acquisition, reconnaissance and surveillance, weaponry, fuzing, tactical communications, information processing, warning, navigation and positioning, electronic warfare, service support, and special operational capabilities such as operations at night and in inclement weather. These objectives are accomplished by research in atomic and molecular physics; optical information, image formation and analysis; laser physics; optical devices, techniques and applications; electrical phenomena in gases; condensed matter, including structure, energy and charge transport; and electromagnetic technology. Emphasis is placed on a vigorous interaction with Army laboratory managers. Given an Army problem, the research community, which includes university scientists and industrial researchers with unique facilities, is probed to stimulate thinking and preparation of proposals. This approach allows for rapid response and flexibility in program orientation not limited by available Army talent or facilities since the entire physics research community can be tapped.

RELATED ACTIVITIES: This program is related to the following projects in Program Element 6.11.02.A: AH42, Research in Materials and Mechanics; AH43, Research in Ballistics; AH44, Research in Fluidics, Nuclear Effects and Ordnance Electronics; AH45, Air Mobility Research; AH46, Research in Signal Detection and Low Energy Lasers; AH47, Electronic Devices Research; AH48, Electromagnetic and Antenna Research; AH49, Missile and High Energy Laser Research; AH51, Combat Support Research; AH52, Research in Support Equipment for the Individual Soldier; AH60, Research in Large Caliber Armaments; AH61, Research in Small Caliber Armaments; AH63, Research in Electronic Warfare; and A31B, Night Vision Devices Research. A direct exchange of common interests is accomplished between the Services and other Government agencies on a continuing basis to avoid duplication of effort.

WORK PERFORMED BY: This program of grants and contracts with academic and not-for-profit institutions and industrial laboratories is managed by the U.S. Army Research Office, Research Triangle Park, NC. The top ten grantees and contractors are: IBM Watson Research Center, Yorktown Heights, NY; Massachusetts Institute of Technology, Cambridge, MA; Stanford University, Stanford, CA; National Bureau of Standards, Washington, D.C.; University of Southern California, Los Angeles, CA; Georgia Institute of Technology, Atlanta, GA; University of California, Berkeley, CA; Case Western Reserve University, Cleveland, OH; Illinois Institute of Technology, Chicago, IL; and the University of Missouri, Rolla, MO. There are an additional 45 grantees and contractors. The value of the additional grants and contracts is $1,900,000.

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #BH57 Title Research in Scientific Problems with Military Applications

Scientific Area 07 Title Physics

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Accomplishments for prior years include the development of a novel infrared switch based on the rapid absorption edge shift in a semi-conductor induced by an intense optical beam; the development of techniques for the understanding of mechanisms for vibrational excitation of molecular lasers; demonstration of an amorphous/crystalline hetero-junction transistor using chalcogenide glass as the emitter and silicon for the base and collector; photodissociation spectra and ion-molecule reactions were measured and analyzed for several important terminal atmospheric negative ions; development of a technique for measuring electron excitations to surface and conduction band states in semi-conductors without requiring large and extremely expensive accelerator facilities; and defect centers responsible for the absorption of radiation in energetic materials were identified. More recent accomplishments are: the first demonstration of infrared image up-conversion in a metal vapor; a detailed theoretical analysis of the performance of the electron tunneling metal-oxide-metal detector; development of a concept for an optical transistor based on the strong dependence of second harmonic generation on the phase matching condition; critical measurements of electronic to vibrational energy transfer and its use to pump molecular transitions in the infrared; the Fermi level and electron affinity of an important explosive material, lead azide, have been determined; measurements have been made for the first time of electron excitations from core levels to empty surface and conduction band states in semiconductors; and a model has been developed from which it is possible to calculate stacking fault energies of all transition and nontransition metals in the periodic table.

2. FY 1977 Program: Examples of problems being addressed in the current year program are: new lasers for ranging and target designation which may be achieved by a study of crystal growth by skull melting; and generation of laser light in the infrared by optical parametric techniques to obtain coherent sources consistent with both eye safety and atmospheric transmission. Rare earth stoichiometric compounds are being prepared to determine the feasibility of miniature laser range finders. Frequency conversion using resonant two-photon pumping is being explored as a means of upconverting from the infrared to the visible for simpler thermal imaging. Various techniques are being investigated to improve special communications, precision navigation, electronic warfare, ballistic missile defense radar cross section codes, and electronic components development. These include work in the electronic structure of atoms and molecules; atomic and molecular interactions with radiation and collision processes; optics, lasers, optical devices, techniques and applications; physics of electric discharges; structure of solids; defects in crystals; electronic and nonelectronic transport properties of condensed matter; surface and interface phenomena; dielectric properties of materials; and photoelectric and optoelectronic devices and systems.

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #BH57 Title Research in Scientific Problems with Military Applications

Scientific Area 07 Title Physics

3. FY 1978 Planned Program: The program will continue to produce and exploit breakthroughs pertinent to Army requirements. Program areas for which problems have been identified include the investigation of sub-millimeter detectors and principles for applications to inclement weather imaging, new analytical techniques for the study of explosive processes and shock propagation, investigation of processes fundamental to high energy lasers, and the physics of conducting inorganic polymers for fuzing. The increase in funds from FY 1977 to FY 1978 is based both on continuing Army requirements for research and Department of Defense policy to provide for a real expansion of the extramural research effort in physics. In order to improve the operational capabilities of the Army at an acceptable cost of materiel it is desirable to intensify the exploitation of scientific advances and novel engineering concepts.

4. FY 1979 Planned Program: The program for FY 1979 is planned along the same guidelines as those of FY 1978, i.e., continuation of existing areas and initiation of work units which show promise for future Army technology. Funds are being increased in FY 1979 to support research proposals that are responsive to the needs of Army laboratories through contracts and grants with industry and academic institutions.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	2724	560	3300	3815	4200	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A

Title Defense Research Sciences

Project #BH57

Title Research in Scientific Problems with Military Applications

Scientific Area 08

Title Chemistry

Category Research

Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: The aim of this extramural program of fundamental research is to provide basic information and increased understanding of chemical phenomena (those occurring on a molecular level) so as to improve the effectiveness and shorten the lead-time requirements both for the applied research effort and for the development of Army materiel. Synthesis programs have a direct bearing on activities in the materials and life sciences categories, and on electronics (via materials) as well. Studies of mechanisms and kinetics hold implications for energy conversion in the broad sense (fuels, oxidizers, propellants and explosives as well as electrochemical devices). Other areas for which the program provides underpinning include the detection and identification of hazardous substances, behavior of materials in a hostile environment (thermal degradation, radiation, corrosion, and upper atmosphere processes) and improvement of commodities procured in quantity (plastics, rubbers, protective coatings, lubricants, fabrics, and adhesives).

RELATED ACTIVITIES: The Navy, Air Force and other government agencies also conduct research in chemistry. Coordination is accomplished by frequent contact with the Army Research Office's Navy and Air Force counterparts, tri-Service participation in Department of Defense topical reviews and workshops, participation at symposia and exchange of technical reports. This program supports related research being performed in various Army laboratories and is planned and executed in conjunction with those efforts. Significant examples of this coordination are the joint efforts in the chemistry of high energy materials which is pursued in conjunction with Project AH60, Research in Large Caliber Armament (Energetic Materials Area) and the area of chemical/biological defense investigations under Project A71A, Research in Defensive Systems for Chemical Warfare/Biological Warfare. Coordination is also maintained with non-defense agencies such as: National Science Foundation, National Aeronautics and Space Administration, and Energy Research and Development Administration.

WORK PERFORMED BY: This program of grants and contracts is managed by the US Army Research Office, Research Triangle Park, NC. The top ten grantees and contractors are: Stanford Research Institute, Menlo Park, CA; University of Southern California, Los Angeles, CA; University of North Carolina, Chapel Hill, NC; Duke University, Durham, NC; Wayne State University, Detroit, MI; University of Massachusetts, Amherst, MA; University of Utah, Salt Lake City, UT; University of Florida, Gainesville, FL; California Institute of Technology, Pasadena, CA; and Johns Hopkins University, Baltimore, MD. There are 35 additional grantees and contractors representing a total dollar value of approximately $2.7 million.

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #BH57 Title Research in Scientific Problems with Military Applications

Scientific Area 08 Title Chemistry

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: A new method for the controlled fluorination of some organic and inorganic compounds has been developed; the perfluorographite made by this technique was found to possess superior properties to any other lubricant at high temperatures. A new method has been found for the preparation of synthetic diamonds from fluorocarbons under high pressures. A new family of polymers (polyphosphazenes) shows great promise for a variety of Army applications (helicopter seals, fuel lines, collapsible light-weight fuel containers, and fire retardant coatings); these materials are completely inert to hydocarbon fuels and oils. A variety of condensed aromatic polymeric systems that have superior thermal stability have been prepared and characterized. A new chemiluminescent system not requiring oxygen or peroxide has been discovered, and its potential use for Army applications evaluated. A better understanding of explosives and detonations has been reached from a study of the kinetics of these reactions. New synthetic methods have been developed for certain compounds of boron that are useful as burning-rate modifiers in rocket motors. A general synthetic route to polyquinoline plastics has been worked out. It is versatile enough to allow many related examples to be prepared, so that they can be characterized and a relationship established between molecular structure and properties. Films have been cast of these materials, and they show extended stability at moderately high temperatures, despite their thinness. A chemiluminescent compound has been synthesized which is stable until a catalyst is added to stimulate light emission. Preparation of a polymer with an electrical conductivity near that of graphite has been accomplished. The techinque of electron nuclear double resonance has been successfully employed to study the mechanism of radiation damage in electron-beam polymeric resists for integrated circuits.

2. FY 1977 Program: Research to create new compounds by synthesis and develop new methods to prepare those with intriguing properties is being carried out. New chemiluminescent systems are being investigated. Efficient explosives production can be expected as a benefit from fundamental studies into nitration. New methods to rid air of toxic agents may result from research in polymer-supported catalysts and novel oxidizing agents. Techniques such as chemical ionization mass spectrometry and nuclear magnetic resonance may facilitate the rapid detection and identification of toxic agents and traces of explosives. Fuel-air explosions, and the mechanism by which they can be inhibited are subjects for continuing study. Chemical reactions in aerosols, microemulsions and other unconventional media are being explored and are expected to bear on such problems as toxic cloud neutralization. Piezoelectric and pyroelectric polymer research has implications for various devices with military applications such as fuze components.

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #BH57 Title Research in Scientific Problems with Military Applications

Scientific Area 08 Title Chemistry

3. FY 1978 Planned Program: In FY 1978 the research program in chemistry will continue to be directed toward problem areas that are relevant to current Army needs and to build the technology base for the Army of the future. The principle thrusts planned are in polymer chemistry, high energy materials, photochemistry/chemiluminescence, and the sensing, detection, and decontamination of chemical agents. The polymer work will address synthesis and characterization of new materials of potential use to the Army. The high energy materials work will constitute the bulk of the synthetic work done in this important area and will complement the characterization of energetics done in Army laboratories. The photochemistry will include fundamental work with implications in such areas as camouflage and photodegradation of materiel. Investigations in chemiluminescence will have potential application in markers and flares as well as in detection devices for chemical and biological agents. New techniques with application in systems for detecting and neutralizing chemical agents are the goal of the investigations planned in the sensing, detection and decontamination area. Additional efforts will be undertaken in atmospheric chemistry dealing with topics important in reentry events and in signal propagation. The planned funding increase in FY 1978 provides for real growth in the extramural research in chemistry in accordance with Department of Defense policy. This will allow faster exploitation of scientific advances of potential importance to the Army.

4. FY 1979 Planned Program: Major efforts in the area discussed for FY 1978 will be continued in FY 1979. As topic areas mature in the research program they will be transferred to the Army laboratories for exploitation. New investigations will be supported in areas showing promise for future Army applications. The planned funding increase in FY 1979 will allow expanded efforts in new areas such as: pyro-and piezoelectric behavior for possible electronic and fuze applications; oxidative and hydrolytic reactions of trace organics for use in chemical decontamination, aerosol and microemulsion reactions useful in biological agent decontamination; chemical neutralization of explosives; laser research leading to the development of new lasers; surfaces and interfaces which are important in air purification and skin decontamination; and electrochemical energy conversion.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	2672	535	3100	3575	3900	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A Title Defense Research Sciences

Project #BS01 Title Basic Research on Military Injury and Diseases

Category Research Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: In order to field healthy, combat-effective troops, and treat casualties from disease or injury, it is necessary to have a basic research program in which new and classical techniques of immunochemistry, histopathology, serology, immunology, microbiology and epidemiology are utilized to solve infectious disease problems such as meningococcal diseases, arbovirus diseases, and parasitic diseases which affect military operations. Enteric studies are directed toward better understanding basic pathogenesis and militarily unique aspects of viral and bacterial infections, in order to develop appropriate preventive or curative measures. Problems of the combat soldier include fundamental studies in areas of vascular injury, sepsis, wound healing, and evaluation of current methods of treatment. Additional studies include biomedical factors associated with psychiatric ineffectiveness in the Army. Worldwide information on the distribution, ecology, taxonomy, and control of arthropod vectors of disease is developed in order to provide the epidemiological data base necessary for further progress in the protection of the health of Army personnel.

RELATED ACTIVITIES: Related work is performed under program elements/Army projects 6.11.02.A/BS03, Medical Defense Against Biological Agents; 6.27.70.A/A802, Military Preventive Medicine and Tropical Diseases; 6.27.70.A/A803, Malaria Prophylaxis and Treatment; and 6.27.72.A/A810, Military Skin Diseases. Other related research is conducted by and coordinated with the Navy, Air Force, National Institutes of Health and US Department of Agriculture by means of project officer visits, committee meetings of the military services and national health agencies, exchange of reports, review of research and technology summaries, symposia on specific subjects, and periodic program reviews.

WORK PERFORMED BY: About 58% of the work is conducted by in-house laboratories at Walter Reed Army Institute of Research, Washington, DC, and affiliated field units in Thailand, Malaysia, and Brazil. Approximately 42% of the research is conducted under contracts with universities, non-profit organizations and industry. Among the large contracts are those with New York University, NY; University of North Carolina, Chapel Hill, NC; Mount Sinai School of Medicine, New York, NY; Harvard Medical School, Boston, MA; University of California, Los Angeles, CA; Health and Social Services Department, Santa Fe, NM; Baylor College, Houston, TX; Yale University, New Haven, CT; and Cornell University, New York, NY. Forty other contracts are also funded for a total contract program of $2.3 million.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments:

a. Developed a control strategy for selected arbovirus diseases based on information of insect vector bionomics; i.e., the control of overwintering infected mosquitoes will prevent or reduce incidence of the disease in the spring. Spraying of selected areas with insecticides controls transovarially-infected mosquito eggs, thus reducing viral disease transmission. The basic

epidemiology of hepatitis, dengue, and Japanese B encephalitis was studied in Thailand, with emphasis on improved methods of virus isolation and seriological detection. A mouse screening system was established for the testing of candidate anti-schistosomal drugs. A seriological test for cutaneous leishmaniasis infections was perfected. Advances were made in the studies of the immunology of scrub typhus, including an understanding of the rickettsia-mite relationship and the establishment of primate models of human disease. Soluble antigen fluorescent antibody and indirect hemagglutination techniques were adopted for use in serologic diagnosis of rickettsial disease.

b. Immunity to schistosomiasis in rats has been shown to be transferable by both antibody and lymphocytes. A successful snail colony with schistosomal infection has been established which is necessary for further drug testing studies against this disease. A new method has been devised for the rapid identification of rubella virus. A unique crystallization procedure was developed which simplified identification of hosts from mosquito blood meals. A new system was developed for mass isolation of infected Anopheles mosquito salivary glands in order to obtain large numbers of viable malaria sporozoites. Psychiatry research in biomedical sciences was directed at description of functional relationships between environmental factors in behavioral, neuro-endocrinological, psychological and psychiatric variables. In the attainment of behavioral change, it was found that informative feedback signaling the correctness of each appropriate response greatly facilitates the acquisition of an entirely new pattern of responses. Studies on the problem of how an organism distributes its behavior between various alternatives which produce different reinforcers show that in animals, food, a primary "need," has an inelastic demand curve whereas electrical brain stimulation appears to have an elastic demand curve. Behavior in an aversive situation is not simply a reflection of the current stress to environment, but is a consequence of the aversive situation imposed without prior preparation to adjust to it behaviorally.

2. FY 1977 Program: Initial efforts will be directed toward developing anti-leishmanial and anti-schistosomal drug screens. Shigella toxin will be purified, characterized, and its mode of action determined as preliminary steps in vaccine development. Group B meningococcal cell wall fractions will be studied as possible vaccine precursors. Continue basic developmental studies of biocontrol agents for utilization in controlling mosquito vector species. Resolve the bio-systematics of arbovirus vectors of Oriental Zoogoeographical Region. Examine and describe the internal morphology of chigger vectors of scrub typhus in order to understand the mechanisms involved in pathogen-vector relationships of the disease. Neuropsychiatric research will be continued on behavioral and neurohormonal responses and adaptations to stress as well as on social and organizational factors which predispose psychiatric breakdown.

3. FY 1978 Planned Program: Models currently under development to be completed include cutaneous leishmaniasis in mice and visceral leishmaniasis in primates. Selective methods for modifying the responses of immune mechanisms to foster wound healing and to prevent graft rejection will be developed. Emphasis will continue to be directed toward gathering immunologic and pathogenic information about militarily important diseases such as dengue, scrub typhus, leishmaniasis, trypanosomiasis, and respiratory diseases to build a data base to permit further vaccine development. Investigations will continue on development of worldwide information on the ecology, biosystematics, distribution, and control of arthropods involved in transmission of diseases affecting

Budget Activity #1 - Technology Base

Program Element #61.11.02.A Title Defense Research Sciences

Project #BS01 Title Basic Research on Military Injury and Diseases

military personnel. Research will continue on the development of methods and procedures for infectious disease diagnosis, prevention and treatment. Studies on pathogen-vector species relationships will be continued. New and improved insect control procedures will be evaluated. Studies will continue to elucidate the time course of bodily responses to stress and to develop behavioral principles. The complex internal-external interactive responses of humans to stress can most efficiently and effectively be studied with a background of behavioral and physiological principles developed through animal models.

4. FY 1979 Planned Program: Research will continue to be directed toward gastrointestinal diseases of military importance, particularly on diarrheal disease, Salmonella and Shigella. Factors involved in directing the responses of lymphocytes in injury, infections, wound healing and tissue rejection will be studied. Basic psychiatric research will continue to provide a data base for interpretation of military field studies and recommendations for prevention and/or treatment of breakdown in soldiers.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	7,170	1,804	7,782	7,923	9,210	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A Title Defense Research Sciences

Project #BS03 Title Medical Defense Against Biological Agents

Category Research Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: Development of an effective medical defense against biological agents is a militarily unique problem. New and classical techniques in virology, immunology, and pathology are used to develop methods for early diagnosis, prevention or treatment of biological agent casualties, and laboratory identification of biological agents, as well as other diseases of importance to be considered in military operations worldwide. Major emphasis is placed on in-house research because of the special biological containment facilities located at Ft. Detrick, MD and required to study safely these diseases. This multifaceted program utilizes techniques offering improved methods of faster, more reliable diagnosis, candidate vaccine development against biological warfare (BW) agents, and innovative drugs for prevention and treatment of BW casualties.

RELATED ACTIVITIES: Related Army studies are performed under Program Elements/DA Projects 6.11.02.A/3S01, Basic Research on Military Injury and Diseases; 6.27.70.A/A802, Military Preventive Medicine and Tropical Diseases; and 6.27.76.A/A841, Medical Defense Against Biological Agents. This DA Project provides the major input in the national program for medical defense against biological agents. General infectious disease research conducted by the Navy and National Institutes of Health is pertinent to this project. Coordination is accomplished by personal contacts at the operating level, technical symposia, and regular exchange of documents for review, which avoids unnecessary duplication of efforts.

WORK PERFORMED BY: Approximately 85% of the work is performed by the US Army Medical Research Institute of Infectious Diseases, Fort Detrick, MD. Extramural contracts include Stanford ResearchInstitute, Menlo Park, CA; Johns Hopkins University, Baltimore, MD; Northwestern University, Chicago, IL; Rutgers University, New Brunswick, NJ; and Korea University, Seoul Korea.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: For early diagnosis and prevention of potential biological warfare agents radioimmunoassay techniques were developed for detecting minute amounts of staphylococcal enterotoxin B (SEB) for use in ultrasensitive detection of these compounds in body fluids and tissues. In addition, the use of SEB toxoid fragments improved the efficiency and specificity of toxoid production providing a new concept for immunization against this toxin. New antiviral drugs for the prevention and therapy of toga virus and influenza virus infections have been shown to be effective in experimental animals. One drug (ribavirin) was effective 24 hours after infection. Aerosol studies involving this drug have shown this route of administration to be better than other comparable routes. A new aerosol system delivering precise particle size to the respiratory tract has greatly aided more definitive studies in respiratory infection, protective immunology, and improved methods of therapy. New adjuvant compounds for enhancing the protective effects of weak antigens have been developed and tested. This procedure shows great promise in promoting quicker immunological responses to infection during the early phases in military operations. Basic studies necessary for the development of vaccines against Rift Valley fever, Q fever, dengue II, tularemia, plague, and other

diseases of importance in military operations or potential biological warfare (BW) concern were completed. An in vitro assay of transfer factor was developed to assess its therapeutic effects of viral disease and immunodeficient states. A novel technique was developed for growing cell monolayers on aluminum foil for use in scanning electron microscopy. Significant improvements were made in detecting viruses with the electron microscope - 10^4 viruses/ml detected with negative staining.

2. FY 1977 Program: Determination of the biochemical composition of several arenaviruses, including Machupo virus, will be completed as a preliminary step in developing an effective vaccine for protection against these disease agents. Scanning and electron microscopy studies of cell cultures and tissues of infected animals will be continued in an effort to ascertain and comprehend the nature and cause of morphologic changes resulting from cellular interation with microbial organisms and toxins of military importance. Investigations of cellular biophysical and biochemical changes due to various exotoxins will be continued. Basic studies of carbohydrate and protein metabolism during infection will be continued in efforts to further elucidate the mechanisms of disease so that effects can be prevented or specifically treated, thus maintaining the effectiveness of the combat soldier or returning him rapidly to duty. Investigations designed to explain the pathogenesis of vascular lesions associated with various tick borne typhus rickettsial diseases will be continued. Radioimmunoassay procedures previously developed will be evaluated in detection of rickettsial diseases of military importance. Basic studies of the pharmacodynamics, toxicity and efficacy of aerosol chemotherapy against respiratory infections resulting from BW aerosol will be continued. Basic studies will be initiated on lassa fever, which are necessary for development of a vaccine to provide protection against this disease. Basic studies on Korean hemorrhagic fever virus will be initiated. The African epidemic of Marberg-like virus will be closely monitored, since this agent may be a serious BW threat.

3. FY 1978 Planned Program: Basic research on Machupo virus related to vaccine development was completed. Basic studies on lassa fever virus will be expanded. Studies will continue toward improving diagnostic and therapeutic procedures against diseases which pose a potential biologic threat to the United States and to military operations. New techniques in immunochemistry, immunology, and virology will be evaluated for their application in the medical defense against biologic agents. Emphasis will be placed on those medically defense BW programs aimed at maintaining combat effectiveness during the early phases of military operations.

4. FY 1979 Planned Program: Basic studies in hemorrhagic fever viruses oriented toward vaccine development will continue. New emphasis will be placed on risk evaluation of agents of potential BW concern, with aim of expanding the program in this vital area. Studies will continue toward improving diagnostic and therapeutic procedures against diseases posing a potential biologic threat to the United States and to military operations. New techniques in immunochemistry, immunology, and virology will be evaluated for their application in the medical defense against biologic agents.

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #BS03 Title Medical Defense Against Biological Agents

5. Program to Completion This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	2,353	592	2,541	2,702	3,022	Continuing .	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A Title Defense Research Sciences

Project #A31B Title Night Vision Device Research

Category Research Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: The objective of this project is to produce foundational knowledge, materials techniques, imaging concepts and device concepts leading to major improvements in the performance of night vision systems. Scientific areas are image intensifiers, thermal imaging research, and battlefield imagery research. Image intensifier systems have limited sensitivity under starlight battlefield illumination conditions. Development of solid state image intensifiers for the 1-2 micrometer region would provide sensitivity improvement by a factor of 20. Thermal (far infrared) systems are complex and costly imaging devices. Development of cooled and uncooled thermal imagers and high density detector array technology would provide for significant cost reductions as well as a factor of 10 improvement in sensitivity. Battlefield imagery research efforts emphasize a target signature base, atmospheric propagation studies, and automatic night sensor technology. The results of this research are used in exploratory and advanced development for improved and novel night vision systems and equipment.

RELATED ACTIVITIES: The Army serves as the lead service in night vision technology. Tri-Service coordination is conducted through the Joint Deputies for Laboratories Panel on Night Vision. Coordination occurs through meetings, exchange of program documents and reports, and through participation in conferences, reviews, and symposia. Coordination occurs at the Department of Defense through participation in Defense Advanced Research Projects Agency programs and through meetings and briefings and by participation in the Advisory Group on Electron Devices. Tri-Service reviews are held under the auspices of the Joint Logistics Commanders.

WORK PERFORMED BY: Approximately 50 percent of the work is accomplished in-house, primarily at the Night Vision Laboratory, Electronics Research and Development Command, Fort Belvoir, VA. The balance is performed by contractors. Contractors are: Hughes Aircraft Company, Culver City, Malibu, and Santa Barbara, CA; Ford Motor Company, Dearborn, MI; Varian, Palo Alto, CA; Chrysler Corporation, New Orleans, LA; and Westinghouse Corporation, Baltimore, MD.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: This research has contributed heavily to the fundamental technology leading to the current competence in night vision devices. The materials research on Gallium Arsenide 3rd Generation image intensifiers was successfully carried out under this program. These investigations have resulted in a ten-fold improvement in the sensitivity in image intensifiers. More recently, electric field enhanced photoemission was observed in Gallium Indium Arsenide Phosphide under photon excitation at 1.6 micrometers. Exploitation of this effect could result in an additional ten-fold improvement in sensitivity for electro-optical image intensifiers operating in the eye safe laser region between 1-2 micrometers. The infrared research program has demonstrated the feasibility of night sensors based on the pyroelectric effect. These uncooled, low cost sensors

offer significant promise for ambush, base protection and remotely piloted vehicle applications. The fundamental feasibility of monolithic silicon charge coupled devices operating in the 3-5 micrometer region was shown. This material appears to be the best candidate for use as a high density focal plane for 2nd generation forward looking infrared imagers (FLIRs) with exceptional tactical performance. The battlefield environmental modeling and target signature programs have made significant contributions to the understanding of the complex properties of tactical atmospheres and targets. These include the development of substantial atmospheric transmission data bases for the visual, near infrared, middle infrared, and far infrared regions and the validation of mathematical models which can predict behavior of the atmosphere under widely varying conditions, such as high temperature and high humidity. The target signature program has developed a data base of U.S. and foreign calibrated target signatures for both the 3-5 and 8-12 micrometer regions. Recently a unique digital computer image processing facility has been developed which permits the evaluation and simulation of complex electro-optical imaging and seeker systems engaged in either target search or terminal homing. This new facility is extremely useful in the evaluation of complex electro-optical weapons systems during research and development phases before actual procurement of hardware. A new start involves the investigation of the properties of Group III-V materials in charge transfer devices for use in detectors. Semiconductor laser research, optical coatings studies, photocathode, and photoemission studies in the 0.9 to 1.06 micrometer region have been completed.

2. FY 1977 Program: Night vision is a high priority operational need in mobility, surveillance, and night or foul weather combat. Research in night vision is a multi-disciplinary activity encompassing detector physics, solid state materials, lasers, electronic atmospheric optics, visual perception and computer image processing. Efforts in this program concentrate on identification and exploitation of major scientific areas of opportunity in materials, concepts and devices in the field of electro-optics perception, psychology, and solid state science applicable to day/night sensors. The investment strategy for FY 1977 is to concentrate on detector physics of hybrid and monolithic charge coupled thermal imagers, uncooled solid state thermal imaging concepts, 1-2 micrometer image intensifier photocathode materials, III-V charge coupled devices, battlefield atmospheric optics and target signatures, image pattern processing algorithms for automatic target search and recognition, and visual perception research on target classification. Anticipated payoffs include: infrared detector arrays for 2nd generation infrared imagers with two times the performance of current imagers; a family of uncooled, low-cost solid state infrared imagers for manportable, combat vehicle, and antiarmor applications with improved operability under foul weather; and a family of image intensifier devices with 10 fold improvement, operating in eye safe laser region. Specific major goals for FY 1977 include: the investigation of infrared charge coupled device focal planes incorporating 1000 detectors (silicon); studies of new dopants for monolithic silicon to achieve higher temperature operation (77°K); and the delineation of fundamental limitations of pyroelectric vidicons. Heavy emphasis has been on investigations of low cost uncooled thermal imaging concepts such as solid state pyroelectric and thermo-optical imagers. In 1-2 micrometer technology, investigations of field enhanced photoemission continues. Finally, the battlefield environment studies emphasize target signatures of tactical targets under foul weather conditions of rain, snow, fogs and battlefield smokes. The automatic sensor program features investigations and evaluations of a wide variety of algorithms for image enhancement and automatic detection.

Budget Activity #1 - Technology Base

Program Element #6.11.02.A Title Defense Research Sciences

Project #A31B Title Night Vision Device Research

3. FY 1978 Planned Program: Research on uncooled low cost thermal imaging concepts and devices will be emphasized. Program will be expanded to include research investigations on operating imagers incorporating advanced concepts such as thermo-optical imaging and charge coupled readout of pyroelectric layers. The dopant program on extrinsic silicon operating at 77°K will be completed. The battlefield environmental modeling will emphasize atmospheric optics and target signature computer codes which would permit prediction of tactical battlefield environment and signatures for world wide conditions. The automatic sensor research program will continue to feature algorithm research as well as experimental confirmations of algorithm effectiveness under field conditions. The 1-2 micrometer program will feature gallium indium arsenic phosphide field enhanced photoemission and charge coupled devices. Although there is a one percent increase in funding over FY 1977, this will probably not compensate for cost growth and will therefore necessitate a slight decrease in the level of effort in this project.

4. FY 1979 Planned Program: Research on uncooled low cost thermal imagers based on band edge transmission and the pyroelectric effect will be continued. Heavy emphasis will be placed on the evaluation of actual research configurations and the verification of the theoretical models. Experimental studies of thermal electrically cooled 8-12 micrometer detectors will be pursued. Image processing studies will emphasize multi-spectral concepts as well as research configurations permitting on chip and off focal plane image processing and automatic detection. Research investigations of the signal processing requirements for operating in heavy fogs and smoke screens will be pursued. The 1-2 micrometer photoemission program will demonstrate actual imaging devices with quantum efficiencies of 1-5%. Increased funding over FY 1978 is aimed at maintaining a viable program in this important area.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	3052	950	4777	4830	5200	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.11.02.A

Title Defense Research Sciences

Project #B53A

Title Research in Atmospheric Sciences

Category Research

Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: Research conducted under this program is directed toward: Acquiring knowledge concerning the local (battle area) effects of small-scale atmospheric processes below a height of 30 kilometers that influence Army tactical operations such as artillery fire, air defense, air/ground mobility, surveillance, detection, target acquisition, night vision devices, and terminal homing; investigation of the physical, chemical and dynamic processes of the atmosphere from the surface to 250 kilometers to obtain information for the design of Ballistic Missile Defense Systems; for design, storage and operation (especially guidance and propulsion) of Army Missiles and Free Flight Rockets.

RELATED ACTIVITIES: Program Element 6.21.11.A, Atmospheric Investigations. The Air Force and Navy and several non-military Federal agencies carry out related programs that are coordinated by the Director of Defense Research and Engineering (DDR&E) with the Interdepartmental Committee on Atmospheric Sciences (ICAS) and the Interdepartmental Committee on Applied Meteorological Research (ICAMR). Coordination maintained at all echelons includes: (1) Coordination among the Atmospheric Sciences Laboratory (ASL), US Army Engineer Topographic Laboratories (ETL), the Air Force Weapons Laboratory, and US Army Missile Research and Development Command (MIRADCOM) pertaining to the High Energy Laser Propagation Study; (2) Coordinated research among the Army, National Weather Service and National Bureau of Standards in remote sensing of the atmosphere; (3) Joint participation in the Quadripartite Working Group/Meteorology (QWG/MET) and Panel XII (Meteorology) of the NATO Army Armaments Group (NAAG); ASL coordination in Aeronomy with the Air Force Geophysics Lab.

WORK PERFORMED BY: Approximately 60 percent of the work is accomplished in-house by the Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico and Fort Monmouth, New Jersey, and the MIRADCOM, Huntsville, Alabama. Out-of-house effort totals $1,082,500. Funds transferred to other Government agencies include $20,000 to the Air Force Geophysics Laboratory. Contracts total $1,062,500. These have been or will be placed with the University of Texas at El Paso; Utah State University, Logan, Utah; Science Applications, Inc., La Jolla, California; Science Applications, Inc., An Arbor, Michigan; Physical Science Laboratory; New Mexico State University; Denver Research Institute, Denver, Colorado; Space Data Corporation, Phoenix, Arizona; Stanford Research Institute, Palo Alto, California; Geo-Atmospherics, Inc., Lincoln, Massachusetts; Mission Research, Santa Barbara, California; Radiation Research Association, Dallas, Texas; and Barnes Engineering, Bedford, Massachusetts.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Aeronomy research resulted in refinement of the computer code for predicting the duration of electromagnetic blackout in the upper atmosphere following a nuclear burst, information vital to the detection, acquisition and surveillance of re-entry vehicles by radars. Ballistic and computer zone density and temperature departure tables for the Mid-East region were completed and provided to the Artillery. Meteorological data, required for operations, storage, guidance, and launching problems were computed and provided for use by the LANCE, SAM-D, SHILLELAGH and PERSHING Systems. Feasibility of a prototype laser crosswind sensing device was successfully demonstrated for the fire control system of the main battletank. Research was initiated to develop atmospheric transmittance models that will adequately predict the interaction of electromagnetic energy with

atmospheric aerosols at low visibilities in support of the Army's Ground Target Signature Program and night vision and terminal homing devices. The feasibility was determined of using laser radar to measure low level winds in the atmosphere in connection with obtaining ballistic meteorological data for artillery, prediction of transport and concentration of screening smokes and pollutants, improvement of optical systems for target detection and tracking, and of acoustic systems for sound ranging and detection. A study was completed for the duration and frequency of occurrence of dust storms in the Middle East. Data acquired have important application to the Army Laser Terminal Homing System Target Acquisition Simulation Code. The properties of atmospheric dust samples collected under a variety of temporal, geographical and meteorological conditions, were measured to determine the optical properties of dust typically encountered during military operations, and its adverse affects on electromagnetic and optical target acquisition, detection, surveillance, and terminal homing devices. The influence of precipitation of different intensities on the formation and variability of low clouds and visibilities was investigated for application to air mobility, air defense, terminal homing, and target acquisition, detection and surveillance. Vertical wind models for mountain-valley, shore line and urban terrain were completed and tested and results applied to artillery fire, air mobility, smoke, and related problems. The variation of the visible and near Infra-Red (IR) absorption properties of atmospheric particulates as a function of season, geographical location and meteorological conditions was investigated in support of Ground Target Signature, night vision, and terminal homing programs. Investigations of potential systems capable of measuring winds to greater than 1.0 kilometers altitude along a trajectory for application to artillery, rocket and missile firing was initiated, prototypes developed, and field experiments begun. Investigations of the AN/GVS-5 laser range finder indicated it may be used to measure cloud heights and visibility in addition to its range finding capability.

2. FY 1977 Program: Research will concentrate on: Developing a hierarchy of numerical/empirical mesoscale models for the Automatic Meteorological System which will provide weather intelligence for meteorological efforts on weapons systems; development of new remote sensors (High Energy Laser, Slant Path Turbulence, Long Range Wind) for support of special tactical operations/ weapons systems; development/testing of in-situ spectrophone systems to measure atmospheric absorption to predict performance of electro-optical and High Energy Laser Systems; development/validation of Chemical Kinetic Model (10-100KM) for Ballistic Missile Defense and Communications Systems; and establishing contingency tables between atmospheric parameters affecting electro-optical propagation for certain typical climatic provinces.

3. FY 1978 Planned Program: An initial mesoscale tropospheric model will be evaluated and a second generation model developed for use by the Automatic Meteorological System. Ultraviolet radiation, Carbon Dioxide and diffusion data will be obtained from multi-agency upper atmosphere experiments for use in solving Ballistic Missile Defense and Communications problems. Measurements and theoretical analyses will continue of gaseous absorption of electromagnetic energy. The study of optical properties of atmospheric particulates, especially dust, will be completed. Deficiencies in atmospheric transmission models will be identified from field experiments and improvements initiated. Field measurements of atmospheric aerosols and spectral transmission in low visibility fog, dust and smoke environment at various geographical locations will continue. The above have application to problems associated

with the attenuation of electro-optical devices on the battlefield. Techniques to remotely measure wind and turbulence for use by pilots of Army aircraft will be experimentally evaluated. Reaction rate coefficients and mobility coefficients will be measured for upper atmospheric ions, important in atmospheric effects and deionization. Research will continue on windshear, small-scale variability of wind, temperature and density, turbulence and wind gust for use in the design, structure, radiance and propulsion systems, and field operations of Army missiles. Increase in funding from FY 1977 to FY 1978 reflects: (1) Cost growth increases and (2) increased effort in developing passive systems for determining winds and temperatures for artillery, rockets and missiles.

4. FY 1979 Planned Program: Theory and performance of remote wind sensors will be evaluated to develop concepts for substantially extending the operating range for use by artillery. Techniques for remotely multi-sensing atmospheric aerosols (including dust and smoke), gaseous absorption and crosswinds will be developed and evaluated. A surface energy balance model will be evaluated to ensure that the model is 2-dimensional coherent for a variety of continguous landscape features such as forests, fields, lakes, hills, and other topographic features. Balloon borne sensors will be used to measure stratospheric conditions in coordination with other agencies and universities. Special attention will be concentrated on measurements helping to determine the response of the upper atmosphere to input of radiation, such as may be made during the solar eclipse of February 1979. Funding increase from FY 1978 to FY 1979 reflects: (1) Cost growth and (2) increase in research on atmospheric transmission (including smoke) properties for predicting performances of electro-optical systems.

5. Program to Completion: This is a continuing Program. Research conducted under this element is responsive to high priorities in the Science and Technology Objectives Guide, FY 1977 (STOG-77)(U).

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	2677	780	2900	3625	4023	Continuing	Not Applicable

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Tape #7

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.21.05.A

Title Materials

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	10430	2817	10526	11205	13923	Continuing	Not Applicable
AH84-01	Advanced Materials for Aircraft	2553	552	2000	2327	2585	Continuing	Not Applicable
AH84-02	Advanced Materials for Armament	1973	707	2535	2357	2522	Continuing	Not Applicable
AH84-03	Advanced Materials for Armor	2419	582	2185	2584	2982	Continuing	Not Applicable
AH84-04	Advanced Materials for Missiles	386	169	765	764	1248	Continuing	Not Applicable
AH84-05	Mechanics of Materials	1000	191	852	886	1523	Continuing	Not Applicable
AH84-06	Advanced Materials for Solution of Special Problems	941	281	986	941	1133	Continuing	Not Applicable
AH84-07	Advanced Materials for Laser Hardening	1158	335	1203	1346	1930	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The work under this element is directed primarily toward four major generic weapon systems; aircraft, armament, armor and missiles. The remainder will address varied problems with special requirements for materials technology. The objective is to develop and characterize materials to provide cost reduction, improved performance and reliability and reduced maintainability for new and improved weapon systems. The approaches are selected on the basis of scientific review and judgement and potential for success.

BASIS FOR FY 1978 RDTE REQUEST: Applied research and exploratory development of new and improved hardware of metal, ceramic, composite and organic materials toward cost reduction, aircraft survivability, firepower, hyper-velocity weapons, air defense, combat vehicle protection and personnel protection.

Budget Activity #1 - Technology Base

Program Element # 6.21.05.A Title Materials

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Because the FY 1977 funding remained constant at the FY 1976 level, tasks for advanced composite materials for bridging and for ground combat vehicles were deferred to compensate for inflationary costs. The increase in FY 1978 will be expended to address the deferred program areas and to compensate for increase in cost of exploratory development.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement) is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ Employees	413	0	413
(2) Contractor Employees	44	0	44
Total	457	0	457

DETAILED BACKGROUND AND DESCRIPTION: The work in this program element is a part of a three-part research, exploratory development and advanced development program for materials. The goals of this program are to produce new materials products, new materials specifications and prototypes made of new materials. Applied research and exploratory development are conducted in the following areas: metallurgical techniques and alloy improvements; organic materials; ceramic materials; composite materials; mechanics of materials; laser hardening of materials; and test evaluation methods. All these efforts are aimed at producing improved materials for use in the design, construction and operation of Army materiel to satisfy superior performance requirements, to reduce costs of weapon systems acquisition and lifetime ownership cost of materiel.

RELATED ACTIVITIES: The Navy, Air Force, other Government agencies, and allied nations have complementary programs in one or more of these materials areas. Coordination within the Department of Defense is achieved through regular updates of the Materials Technology Coordinating Paper and meetings of the Office of the Director of Defense Research and Engineering's ad hoc Service Materials Laboratories Council. Coordination with the non-military federal agencies is effected through participation in activities of the National Materials Advisory Board of the National Academy of Sciences — National Academy of Engineering and the Interagency Council on Materials. International coordination is effected through participation in The Technical Cooperation Program with Australia, Canada, and the United Kingdom and the Structures and Materials Panel of the Advisory Group for Aerospace Research and Development of the North Atlantic Treaty Organization.

Budget Activity #1 - Technology Base

Program Element # 6.21.05.A Title Materials

WORK PERFORMED BY: Approximately 70% of the work is accomplished in-house at the Army Materials and Mechanics Research Center, Watertown, Massachusetts; Redstone Arsenal, Huntsville, Alabama; Mobility Equipment Research and Development Command, Fort Belvoir, Virignia; US Army Armament Research and Development Command (ARRADCOM), Watervliet, New York; ARRADCOM, Rock Island, Illinois; Natick Research and Development Command, Natick, Massachusetts; ARRADCOM, Dover, New Jersey; and ARRADCOM, Aberdeen, Maryland. Typical contractors with unit cost exceeding $25,000 are: Princeton University, Princeton, New Jersey; Massachusetts Institute of Technology, Cambridge, Massachusetts; University of California, Berkeley, California; FMI Corporation, Biddeford, Maine, Battelle Memorial Institute, Columbus, Ohio; and Syracuse University, Syracuse, New York.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976 and Prior Accomplishments: Accomplishments include: development of full scale plastic rotating bands for large caliber ammunition with test results which indicate an overall function improvement over conventional bands; a special Mica was developed and successfully incorporated in the inner layer of a prototype rocket launch tube thus enhancing lubricity and thermal properties; a new neoprene compound was developed, tested and approved for use in the fabrication of 155mm obturator pads; work on specially processed aluminum alloys was completed with significant improvement in fracture toughness; alloy development to improve uranium corrosion retardation in high velocity penetrator ammunition is in progress; armor is being developed from new specially processed electroslag remelted steels; transparent armor materials work has resulted in development of a polyurethane copolymer with improved ballistic properties; glass-plastic transparent armor for improved aircrew protection and aircraft survivability was incorporated into a current inventory helicopter; ceramic radomes have undergone sled tests to demonstrate improved rain-erosion characteristics; sandwich panel construction of fiberglass skins-foam cores have demonstrated improvement in laser resistance over steel and aluminum by a factor of four and at a fraction of the weight. Cylinders of advanced composite were fabricated in a design which met the strength and stiffness requirements of the UH1 tail rotor drive shaft. A chemical milling process has been developed and successfully applied to prototype fragmenting submunition components. Low cost thermal plastic materials were evaluated as potential replacement for metals in selected weapons applications. Improved elastometric armament neoprene obturator pads for 175mm guns have been developed and evaluated. A laboratory method for creating "white layers" in cannon bores will aid understanding the phenomena of surface damage associated with wear, erosion and fatigue of cannon tubes. A new aluminum alloy armor materials has shown higher strength, 10% ballistic improvement, and superior stress corrosion resistance over comparable 7039-T6 armor; residual strength data were obtained for ESR 4340 steel. Enhancement of Al and steel armors by incorporating Kevlar backup components has been demonstrated against both armor piercing projectiles and munition fragments; effectiveness of candidate armor materials for the Army Attack Helicopter aircrew protection has been evaluated; fabrication methods for new radomes materials which are radio frequency transparent and fragment resistant have been developed. Methods are being developed to predict structural damage resulting from laser impingment.

2. FY 1977 Program: Anticipated program accomplishments are: Development of new and improved structural materials; investigating, fabricating, processing and bonding techniques; evaluating and improving the mechanical, thermal and fatigue properties and the resistance to erosion and corrosion in lightweight high-strength systems such Cu-Zn amorphous metals, aluminum graphite composites,

silicon carbide filament reinforced superalloy composites, hybrid composites, silicon nitride ceramics, adhesives for bonded joints, and coating materials for corrosion impression; studies to develop design guides and concepts to extend and predict the service life of Army materiel; development of new and improved materials for gun tubes, rotating bands, projectiles and penetrators, and investigation of novel metal forming and composite fabrication processes, melting and alloying, welding methodologies, corrosion/erosion effects, and non-destructive testing procedures; development of new and improved high strength materials with optimum ballistic properties development and evaluation of materials to inhibit spall, and development of elastomeric materials for seals and obturating devices; and development of materials for radomes, windshields and canopies, and materials including clothing for personnel protection against laser threats.

3. FY 1978 Planned Program: Aircraft materials developments will be directed toward improved system components with increased emphasis on cost reduction and survivability and will stress the utilization of advanced composites, improved titanium and aluminum alloys, and ceramic materials for engine applications. Armament materials major efforts will include increased emphasis and resources applied to improved anti-armor weapons and ammunition, more effective fragmenting munitions, longer life gun tubes, and the exploitation of recent advancements to provide for more cost effective systems. Armor materials technology major efforts will encompass survivability and cost/weight reduction through development and exploitation of composites, ceramics and metallic armor materials. Special emphasis will be placed on the development of improved heavy vehicle armor to defeat high-density, long-rod penetrators. Missile materials development will be directed toward higher strength, higher stiffness and low density alloys and composites for skins and supportive structures, improved motor cases and nosetip fabrication methods. Significantly increased work on advanced materials for laser hardening will include damage analysis, mechanics of materials/laser interaction, and the development and testing of improved laser hardened materials for Army weapon systems. Funding increase will be used to start work on advanced materials for armored vehicle suspension systems and mine protection for tanks.

4. FY 1979 Planned Program: This element will continue to focus on provision of direct materials support for aircraft systems cost reudction and improved-performance propulsion systems, and support of advanced armament development for longer life gun tubes and weapon components. Significantly increased resources and emphasis will be applied to advanced materials for improved heavy vehicular armor to defeat high density long-rod penetrators; high strength, high stiffness, low density alloys for missiles; and advanced high temperature ceramics for Army gas turbine engines with higher efficiency and increased power.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.21.11.A

Title Atmospheric Investigations

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	4450	1390	4330	6452	5557	Continuing	Not Applicable
AH71-01	Automatic Meteorological Technology	1193	261	1165	1690	1335	Continuing	Not Applicable
AH71-02	Meteorological Satellite Techniques	1143	465	1300	1475	1305	Continuing	Not Applicable
AH71-03	Atmospheric Sensing and Techniques	1357	424	1170	1800	1430	Continuing	Not Applicable
AH71-04	Atmospheric Environment of Military Systems	500	150	500	700	700	Continuing	Not Applicable
AH71-05	Meteorology of Transport and Diffusion	235	90	175	287	287	Continuing	Not Applicable
AH71-09	Concept Development and Validation	0	0	0	500	500	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Develop prototype equipment and techniques to directly support weapons systems; smoke and camouflage; nuclear defense; and Army field combat operations.

BASIS FOR FY 1978 RDTE REQUEST: The Remote Automatic Weather Station will be tested/evaluated for intelligence support; the pulsed laser remote crosswind sensor for tanks will be delivered to the Automatic Cannon Technology Program; a remote wind sensor for helicopter fire control systems will be flight tested; the experimental model of the remote short range wind set for rocket artillery support will be assembled; a ceiling/visibility sensor will be demonstrated to the Aviation School; techniques will be investigated to assess effects of Infra Red emission on optical sensor concepts; the Automatic Meteorological System effort will address chemical-biological defense, smoke screening operations and helicopter operations; and a prototype meteorological satellite data acquisition system will be developed which will provide data for Infantry, Artillery, Armor, Aviation and Chemical interests.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Funding in FY 78 is increased by $2,122,000. The increase results from (1) Support for high-priority user requirements for which prototype items (e.g., the Remote Automatic Weather Station) and Letters of Agreement have been or are being developed and prepared; (2) to reflect Office, Director of Defense and Engineering (ODDR&E) guidance to increase efforts on the impact of natural and artificial constituents of the atmosphere on electro/optical/submillimeter weapons systems and devices; and (3) increase in the costs of research.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	80	0	80
(2) Contractor Employees	17	0	17

Budget Activity #1 - Technology Base

Program Element #6.21.11.A Title Atmospheric Investigations

DETAILED BACKGROUND AND DESCRIPTION: This program determines atmospheric effects on Army weapons systems and field operations. Work concentrates on: (1) The development of the Automatic Meteorological System (AMS) to disseminate information with the timeliness required by Army operational users; (2) remote atmospheric sensors required in direct support of weapons systems; (3) applications of Meteorological Satellite data to Army operations and weapons systems; (4) development of techniques to access/mitigate and/or circumvent ionospheric effects on Ballistic Missile Defense systems; and (5) development of real-time sensing techniques for aircraft survivability and operations.

RELATED ACTIVITIES: 6.11.02.A Atmospheric Sciences, 6.37.41.A, Meteorological Equipments Development. Work is coordinated within the Department of Defense by the Director of Defense Research and Engineering (DDR&E). DDR&E coordinates with the Interdepartmental Committee on Atmospheric Sciences (ICAS), and the Interdepartmental Committee on Applied Meteorological Research (ICAMR). Direct coordination at all echelons as well as cooperative programs are conducted. For example: Cooperation between the Meteorology Division, Dugway Proving Ground, Utah, and the National Oceanographic and Atmospheric Agency (NOAA), Environmental Protection Agency (EPA), National Aeronautical and Space Administration (NASA), and the Energy Research and Development Agency (ERDA) on prediction of the transport and diffusion of atmospheric aerosols and particulates; cooperation by the Atmospheric Sciences Laboratory (ASL) with the Air Force in field experiments and in the development of new meteorological equipment and techniques; investigations of the ionosphere and its effects on the anti-ballistic missile system and communications blackout are coordinated with the Air Force, the Energy Research and Development Agency (ERDA), and the Defense Nuclear Agency (DNA); development of techniques for interpreting and using meteorological satellite data are coordinated within the Department of Defense (DOD) through the Joint Environmental Satellite Coordinating Group (JESCG), and directly with the AF, Navy, NOAA and NASA; a prototype laser crosswind sensor, being developed for use in tank gunnery, has been made available for use by both the Army and Air Force High Energy Laser programs and by the Air Force for rain erosion tests; international coordination through participation in the Quadripartite Working Group/Meteorology and Panel XII (Meteorology) of the NATO Army Armaments Group. In FY 1977 the Field Artillery Meteorological Acquisition System (FAMAS) will advance from this program to Advanced Development (PE #6.37.41.A).

WORK PERFORMED BY: Approximately 70 percent of the work is accomplished in-house at the US Army Atmospheric Sciences Laboratory (ASL), White Sands Missile Range (WSMR), New Mexico; and Dugway Proving Ground, Utah. Out-of-house effort totals $1,179,850. Of this, $287,000 will be transferred to the Office of the Naval Research, National Aeronautics and Space Administration, Wave Propagation Laboratory (National Oceanic and Atmospheric Administration), National Center for Atmospheric Research, and the Army Research Office. Contracts total $892,850. These have been or will be placed with the University of Miami; Physical Science Laboratory; New Mexico State University; Colorado State University; Utah State University; Denver Research Institute, Colorado; Geo-Atmospherics, Lincoln, Massachusetts; GE-TEMPO, Santa Barbara, California and H. E. Cramer Co., Salt Lake City, Utah; and $90,000 to other successful bidders.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: The effect of the vertical wind component on artillery accuracy in mountainous terrain was found to be large and significant. A lesson plan, "Fog Dissipation Techniques for Emergency Use," applicable to the clearing of warm fog, was delivered to the Army Aviation School. Deionization of the ionosphere after a 5 megaton burst was

calculated and a map of attenuation expected for Ballistic Missile Defense radars from a high-level nuclear burst constructed. Ballistic and computer zone density and temperature departure tables for Southeast Asia were completed and forwarded to the Field Artillery School for incorporation to Field Manuals. The feasibility of the laser crosswind sensing device for tank gunnery was verified and a prototype model developed. Satellite temperature data were analyzed to derive winds at these levels for real-time nuclear fallout prediction techniques for Field Army commanders. A satellite based system for wind observations in the 15-30 km altitude region over the battlefield was devised to provide nuclear fallout prediction for the Field Artillery and Chemical Officer. A satellite nuclear fallout prediction Letter of Agreement (LOA) was approved by US Army Training and Doctrine Command (TRADOC)-Department of the Army Materiel Development and Readiness Command (DARCOM) in FY 77. A prototype experimental development model of the Remote Automatic Weather Station (RAWS) system was constructed. A RAWS LOA was submitted to HQ DARCOM and HQ TRADOC for approval. RAWS will provide surface measurements of wind velocity, temperature, pressure and dew point temperature (or relative humidity) for the combat Army in forward and inaccessible areas. Shock-wave-induced reionization effects on radar blackout were examined to aid in the prediction of atmospheric environments for Ballistic Missile Defense and Communications Systems. Fabrication of prototype systems were initiated for the Field Artillery Meteorological Acquisition System (FAMAS) and multi-system comparisons were conducted. A FAMAS LOA was forwarded to HQ DARCOM and HQ TRADOC for approval. An experimental model of the Automated Meteorological System-Artillery (AMS-A) was designed and demonstrated. The AMS-A will provide increased accuracy/lethality for the Artillery.

2. FY 1977 Program: An experimental prototype of the helicopter remote wind sensor will be completed and ground tested. This wind sensor system will be integrated in the Fire Control System by US Army Armaments Research and Development Command (ARRADCOM). An experimental prototype accessory to adapt the AN/GVS-5 laser range finder to ceiling and visibility measurements will be completed and will provide portable, low cost equipment to remotely measure cloud height and visibilities for close support Army air operations. Remote crosswind sensors, which will increase the probability of a first round hit at longer ranges for tanks, will be demonstrated to the Project Director, Automatic Cannon Technology Program, ARRADCOM. Temperature and density departure tables will be completed for Europe and forwarded to the Field Artillery School. Upper atmosphere measurements will be taken in Alaska to investigate enhanced, fluctuating infrared emissions. These data are used to determine the effects of the infrared micropulsations on proposed optical systems. Prototype design and deployment concepts will be established and prototype fabrication initiated for the satellite nuclear fallout prediction system. A design will be developed to provide an operational meteorological satellite telemetry system that under battlefield constraints can effectively supply the meteorological data required for implementing Army applications of meteorological satellite data. A Satellite Cloud-Severe Storm LOA will be initiated. The Automatic Meteorology System (AMS) efforts will address the tactical employment of smoke, chemical-biological defense, and information for Army helicopter and airborne assault operations.

3. FY 1978 Planned Program: The experimental development model of the remote short range wind set will be completed for rocket artillery support; a remote wind sensor for helicopter fire control systems will be flight tested; the Remote Automatic Weather Station will be tested/evaluated for Intelligence support; a ceiling/visibility sensor will be demonstrated to the Aviation School;

the experimental development pulsed laser remote/crosswind sensor for tanks will be delivered to the Automatic Cannon Technology Program; a prototype meteorological satellite data acquisition system will be developed which will provide data for Infantry, Artillery, Armor, Aviation and Chemical interests; data from the Defense Meteorological Satellite Program microwave sounder will be incorporated into Nuclear Fallout computations; system integration and user evaluation will be completed for smoke screening operations and CB defense efforts related to the Automatic Meteorological System. The data base and terrain-meteorology models will be integrated for helicopter operations and a user review conducted; and techniques will be investigated to access effects of Infra Red emission on optical sensor concepts. Funding in FY 78 is increased by $2,322,000 for: (1) cost growth and (2) development of prototypes and field testing of techniques and sensing devices required for Artillery, Armor, Intelligence, Ballistic Missile Defense and Communications Systems, Aviation, Advanced Attack Helicopter, Chemical-Biological-Nuclear, and the US Army Engineers.

4. FY 1979 Planned Program: Infrared emission studies and the sensitivity analysis of weapons effects codes to atmospheric parameters will continue. Results will be used in determining and predicting the atmospheric environment likely to be encountered (including nuclear) by Ballistic Missile Defense and Communications Systems. Graphic displays will be developed and data processing techniques improved for the satellite cloud-severe storm observational system (SATSTM). SATSTM Letter of Agreement approval is anticipated in FY 1979. A prototype of the meteorological satellite data acquisition will be developed. Geostationary satellite sounder techniques will be analyzed for use in the satellite nuclear fallout prediction system. A passive remote crosswind sensor will be delivered to US Army Armaments Research and Development Command (ARRADCOM). Temperature and density departure tables will be completed for Siberia-Alaska and Africa. Transport diffusion models will be incorporated into the Automatic Meteorological System. Experimental software for the Automatic Meteorological System-Artillery (AMS-A) will be completed and the AMS-A will enter the Advanced Development state. A user review will be conducted for the Automatic Meteorological System for smoke screening operations and Chemical-Biological defense. Funding in FY 79 is decreased by $1,095,000 for the following reasons: (1) The Automatic Meteorological System-Artillery (AMS-A) will be completed in 6.2 and moved into a 6.3A effort; (2) exploratory development efforts in 6.2 on the Remote Automatic Weather Station will be completed and the program moved to 6.3B; and (3) the Satellite Nuclear Fallout Prediction System (SATFAL) effort will move to 6.3A to satisfy the Letter of Agreement approved in FY 197T.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.21.20.A

Title Fuzing, Nuclear Weapons Effects, Fluidics

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	11007	3179	12884	11905	11810	Continuing	Not Applicable
AH25-01	Fuze Technology	4507	1265	4632	4805	5000	Continuing	Not Applicable
AH25-02	Nuclear Weapons Effects Research	5000	1525	6900	6300	6000	Continuing	Not Applicable
AH25-03	Fluidics Technology	1500	389	1352	800	810	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The fuze technology program supports all future advanced and engineering development efforts and product improvements by providing generic data and new technology to fuze designers. This includes technical areas of target sensing systems, electronic counter-countermeasures, specialized subsystems, simulation, and design. The nuclear weapons effects research and test program provides the cost effective technology to significantly improve the nuclear hardening and survivability of current and future Army systems. Emphasis is placed on critical environments and critical equipments seeking to achieve balanced hardening of Army equipment and systems. The fluidic technology program provides a coordinated Army-wide program for the design, development, testing and feasibility demonstration of fluidic systems for use in Army materiel. Fluidic systems offer the potential of greatly improved reliability, availability and maintainability characteristics and reduced life-cycle cost while providing comparable improved end-item performance.

Budget Activity #1 - Technology Base

Program Element #6.21.20.A Title Fuzing, Nuclear Weapons Effects, Fluidics

BASIS FOR FY 1978 RDTE REQUEST: Target sensing systems for fuzes must be improved to achieve full effectiveness of new and future weapon systems, especially against countermeasures. Subsystems must be reduced in cost to improve cost-effectiveness. Simulation and design techniques will reduce time and risk in fuze development and product improvement. of critical Army equipment will be supported by technical expertise, supporting research, development and tests to provide the broad nuclear survivability technology needed to assist user and developer to successfully improve Army systems nuclear survivability. Develop new technology for endoatmospheric electromagnetic pulse, and test signal shelter Initiate development of a methodology to, of current and future Army systems. Fluidic control systems for turbine engines will enter feasibility testing. Fluidic flight controls will become ready for 6.3 Advanced Development. Prototype engineering and testing will continue on the fluidic damper. Active suspension system concepts will be evaluated. Fluidic controls for beam rider missile will be designed and fabricated. Coordination, reliability, and component development will continue.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Contractual efforts in radio fuzing will increase. Demonstration of advanced technology in air defense projectile fuzing is to be performed. Due to deferred scheduling of a nuclear survivability testing program some minor downward revision is made. Funding decrease is attributable to normal program adjustments in fluidics and nuclear weapons effects balanced by a slight increase in the fuzing area.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	257	0	257
(2) Contractor Employees	157	0	157
Total	414	0	414

DETAILED BACKGROUND AND DESCRIPTION: Fuzing must meet the changing needs of new munitions, delivery systems, and countermeasures. This generally requires more ruggedness, more sophistication, and more reliability at lower cost. No commercial need exists to insure that these fuzing needs would be met without this effort. This requires sensing system design and analysis, and specialized subsystem concept development and validation. Nuclear weapons effects research and test program provides the technology to significantly improve Army system survivability, focusing on a balanced hardening approach, critical environments for systems

are identified and improved survivability techniques are developed, tested and implemented. Data on the full spectrum of nuclear weapon effects, material responses and survivability methods are provided project and commodity managers. Fluidic control systems offer lower cost, high reliability, intrinsic safety and operation in harsher environments than other controls, adaptive suspension systems for vehicles, fuze arming controls.

RELATED ACTIVITIES: Fuze technology supports artillery and mortar programs, and several other weapon and ammunition development programs. The Joint Logistic Commanders Fuze Group reviews, coordinates all DOD fuze activities, and eliminates duplication. Information exchange via the Interagency Power Group, Power Information Center includes research and development programs of the Army, Navy, Air Force, Energy, Research and Development Agency, National Aeronautics and Space Administration, Department of Transportation; Department of Health, Education and Welfare; Environmental Protection Agency; National Science gFoundation; and Department of Interior. Nuclear weapons effects is part of tri-service effort coordinated by the Defense Nuclear Agency, and supports US Army Materiel Development and Readiness Command (DARCOM) system developers. This supports programs in 6.27.19.A, 6.33.04.A and 6.57.08.A. Fluidic technology follows up on research in many areas such as aeronautical technology, and flight structures. This also supports coordination of the Joint Technical Coordinating Group - Fluidics.

WORK PERFORMED BY: Harry Diamond Laboratories, Adelphi, Maryland; US Army Armament Research and Development Command, Dover, New Jersey; AARADCOM, Aberdeen Proving Ground, Maryland; US Army Electronics Research and Development Command, Fort Monmouth, New Jersey; US Army Missile Research and Development Command, Huntsville, Alabama; White Sands, New Mexico; US Army Tank Automotive Research and Development Command, Warren, Michigan; Air Mobility Research and Development Laboratory, Fort Eustis, Virginia; Mobility Equipment Research and Development Command, Fort Belvoir, Virginia. Contractors include General Electric, Schenectady, New York, Burlington, Massachusetts and Philadelphia, Pennsylvania; AVCO, Wilmington, Massachusetts; University of Florida, Gainesville, Florida; Shock Hydrodynamics, Ventura, California; Physics International, San Leandro, California; GTE Sylvania, Needham, Massachusetts; Science Applications, La Jolla, California; Kaman Sciences Corporation, Colorado Springs, Colorado; Mission Research Corporation, San Diego, California; Kaman Avidyne, Boston, Massachusetts; Braddock, Dun and McDonald, Albuquerque, New Mexico; Unidynamics, Phoenix, Arizona; Northrop Corporation, Hawthorne, CA; Denver Research Institute, Denver, Colorado; Lovelace Foundation, Albuquerque, New Mexico; EMX Engineering Incorporation, Wayne, New Jersey; Martin-Marietta Corporation, Orlando, Florida; Bendix Corporation, Detroit, Michigan; Honeywell, Minneapolis, Minnesota; and AiResearch Manufacturing Company, Phoenix, Arizona; among others.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: A data base for design of contact fuzes has been developed. Fuzing systems based on magnetic, optical, radio frequency, contact sensing and processing of guidance information has been examined. Remote setting of fuzes has been developed. Microelectronics have been employed. Safety of fuzes has been improved. Initiated Multiple System Evaluation Program (MSEP) as a comprehensive Electro Magnetic Pulse (EMP) technology development program under

which the survivability has been established for numerous Army single and multi-channel radios, repeaters, and telephone terminals and fixes developed. Tests on the PERSHING and LANCE systems were completed and recommendations implemented. Blast vulnerability levels established for helicopter, LANCE, signal shelters, antennas, and other Army equipments. A cost effective Transient Radiation Effects in Electronics (TREE) hardening program was begun, radiation protection factors established for and a code developed. Provided survivability support to project and commodity managers. Fluidic controls have been developed for helicopter stablization, missile steering. Design and process data obtained for injection molding of fluidic explosive initiators, temperature sensors, vortex rate sensors, nuclear weapons effects on fluidics, effects of contamination of fluid, fluidically controlled damper, and electrical to fluidic interface devices.

2. FY 1977 Program: Air defense projectile radio frequency and delay fuzes will be designed for validation of concept. Anti-Armor magnetic and improved contact fuzes will also be designed for concept validation. A submunition optical fuse concept will be developed. Each of these will use advanced technology to define areas requiring further effort and make advanced available to developers of fuzes. Implement survivability improvements such as EMP hardening fixes for communications equipments and under Multiple System Evaluation Program (MSEP), perform vulnerability/survivability analyses and tests on system, and apply results to related systems. Evaluate DICE THROW blast experiment. Continue TREE vulnerability on systems studies under MSEP. Evaluate of PERSHING, LANCE and communications systems. Provide survivability support to project and commodity managers. A turret stabilization design will be selected for validation. The fluidic damper will be fabricated and tested. Modular missile steering and homing controls will be demonstrated. Flight controls for helicopters will be designed.

3. FY 1978 Planned Program: Air defense projectile and submunition fuzing concepts developed in FY 1977 will be validated. Anti-armor fuze concepts will be developed for validation in FY 1979. Air defense missile fuze concepts will start development. Specialized subsystems will evolve to correct deficiencies and reduce cost. Continue to develop EMP hardening fixes for Army communications. Under MSEP and conduct EMP analysis and tests on and selected Army Continue radiation, blast and EMP vulnerability/survivability work on critical Army systems. Assist project and commodity managers. The fluidic damper design for adaptive suspension systems will be validated and transferred to 6.3 Advanced Development. Turbine engine control design will be validated. Flight controls for helicopters and steering controls for missiles will enter validation phase. Funding decrease is attributed to normal program adjustments in fluidics and nuclear weapons effects, balanced by a slight increase in fuzing area.

4. FY 1979 Planned Program: Anti-armor fuzes will be validated. Air defense missile fuzes will enter concept validation phase. Concept development will be emphasized on fuzing for extended range projectiles and rockets with terminal homing. Continue application of technology approach to insure Army equipments/systems are appropriately hardened to nuclear threats and to develop and implement techniques for hardness assurance. Continue work. Fluidic component concept development for servo-valves, flight controls, and suspension systems will be pursued. A round-counting computer for artillery ammunition will enter concept development.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.22.01.A Title Aircraft Weapons Technology

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	1600	500	1842	1227	1310	Continuing	Not Applicable
DH96-01	Gun and Mount	890	205	742	350	370	Continuing	Not Applicable
DH96-02	Fire Control	320	130	452	400	420	Continuing	Not Applicable
DH96-03	Aerial Ammunition	295	140	450	300	320	Continuing	Not Applicable
DH96-04	Rocket Accuracy	95	25	198	177	200	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program element is utilized to determine the feasibility of applying advanced armament techniques and weapons to Army aircraft.

BASIS FOR FY 1978 RDTE REQUEST: Program efforts will lead to the demonstration of a high performance, constant recoil, precision gun pointing system and advanced systems tradeoff analysis. Second generation fire control components will be fabricated by utilizing optimized sensor data; advanced stabilization control and sighting techniques; and a millimeter radar for long range, fixed target, detection and tracking. The final report on shallow cone shaped charge (SCSC) program will be completed. Data accumulated will be analyzed and major payoff areas established to improve rocket accuracy.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Level of effort decreased in technology base programs due to reduced scope of programs and to address specific technology opportunities.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	259	0	259
(2) Contractor Employees	171	0	171
Total	430	0	430

Budget Activity #1 - Technology Base

Program Element #6.22.01.A Title Aircraft Weapons Technology

DETAILED BACKGROUND AND DESCRIPTION: The objective of this program element is to determine the feasibility of applying advanced armament techniques and weapons to Army aircraft. Through investigations, analytical studies and laboratory tests, data are acquired to determine the feasibility of improved aerial weapons systems. The program element has four technical areas structured to achieve the foregoing objectives. The technical areas are: gun and mount, fire control, aerial munitions, and rocket accuracy.

RELATED ACTIVITIES: Close liaison is maintained with the other military services and industry to avoid duplication of effort. The Army participates in the Tri-Service Joint Technical Coordinating Group for Air Launched Non-Nuclear Ordnance, an organization chartered at the major field command level. This group provides a medium for exchange of technical information and determination of joint use implications. An Army representative serves on the Air Munitions Requirements and Development Committee, an organization within the Office of the Secretary of Defense. One of the functions of this committee is the establishment of joint service requirements and development of air munitions. Related Advanced Development work is conducted under Program Element 6.32.06.A, Aircraft Weapons and Engineering Development is under Program Element 6.42.02.A, Aircraft Weapons.

WORK PERFORMED BY: Armament Research and Development Command (ARRADCOM), Dover, NJ; US Army Missile Research and Development Command, Huntsville, AL; US Army Materiel Systems Analysis Agency, Aberdeen, MD. Contractors: General Electric, Binghamton, NY; Westinghouse, Baltimore, MD; Firestone, Akron, OH; Aerojet General, Downey, CA; and Boeing Aerospace, Seattle, WA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: A comparative cost effectiveness study of heliborne TOW and SHILLELAGH Anti-armor missile systems was completed and TOW was selected. Four contenders for a second generation area weapon were evaluated and the 30mm automatic gun was selected. A synthesis and cost comparison of potential third generation antitank guided missiles were completed. An evaluation was made of the cost of fire control effectiveness as a function of complexity and sophistication. Conducted studies to determine aerial weapon systems reaction forces and blast effects on helicopters. Simulation models were developed to evaluate gun-type weapons with respect to weight, rate of fire, cost, accuracy and reliability. Additionally, concepts for a helicopterlaunched anti-radiation missile were evaluated. Fire control parameter analyses related to extend range capabilities, ballistic and rocket weapons, remote control (drone) delivery systems, and night/all weather systems were conducted. Two firing tests using AH-1G, one turret and one wing mounted gun, were conducted to identify the different components contributing to the total firing error and magnitude of each error source and a control law derived. An impulse generator that simulates firing impulses was designed to permit exploitation of the constant recoil system as applied to an aircraft cannon. The spin insensitivity and penetration potential of shallow cone shaped charge were demonstrated. A 70% reduction in projectile base drag by using fumers was demonstrated. Initial firing demonstrations using 2.75 inch rockets indicated that placement of submunitions in the target area are insensitive to variations in rocket trajectory but do require an appropriate drag device to be incorporated into each submunition. Advanced ammunition concepts in telescoped configuration were investigated for optimization.

Budget Activity #1 - Technology Base

Program Element #6.22.01.A Title Aircraft Weapons Technology

2. FY 1977 Program: The breadboard of a precision gunpointing system will be fabricated and an advanced tradeoff analysis will begin. Design and analysis of the hybrid constant recoil approach, using both hydraulic and mechanical/electronic concepts, to fabricate a turret to accept a high impulse gun will begin. Design of a test fixture for third generation gun will commence. Development and feasibility testing of fixed target filters using a millimeter radar will be initiated. Optimal onboard filtering and trajector solution computer requirements study will begin as well as the development of electronic advanced airborne boresight techniques. The development of design rules for the shallow cone shaped charge (SCSC) will continue. The analysis of the rotor downwash data on helicopter rocket firings will be completed.

3. FY 1978 Planned Program: The breadboard precision gunpointing system will be tested on the six-degree of freedom simulator and stabilization boundaries determined which will allow a system synthesis for a precision weapon to be performed. The contract for a breadboard hybrid constant recoil system will be awarded and integration for the follow-on flight test will begin. The third generation gun test fixture will be fabricated and test will commence. Algorithms developed for on-board filtering and trajectory solutions will be programmed for use with the current multi-weapon fire control system (MWFCS) testbed. Advanced airborne boresighting techniques and millimeter radar efforts will continue. The final report on SCSC will be completed and permit limited breadboarding of feasible projectiles for demonstrations. New submunition concepts will be tested using the 2.75 inch rocket as a testbed. Terminal trajectory correction concepts will be developed for the 2.75 inch rocket. The concept of arming Remotely Piloted Vehicles (RPV) with 2.75 inch rockets will be investigated. Funding decrease due to reduced scope of programs.

4. FY 1979 Planned Program: Effort in the precision gunpointing and constant recoil program will merge and design analysis for a complete advanced system will be initiated. Millimeter radar and advanced boresighting projects will lead to breadboard of hardware. SCSC prototype projectiles will be demonstrated. Hardware for terminal trajectory correction of 2.75 inch rockets will be fabricated and arming the RPV with 2.75 inch rockets project will continue.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.22.02.A Title Aircraft Avionics Technology

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	4250	1150	5006	5850	6003	Continuing	Not Applicable
AH85-01	Aviation Communications	450	56	460	700	613	Continuing	Not Applicable
AH85-03	Instrumentation	200	38	367	300	455	Continuing	Not Applicable
AH85-04	Navigation and Positioning	525	108	650	660	740	Continuing	Not Applicable
AH85-05	Air Traffic Management	300	152	467	460	585	Continuing	Not Applicable
AH85-06	Landing Guidance	400	97	445	400	500	Continuing	Not Applicable
AH85-12	Environment Sensing	660	99	670	790	850	Continuing	Not Applicable
AH85-13	Avionics System Integration and Simulation	835	297	967	1140	875	Continuing	Not Applicable
AH85-16	Advanced Avionics Systems Analysis	450	153	340	500	540	Continuing	Not Applicable
AH85-17	Digital/Modular Avionics	430	150	640	900	845	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program element provides the technology base for Army avionics. The areas of investigation include communications, environment sensing, navigation, air traffic management, landing systems, cockpit instrumentation, digital/modular avionics and advanced avionics systems analysis.

BASIS FOR FY 1978 RDTE REQUEST: The FY 1978 request is based on the need to maintain a broad effort in the technology areas noted above. Investigations include application of laser and other technology to the wire detection problem, efforts to find reduced cost navigation systems for nap-of-the-earth (NOE) operations, improvement of the man-machine interface, the Digital Modular Avionics Program (DIMAP) and techniques to expand capabilities and functions of existing avionics equipment at a low cost.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The increase in FY 78 is due to increased effort in the areas of system integration and simulation, advanced systems analysis and the Digital Modular Avionics Program (DIMAP). This reflects increased emphasis on the "systems approach" and the use of modern digital technology for system integration.

Budget Activity #1 - Technology Base

Program Element #6.22.02.A Title Aircraft Avionics Technology

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement) is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	63	0	63
(2) Contractor Employees	14	0	14
TOTAL	77	0	77

DETAILED BACKGROUND AND DESCRIPTION: This exploratory development program provides the technological base for investigation of new ideas, concepts and techniques in aviation electronics. The objective of the program element is to obtain data and to determine the feasibility of applying new aviation electronics technology to Army aircraft and related ground equipment. Particular emphasis is placed on helicopter operation at night, in adverse weather and at low level/nap-of-the-earth altitudes. These efforts are aimed at achieving a capability to provide around the clock airmobility support in a mid-intensity warfare environment.

RELATED ACTIVITIES: Related programs of other services and the Federal Aviation Agency are monitored by the Army through committees, working groups and joint developments to take advantage of techniques that can be applied to Army problems. Resources are concentrated on problems which are Army unique or not addressed by other development activities. This Program Element provides the technology base for Program Elements 6.32.07.A (Aircraft Avionics Equipment) and 6.42.01.A (Aircraft Avionics).

WORK PERFORMED BY: US Army Aviation Research and Development Command, Avionics Laboratory, Ft Monmouth, NJ. Contractors include: Marchand Electronics, Greenwich, CT; McDonnell Douglas, St Louis, MO; GTE Sylvania, Needham, MA; American Electronic Laboratories, Farmingdale, NJ; Cutler Hammer Inc., Farmingdale, NY; Bendix Corporation, Baltimore, MD; Sperry Rand Corporation, Phoenix, AZ; United Technologies Inc., East Hartford, CT; and Fairchild Camera Corporation, Syosset, NY.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Tactical landing system studies were conducted with emphasis on confirming the behavior of microwave scanning beams in the tactical environment and evaluation of the problems associated with simultaneous aircraft approaches. Investigation of cockpit instrumentation symbology, shapes, size and brightness was conducted. The phase front homing investigation led to a product improvement program which will improve the homing range and accuracy of standard aircraft radios. Flight tests of a low cost hover sensor were conducted. Displays for helicopter steep angle approaches were flight tested.

A "cross banded" system, using a landing system up link and standard transponder down link to provide aircraft data on the ground was demonstrated. The use of charge coupled devices was identified as a promising low cost approach for a wire detection system. Data was collected on acoustic and electrical noise sources that impact speech intelligibility and hearing loss. Tactical hover sensor flight tests were initiated. An antenna design computer model was validated. Investigation of a low cost electronic counter-countermeasures technique for tactical radios was initiated. Participation in Air Force and Navy inertial navigator programs continued. Low cost ground velocity sensors and heading references were investigated. Work was initiated on the evolution of three dimensional (3D) nap-of-the-earth (NOE) navigation system. Investigation of hybrid navigation systems continued. The development of techniques to capitalize on existing airborne equipment and obtain lightweight air traffic management equipment was initiated. Flight testing was conducted for investigations of low visibility/low decision height approaches and landing guidance requirements. The Laser Obstacle/Terrain Avoidance Warning System (LOTAWS) was flight tested and development of a multifunction LOTAWS initiated. A terrain trend sensor was demonstrated in flight. The digitally generated symbology computer program was developed and the digitally generated map program was flight tested. The Multifunction Aviation Display (MAD) underwent a simulation evaluation. The MAD uses pilot night vision goggles as means of displaying a navigation map, forward looking infrared imagery and alphanumeric symbology to the pilot. The study design phase of the Digital Modular Avionics Program (DIMAP) was completed. The Low Level Night Operations (LLNO) program was completed - results lead to significant conclusions regarding night vision devices, wire detection, symbology, and navigation.

2. FY 1977 Program: The acoustic and electrical noise sources data base will be expanded to other aircraft types. Use of a standard airborne radio to provide hearing to a tactical radio transmitter will be investigated. Investigation of low cost electronic counter-countermeasures (ECCM) techniques for tactical radios will continue. The use of a computer model for designing antennas for frequency modulated (FM) tactical radios will be investigated. Analysis of communications requirements and concepts for 1990 and beyond will begin - initial effort will include analysis of radio frequency requirements such as band width, channelization and modulation techniques. Work will begin on development of a solid state radio magnetic indicator/horizontal situation indicator. Low cost heading reference and ground velocity sensor flight test data will be analyzed. Work on multi-sensor navigation systems will continue. Alternative designs of a standard navigation control display unit will be tested in simulation. Tests of lightweight air traffic management equipment will be started. Investigation of far term air traffic management concepts will be initiated. Investigation of low visibility/low decision height approaches will continue. Simulation tests of multiple aircraft approach and landing techniques will be conducted. Development of an advanced landing display will be started. The multifunction Laser Obstacle/Terrain Avoidance Warning System (LOTAWS) will be flight tested. A low cost obstacle avoidance system and a multifunction transponder will be fabricated. Digitally generated symbology, the digital map and a Doppler navigator will be integrated into a night navigation and pilotage system. Design and computer programming of the Digital Modular Avionics Program (DIMAP) bench facility will be completed.

Budget Activity #1 - Technology Base

Program Element #6.22.02.A Title Aircraft Avionics Technology

3. FY 1978 Planned Program: Electronic Counter-Countermeasures (ECCM) and audio processing techniques for Army helicopters will be analyzed. Antenna techniques analysis will continue. The bearing sensor application of a standard tactical radio will be flight tested. Communication concepts analysis will continue. The solid state radio magnetic indicator/horizontal situation indicator will be flight tested. Exploratory development of an integrated multifunction display will be initiated. Integration of a low airspeed sensor into the three dimension (3D) nap-of-the-earth (NOE) navigation system will be initiated. Flight tests of the standard navigation control display unit will be initiated. Multi-sensor navigation systems will be flight tested. Feasibility effort on the lightweight air traffic management equipment will be completed. Far term air traffic management hardware techniques and systems concepts will be investigated. Multiple aircraft approach and landing work will be completed. The advanced landing display will be flight tested. Promising technical approaches for a self contained landing capability will be identified. Low cost obstacle system flight tests will be completed. Development of a multi-function transponder will continue. Flight tests of the night navigation and pilotage system will be conducted. Construction of the Digital Modular Avionics Program (DIMAP) bench facility will be completed. The increase in FY 78 is due to increased effort in the areas of system integration and simulation, advanced systems analysis and the Digital Modular Avionics Program (DIMAP). This reflects increased emphasis on the "systems approach" and the use of modern digital technology for system integration.

4. FY 1979 Planned Program: Flight tests of the tactical radio bearing sensor will be completed. A final report on far term communications concepts will be published. Definition of communications system design concepts for the 1990's will be started. First phase hardware of the 3D NOE navigation system will be ven tested. The integrated multi-function display will be flight tested. Flight tests of the standard navigation control display unit and multi-sensor navigation systems will be completed. Promising far term air traffic management concepts will be tested and evaluated. Self contained landing system bread board hardware will be fabricated. The multi-function transponder will be flight tested. The digital modular avionics system will be used in a test bed helicopter as a flexible tool for flight evaluation of new system and subsystem concepts.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.22.09.A Title Aeronautical Technology

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES PROJECT LISTING: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	14601	3970	15810	15693	15752	Continuing	Not Applicable
AH76-01	Aerodynamics	2224	615	1970	2102	2102	Continuing	Not Applicable
AH76-02	Structures	2303	600	2464	2575	2602	Continuing	Not Applicable
AH76-03	Propulsion	2865	814	2950	2800	2800	Continuing	Not Applicable
AH76-04	Reliability & Maintainability	1618	508	1686	1500	1542	Continuing	Not Applicable
AH76-05	Safety & Survivability	2221	596	2250	2218	2428	Continuing	Not Applicable
AH76-06	Mission Support	912	357	1010	925	925	Continuing	Not Applicable
AH76-07	Aircraft Systems Synthesis	1069	294	1070	1060	1070	Continuing	Not Applicable
AH76-08	Aircraft Subsystems	740	95	510	650	694	Continuing	Not Applicable
AH76-09	Remotely Piloted Vehicles (RPV)	649	91	500	340	0	Continuing	Not Applicable
AH76-10	R&D Flight Simulator	0	0	1100	1300	1343	Continuing	Not Applicable
AH76-11	Aviation Human Engrg	0	0	300	223	246	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program provides and develops the aeronautical technology base required for improvements in the operational effectiveness and mission capability of Army aviation systems. Technical areas included are: aerodynamics, structures, propulsion, reliability and maintainability, safety and survivability, mission support, aircraft systems synthesis, aircraft subsystems, remotely piloted vehicles, flight simulation, and aviation human engineering.

BASIS FOR FY 1978 RDTE REQUEST: The FY 1978 program is directed toward the continuing development of the aeronautical technology base with particular emphasis directed toward filling technological voids or deficiencies in the areas of rotor flow field, dynamic stall, helicopter drag, rotor/fuselage interaction, ground proximity effects, dynamics of hingeless rotors, vibration reduction, stability, control, handling qualities, acoustic signature, design criteria, advanced structures (composites) for rotors and airframe, and small gas turbine engine components. Additional areas of effort include development of diagnostic-condition monitoring capability; reduction of visual, acoustic, radar and infrared signatures; improved ballistic tolerance and crashworthiness; development of day/night terrain flying capability for tactical and cargo transport missions; development of adverse weather mission capability including helicopter ice protection; development of small RPV technology; and R&D simulator capability.

Budget Activity #1 - Technology Base

Program Element #6.22.09.A Title Aeronautical Technology

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The minor change in FY 1978 is due to decrease in test activities.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement) is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	259	0	259
(2) Contractor Employees	171	0	171
Total	430	0	430

DETAILED BACKGROUND AND DESCRIPTION: The purpose of this program is to provide a sound technological base for advanced and engineering development programs by providing and developing the aeronautical technologies required for improvements in the operational effectiveness and mission capability of Army aviation systems. Areas of investigation within the technology disciplines consist of the following: fluid mechanics, dynamics, flight control, acoustics; design criteria, weight prediction, material engineering, internal/external loads, fatigue and fracture mechanics, structural concepts; small air flow gas turbines including aerothermodynamics and controls, engine accessories, thrust producers, high-temperature materials, mechanical drive systems; diagnostics and prognostics, maintenance and support; survivability through reduced detectability and aircraft and aircrew protection flight safety; cargo handling systems, ground support equipment; secondary power systems, environmental control systems; remotely piloted vehicles; flight simulation; and aviation human engineering. Developments in these technologies have application to all Army aircraft systems of the future, including the Advanced Scout Helicopter, the Advanced Attack Helicopter, the Utility Tactical Transport Aircraft System, the CH-47 Modernized Medium Lift Helicopter, and other product improvement programs.

RELATED ACTIVITIES: Related programs are performed by the National Aeronautics and Space Administration (NASA), Navy, Air Force, and Department of Transportation. Coordination to eliminate unnecessary duplication is accomplished by: program reviews, exchange of program data sheets, research and technology resumes, and technical reports; interservice liaison, attendance at scientific meetings and conferences; and joint participation in the Technical Cooperation Program, NASA Research and Technology Committees, and the North Atlantic Treaty Organization (NATO) Advisory Group on Aerospace Research and Development. This program is included in the Tri-Service Aeronautical Vehicle, Structures and Aircraft Propulsion Technology Coordinating Papers. Efforts under this program element lead into Advanced Development under Program Elements 6.32.01.A, Aircraft Power Plants and Propulsion; 6.32.08.A, Aircraft Survivability; 6.32.09.A, Air Mobility Support; 6.32.11.A, Advanced Vertical Take-Off and Landing (VTOL); and 6.32.12.A, Tilt Rotor Research Aircraft, as well as aircraft systems development.

Budget Activity #1 - Technology Base

Program Element #6.22.09.A Title Aeronautical Technology

WORK PERFORMED BY: The in-house portion of this program is accomplished at the US Army Air Mobility Research and Development Laboratory, Moffett Field, CA, through the Ames Directorate, Moffett Field, CA; Eustis Directorate, Ft. Eustis, VA; Langley Directorate, Langley Research Center, VA; and Lewis Directorate, Lewis Research Center, OH. The top ten contractors are: Boeing Vertol Company Philadelphia, PA; Sikorsky Aircraft, Stratford, CT; Pratt & Whitney Aircraft, West Palm Beach, FL; Bell Helicopter Textron, Ft. Worth, TX; Hughes Helicopter, Culver City, CA; Kaman Aerospace Corporation, Bloomfield, CT; General Electric Aircraft Engine Group, Lynn, MA; Lockheed Aircraft Corporation, Burbank, CA; Hamilton Standard, Windsor Locks, CT; and Teledyne CAE, Toledo, OH.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Controllable Twist Rotor tested in NASA/Ames 40 x 80-Foot Wind Tunnel. Completed preliminary stability and control and structural analyses for a Vee tail empennage for the AH-1G. Completed limited flight evaluation of advanced fluidic stabilization system. Initiated fabrication of dynamically scaled Variable Geometry Rotor. Fabricated advanced composite aft fuselage for UH-1/AH-1 helicopters and conducted structural tests. Developed analytical modeling techniques for small, high temperature combustors. Developed simulation model for assessing reliability and maintainability of current and advanced development helicopters. Developed technology for reducing radar signature of helicopter rotor blades. Completed design studies of more than 200 new development, inventory and off-the-shelf aircraft designs to support advanced Scout Helicopter Special Study Group. Initiated design and fabrication of helicopter ice protection system. Initiated test of remotely piloted vehicle (RPV) engines. Developed design criteria and methodology for separated air flow in region of rotor hub. Completed mathematical modeling for rotor flapping dynamics. Completed a study to define Army R&D simulator needs. Conducted structural load survey of AH-1G obtaining detailed knowledge of rotor aerodynamic environment and structural response. Initiated development of a Surge Margin Centrifugal Compressor for small turbine engines. Continued combustor design and criteria evaluation program for improved performance and lower emissions. Adapted Aircraft System Cost and Operational Effectiveness Analysis. Continued testing of aircrew/troop seats and restraint system in CH-47 Crash Test II and test rigs. Initiated secondary power system studies. Conducted simulated and limited natural ice-protection system testing on UH-1H. Continued the development of mini-RPV supporting technology. Provided support to other Army agencies and Program Managers through preliminary system design efforts, technical risk assessments, design reviews, and R&D program reviews and assessments.

2. FY 1977 Program: Controllable Twist Rotor testing will continue with multicyclic flap input for vibration and load reduction. Helicopter flow field investigation will continue including rotor hub drag/pressure distribution study. Analysis of Vee tail for AH-1G will be made to establish if full scale testing is warranted. Preliminary design of a wide-angle visual system for helicopter simulation will be completed. Noise and blade loading experiments on the 35-foot diameter rotor will be continued. A 9-foot diameter scaled Composite Structures Rotor will be tested in Transonic Dynamics Tunnel. The wind tunnel testing of the Variable Geometry Rotor will be completed and analyzed. A half scale fail-safe composite rotor hub assembly will be fabricated and laboratory tested. Nine improved surge margin compressor configurations will be tested. Initiate investigation for improvement of an advanced technology engine air particle scavenge system. Continue evaluation of drive system component improvement including overrunning clutches. Continue development of advanced diagnostics and prognostics techniques. Continue vulnerability investigations

and methods for radar, infrared and acoustic signature reduction. Continue external cargo gondola system fabrication and test. Initiate multi-year efforts covering selected external load terrain flying concepts. Maintain, refine, and apply the parametric preliminary system design engineering modeling capability. Continue development of electrothermal rotor blade deicing as well as microwave and vibratory type concepts. Continue development of remotely piloted vehicle (RPV) technology including launch and recovery and propulsion systems. Initiate specification and component acquisition for rotorcraft flight simulator for Systems Integration Research and Development(R&D).

3. FY 1978 Planned Program: Controllable twist rotor testing program will continue with analysis of FY 1977 testing of multicyclic controls and determining additional R&D efforts. Wind tunnel test of optimized fuselage configuration to validate drag design methodology will be initiated. Acoustics efforts will include wind tunnel, whirl tower and flight tests to identify noise sources and to analyze their mechanisms of development. Continue composite structures efforts for both advanced rotors and fuselage configurations. Conduct load surveys to substantiate second generation aeromechanics model. Continue efforts on ballistic improved rotor blades and fail-safe rotor hub design. Continue investigations of small gas turbine engine and propulsion system components to increase performance, reduce specific fuel consumption, reduce emissions with overall reduction in weight and cost. Continue assessment of operating cost reduction through development of improved reliability and maintainability technology and equipment concepts. Continue investigation of methods for reducing radar and infrared signatures of helicopters and RPVs. Efforts will continue on vulnerability reduction through helicopter component improvements. Flight test experimental gondola for external cargo transport and initiate development of advanced terrain flying external cargo transport concepts. Initiate validation efforts for advanced rotor blade deicing concepts. Continue mini-RPV development efforts with emphasis on propulsion and safety through FY 1978. Continue human engineering efforts in area of aircrew workload, crew station controls, displays and environment, and aircrew performance model. Acquisition of components for flight simulator Phase I system will be completed.

4. FY 1979 Planned Program: The need for additional R&D efforts in FY 1979 on controllable twist rotor will be determined from FY 1978 results. Wind tunnel testing of optimized fuselage configuration to validate drag design methodology will continue. Acoustic test efforts will continue with program redirection and/or additional efforts determined from results. Composite programs on fuselage and rotor will continue. Load survey for second generation aeromechanic model will continue. Continue development of small gas turbine engine components, reliability, availability, and maintainability technology, safety and survivability and vulnerability. Continue efforts in terrain flying techniques and equipment for cargo transport. Continue ice-protection systems development. Continue laboratory support including human engineering efforts.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.22.10.A Title Airdrop Technology

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	768	250	995	1230	1283	Continuing	Not Applicable
D283	Airdrop Technology	768	250	995	1230	1283	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program supports exploratory development in technology for airdrop of personnel/equipment from United States Air Force and Army aircraft. Develops basic airdrop technology and evaluates the feasibility of concepts which enhance the effectiveness of operational capabilities. Simulation techniques/computer programs are utilized to determine criteria and predict performance of airdrop concepts and hardware. Areas of investigation are: aerodynamic decelerations, airdrop impact effects, energy dissipator materials, flexible materials and structure, textile improvement for airdrop and cargo sling materials, simplification of rigging for airdrop, high speed/high level airdrop, extending airdrop capability to altitudes of 25,000 feet.

BASIS FOR FY 1978 RDTE REQUEST: Efforts by task: Gliding Deceleration - Study inflation dynamics of large gliding canopies and evaluate guidance prototype hardware. Rigging Technology - recommend rigging simplification design for equipment loads. Outline program for modular, prepacking concept for equipment. High Speed Airdrop - analyze the 2-stage personnel parachute system to establish criteria for higher exit speeds. High Level (Altitude) Airdrop - conduct high level stability improvement test. Advanced Airdrop Technology - establish design of energy dissipator. Develop method for load separation of containers delivered at high altitudes. Evaluate turbulence, temperature, and pressure effects of Advanced Medium STOL Transport (AMST) on personnel and equipment loads. Initiate computer simulation which incorporates all airdrop variables. Freedrop Technology - define impact limits for selected loads, drop test container material. Airdrop Ground Assembly/Identification Aid - identify and evaluate concepts for post-airdrop assembly of personnel and location of equipment to include night and adverse weather.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Increase is utilized in Advanced Airdrop Technology to support the evaluation of the USAF Advanced Medium STOL Transport (AMST) prototype program; Gliding Decelerators for contract procurement and in-house evaluation of prototype for heavy equipment airdrop; wind tunnel evaluation of platform stability; and test and evaluation of new rigging concept; contract procurement of prototype articles for concept evaluation of freedrop containers.

Budget Activity #1 - Technology Base

Program Element #6.22.10.A Title Airdrop Technology

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	21	0	21
(2) Contractor Employees	8	0	8
TOTAL	29	0	29

DETAILED BACKGROUND AND DESCRIPTION: This element provides a technological base for advanced and engineering development programs required to correct deficiencies and to improve operational effectiveness of airdrop operations. Areas of investigations include aerodynamics, deployment and inflation techniques of parachutes and gliding decelerators, opening shock to fabric/parachute material, guidance and control of gliding decelerators, aircraft roller stress forces, design/evaluation of materials for deceleration/restraint, platform/container load stability during extraction, staged descent and recovery, recovery velocity, computer simulation for airdrop component/systems performance free-fall/drop dynamics, protect against impact loading, ground assembly/identification aid concepts for night and adverse weather conditions. Developments in these technologies have application for other Services in their needs for airdrop as the Army is lead service for airdrop development. Due to limited commercial use of airdrop systems, most experience in research and development (R&D) of airdrop systems is contained within the Government.

RELATED ACTIVITIES: Program Elements 6.32.09.A, D266, Airdrop Prototype and Techniques; 6.42.04, D279, Airdrop Equipment Development. Coordination with other Services is effected through the Joint Air Movement Board and Joint Technical Coordinating Group for Aerial Delivery. Cooperative agreements with North Atlantic Treaty Organization and American, British, Canadian, Australian (ABCA) work groups on Military Airtransport and Aerospace Research and Development allow maximum advantage to be taken in areas of common interest.

WORK PERFORMED BY: Natick R&D Command conducts Exploratory Development to Engineering Development Airdrop R&D efforts. Work is also performed at Yuma Proving Grounds, AZ and by the US Army Airborne, Communication, and Electronics Board, Fort Bragg, NC. Coordination is in effect to avoid duplication and insure system compatibility with United States Air Force (USAF) aircraft. Test, evaluation and studies are also contracted on Military Interservice Purchase Request for conduct by USAF and other Armed Forces. Contractors are: Monsanto Chemical Corporation, Dayton, OH, Brown University, Providence, RI, Brooks and Perkins, Inc., Livonia, MI, Goodyear Aerospace Corp., Payne Inc., Pioneer Recovery Systems, Manchester, CT.

Budget Activity #1 - Technology Base

Program Element #6.22.10.A Title Airdrop Technology

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS

1. FY 1977, FY 1976 and Prior Accomplishments: Demonstrated 35,000 lb airdrop load from 500 feet with recovery by Parachute Retro-Rocket System (PRADS). Computerized simulation for airdrop trajectory analysis was completed. Completed study of 50,000 pound airdrop system. Determined critical areas in airdrop of personnel from 500 ft. Critical factors for high altitude, platform airdrop were determined. Determined critical effects of launch in predicting accuracy. Rigging procedures were developed for Low Altitude Parachute Extraction System (LAPES) delivery of the 155mm towed howitzer, the 5 ton truck, 21 equipment loads and 39 ammunition loads. Demonstrated use of precut honeycomb energy dissipators for common use in airdrop equipment loads. Developed techniques for airdrops of equipment at altitudes up to 25,000 feet. Perfected the use of the anti-inversion net for the maneuverable personnel parachute. Analyzed six degrees of freedom in Gliding Deceleration technology. Developed rigging procedure for free-fall of accompanying equipment. Identified new materials for free drop of potable water.

2. FY 1977 PROGRAM: Gliding Decelerators - fabricate guidance and control system for techniques of controlling flight path. Analyze decelerator performance and identify wind tunnel and flight test requirements. Rigging Technology - continue to develop/improve procedures/equipment to optimize the integration of personnel, weapons and accompanying equipment for airborne operations. High Level (Altitude) - Continue efforts for stabilization of platform loads during high rate of descent (first stage). Develop concepts for recovery stage to eliminate parachute damage. Advanced Airdrop - participate in contractor/government testing of the US Air Force Advanced Medium STOL Transport (AMST) for airdrop capability. Develop concept for new reserve personnel parachute system. Complete feasibility study for advanced airdrop soft landing concept. Ground Assembly Aids - initiate development for new equipment/technique to facilitate ground linkup of personnel/equipment during post-airdrop operations. Free drop fabricate and test new freedrop water container to devise test methods for determining fragility of free fall items.

3. FY 1978 PLANNED PROGRAM: Gliding Decelerators - provide design for and procure contractor prototype for heavy equipment airdrop and conduct in-house evaluation of performance. Incorporate guidance hardware on prototype decelerator. Evaluate modular, pre-packing concept for rigging airdrop loads. High Speed Airdrop - analyze the 2-stage personnel parachute system to evaluate higher exit speeds. High Level (Altitude) - conduct wind tunnel test and develop concepts for improving platform/load stability at high rate of descent. Design load transfer prototype device. Advanced Airdrop - participate in contractor/government testing of potential airdrop capability of the AMST. Complete design concept studies and evaluation of new reserve personnel parachute system and select concept for development. Complete study of concepts for soft landing equipment airdrop systems and select system for continued development. Continue effort to develop new Ground Assembly Aids and technique to facilitate ground link up of personnel, weapons and equipment during all weather conditions in post-airborne operations. Free drop-design and fabricate laboratory equipment capable of determining fragility of free dropped resupply items. Increase in FY 78 funding over FY 77 is required for contract procurement of bread board articles for further concept evaluation in High Speed Airdrop, soft landing equipment, free drop containers and ground assembly aids.

Budget Activity #1 - Technology Base

Program Element #6.22.10.A Title Airdrop Technology

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

4. FY 1979 PLANNED PROGRAM: Gliding Decelerators - complete test of guidance/control concepts - select best concept for continued development. Continue testing of large capacity decelerators and specify design compatible with selected guidance/control concept. High Speed - collect data for contract to investigate feasibility of high speed airdrop systems. Conduct in-house analysis of extraction decelerator design and investigate aircraft safety interface requirements. High Level (Altitude) - initiate full scale test of concept for platform load stability at rapid rate of descent. Advanced Airdrop - Evaluate prototype assembly aids hardware and techniques. Design and fabricate breadboard soft landing airdrop system. Study methods for reduction of parachute snatch force and opening shock for high aircraft release speeds. Free Drop - investigate new technique for low altitude resupply. Airdrop Simulation - continue studies for simulation of airdrop environment using computers, math models and laboratory scale models.

5. PROGRAM TO COMPLETION: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.23.03.A

Title Missile Technology

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	27894	5688	28940	28500	30140	Continuing	Not Applicable
A214-01	Sensors	3700	925	4630	4723	5100	Continuing	Not Applicable
A214-02	Guidance and Control	4000	435	4530	3846	4340	Continuing	Not Applicable
A214-03	Terminal Guidance	3300	895	4400	3861	5000	Continuing	Not Applicable
A214-04	Propulsion	2200	500	2530	2669	2650	Continuing	Not Applicable
A214-05	Aerodynamics	2184	445	2200	2975	2300	Continuing	Not Applicable
A214-06	Ground Support Equipment Technology	500	158	900	932	1000	Continuing	Not Applicable
A214-07	Nuclear Weapons Effects	200	50	250	125	100	Continuing	Not Applicable
A214-08	Structures	700	150	1000	1090	975	Continuing	Not Applicable
A214-09	Experimental Systems	7480	1083	4300	2765	3200	Continuing	Not Applicable
A214-10	Systems Concept Analysis	800	267	950	899	975	Continuing	Not Applicable
A214-11	Hybrid Microelectronics	400	190	380	389	400	Continuing	Not Applicable
A214-12	Simulation Research	2300	500	2700	2649	2600	Continuing	Not Applicable
A214-13	Laser Technology	130	90	170	0	0	Continuing	Not Applicable
A214-14	Free Flight Rocket Technology	0	0	0	1577	1500	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program includes virtually all exploratory development work conducted by the US Army Missile Research and Development Command to provide the technological base for future Army tactical missiles. While demonstrating the feasibility of advanced concepts, the work includes applied research, laboratory hardware and component development, and limited full scale experimental testing.

BASIS FOR FY 1978 RDTE REQUEST: Continue exploratory development of missile related technology applicable to future missile systems.

Budget Activity #1 - Technology Base

Program Element #6.23.03.A Title Missile Technology

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Decrease results from elimination of Simplified Inertial Guidance-Demonstration flight testing, postponement of acoustic homing investigations for one year to FY 1979, and minor scope reductions in other efforts.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	267	0	267
(2) Contractor Employees	292	0	292
Total	559	0	559

DETAILED BACKGROUND AND DESCRIPTION: This program element provides Army research in missile and rocket technology and supports improvements to currently deployed systems and development of future systems. This program element includes virtually all exploratory development work conducted by the US Army Missile Research and Development Command to provide the technological base for future Army tactical ground support equipment, system concept and analysis, missile aerodynamics, structures, sensors, nuclear weapons effects, experimental systems, simulation research, hybrid microelectronics, and free flight rockets. While demonstrating the feasibility of advanced concepts, the work includes applied research, breadboard hardware and component development, and limited full scale experimental testing.

RELATED ACTIVITIES: These efforts are closely related to work in the same technology areas being conducted by the Advanced Research Projects Agency, the US Air Force, the US Navy, NASA and other activities within the Army. Coordination is effected through interagency groups, frequent liaison visits, independent research and development, and information exchanged through the Defense Documentation Center. Unproductive effort and duplication is precluded by this information flow and by concentrating on specific areas particularly critical to Army tactical missile requirements.

WORK PERFORMED BY: US Army Missile Research and Development Command, Huntsville, Alabama; Harry Diamond Laboratories, Washington, DC; Aeronutronic Ford Inc., Newport Beach, California; Texas Instruments, Inc., Dallas, Texas; General Electric Company, Philadelphia, Pennsylvania; Hughes Aircraft Corporation, Canoga Park, California; Thiokol Chemical Corporation, Huntsville, Alabama; US Army Aviation Research and Development Command, St. Louis, Missouri; US Army Armament Research and Development Command, Aberdeen, Maryland; US Navy Ordnance Laboratories, Silver Spring, Maryland; Martin-Marietta Corporation, Orlando, Florida; Emerson Electronics Company, St. Louis, Missouri; and approximately 20 additional contractors and universities.

Budget Activity #1 - Technology Base

Program Element #6.23.03.A Title Missile Technology

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments:

Designed, flight tested and evaluated motor concepts for a shoulder-fired anti-tank weapon. Conducted terminal homing flight demonstrations with wide angle and dual mode seekers. Designed and fabricated a real image correlator to refine optical data processing techniques. Completed fabrication of stabilized airborne missile launcher and test fixture to duplicate vibration motion of helicopter. Performed hardware evaluation of critical components of an airborne laser designator. Completed static test firing of improved propellant for PATRIOT (SAM-D) at critical temperature ranges. Conducted flight tests of fluidic directional control with HONEST JOHN missile as test vehicle. The first two prototype infrared imaging seekers underwent satisfactory preliminary tracking performance test. The Army Laser Seeker was redesigned to double the collecting aperture and provide extended range signal processing to achieve an increase in sensitivity by a factor of five. Feasibility of the following was demonstrated: (1) Lighterweight, less costly filament wound fiberglass tube launchers; (2) a solid state firing mechanism using a printed circuit board as a built-in switch; (3) optimized design parameters of the Light Anti-tank Weapon Program (LAWT) precision warhead which is smaller, lighter weight, and has better penetration performance, and (4) reformulation of a high burning rate carborane propellant which uses less of the costly carborane additive. Full power search was accomplished with the experimental array radar and engineering design analysis was begun on passive radio frequency and spread spectrum radar techniques. Static field tests on the optical beamrider concept were completed and 13 flight tests with modified SHILLELAGH and DRAGON missiles using three different guidance techniques were completed under the Advanced Research Projects Agency and Army funding. Captive tests of infrared imaging seekers were conducted using a US tank and a foreign vehicle. Contracts were awarded to Martin and Hughes for Active seeker development work. A low cost multipurpose digital processor was designed and breadboard fabricated using advanced microprocessor technology. A strapdown laser gyro unit and a conventional strapdown guidance unit were procured and tradeoff studies initiated to determine low cost inertial guidance parameters. Evaluation of both Hughes and Martin advanced TV seekers were begun. Army laser seekers were tested in firings from hovering helicopters. Terminal homing measurements and the Data Bank were expanded. Small motor firings of a fast burning propellant were conducted. Exploratory development of an advanced smokeless motor for the CHAPARRAL missile was completed. Aeroballistic design studies were conducted and the helicopter downwash measurement program completed. Hot gas feasibility testing of a composite motor case suitable for shoulder fired missiles was completed. Radome rain erosion effects studies were completed and laboratory testing begun. A large acoustical holography system was designed, fabricated, installed and became operational. This system is used for flow detection and location in ceramic nose cones, spot welded plates and aluminum blocks. Distance Measurements Equipment (DME) hardware evaluation and laboratory testing was completed. Step and smooth bore launchers were fabricated for the free flight rocket program. Hybrid microelectronic program included design and fabrication of missile electronic component interconnection and support structures. Experiments using gold filled epoxy circuits printed on cover demonstrated a 30-60% reduction in resistance. The Advanced Simulation Center (ASC), Infrared and Electro-optical, cells were completely operational. Work on the Radio Frequency cell continued with completion scheduled early in FY 1976.

Budget Activity #1 - Technology Base

Program Element #6.23.03.A Title Missile Technology

Critical components for a quiet missile control radar were built and field tested. Missile firing demonstrations of a prototype laser beam rider guidance system for SHILLELAGH were initiated. Flight tests of the optical contrast seeker were conducted. Experiments initiated in FY 1975 on fast burning, low cost and low signature propellants were continued. An air spring isolator capable of isolating helicopter missile launchers from vibrations were laboratory tested and redesigned for helicopter flight tests. Low cost launcher technology efforts to develop multiple, disposable containers/launchers were continued. Radome rain erosion effects investigations were continued. Demonstration of the applicability of hybrid microelectronic technology to missile systems was continued. The Advanced Simulation Center (ASC) became completely operational and "hardware in the loop" simulations were conducted in support of weapons systems development. A design contract for a multi-purpose supersonic laser beam rider missile system was negotiated. Demonstration of distance measuring equipment (DME) using a modified basic HAWK missile and the Air Force Airborne Location and Strike System (ALSS) was initiated. The effort included guidance law simulation, missile modifications, telemetering and integration engineering.

2. FY 1977 Program: A transmitter exciter for a quiet missile control radar will be designed and fabrication begun. Tests of alternative optical beam rider transmitter designs will be made in countermeasures and other adverse environments. A spiral scan infrared homing sensor will undergo captive flight tests. Infrared correlation techniques for infrared imaging seekers will be investigated. Test and analysis of multienvironment active RF seekers will be initiated. Simplified inertial guidance using strapdown laser gyros will be continued leading to flight tests in FY 1978/FY 1979. Solid state imaging devices and microprocessor computer technology will be investigated in proof of principle tests. Efforts will continue on long wavelength laser sensor measurements and target discrimination studies. Low cost graphite linter high rate double base and low signature propellants will be demonstrated in prototype hardware for anti-tank, air defense and assault roles. A single station prototype laser altitude tracking system will be developed and performance verified during flight tests. Helicopter testing of the isolator hardware will be completed. Fabrication of low cost multitube launcher pads for multiple rockets will be accomplished. Concepts for the automatic, rapid-fire launching of free flight rockets from armored personnel carrier will be investigated. Radome rain erosion effects investigations will continue. An investigation in the use of composite materials for other than missile launch tube structural components will be initiated. An active RF air defense seeker will be demonstrated during flight tests. A demonstration of accurate low cost rockets will be conducted. Carbon Dioxide laser beam guidance will be investigated and missile designs for a supersonic laser beam rider missile evaluated. Fabrication of a hybrid microelectronic digital autopilot will be completed and evaluated in a field environment. The Advance Simulation Center will continue in full operation.

3. FY 1978 Planned Program: A measurements/analysis effort for the controlled signature (quiet) radar will be initiated. Testing and analysis of the non-imaging and imaging array infrared homing sensors, and the multienvironment active radio frequency (RF) seeker will be completed. Algorithm development for sensors integration with systems for use in the ASC will be continued. Design, fabrication and laboratory testing of critical components for simplified inertial guidance will continue. Flight tests of an automatic airborne target correlator for handoff to imaging missile seekers will be accomplished. Measurements testing and analysis of infrared (IR) and RF seekers in the presence of smoke/clutter will continue. Integration of sensor components into terminal homing RF/millimeter wave will be accomplished to include bench testing. Long wave (2 to 14 micron) laser guidance and designation

testing will continue. Test and evaluation of the second design iteration of the dual mode laser/infrared seeker will continue. Captive flight testing of electronic countermeasures hardened distance measuring equipment (DME) will be completed. Pseudo-random noise active RF seeker and passive RF surveillance system testing will be completed. Technologies supportive of free flight rockets will continue to include multiport nozzles and effects of temperature extremes, inflight flow field analyses, effects of mallaunch/malaim and transient launch forces on flight trajectories, and testing using suitable rockets to verify accuracy predictions. Effort will continue to provide low cost, low exhaust propulsion that will satisfy the requirements for high performance, predictable functioning rocket/missile motors. Analysis of a hypervelocity armor defeating aerial rocket and aeroballistics of sub-missiles will be initiated. Launcher structural technology in support of missiles and rockets will continue. The Advanced sSimulation Center (ASC) will continue in full operation. The decrease results from elimination of the flight testing of the Simplified Inertial Guidance-Demonstration vehicle, postponement of acoustic homing investigations for one year to FY 1979, and minor scope reduction in other efforts.

4. FY 1979 Planned Program: Measurements/analysis efforts on the controlled signature (quiet) radar will be accomplished. Measurements/analysis of infrared and radio frequency seekers in the presence of smoke/clutter will continue. Flight testing of sensor components for terminal homing guidance, radio frequency and millimeter wave will be accomplished. Long wave laser guidance and designation testing will continue. Test and evaluation of the dual mode laser/infrared seeker will be accomplished. Low cost, low exhaust propulsion investigations will continue. Flight verification of hypervelocity armor defeating rocket will be accomplished. Acoustic homing investigations will be initiated. The Advanced Simulation Center will continue in full operation.

5. Program to Completion: This is a continuing exploratory development program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.23.03.A

Title Missile Technology

Project #A214

Title Missile Technology

Technical Area 01

Title Sensors

Category Exploratory Development

Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: The objective of this work is to develop, test, and evaluate infrared and radio frequency (RF) homing seekers; ground-based radar and infrared sensors and sources for performing the functions of search, acquisition, and track; and command guidance concepts for Army missile and projectile systems. Identification of the need for special test, measurement, and diagnostic techniques is made as part of the planning and execution of the work. A consideration of countermeasure problems and life cycle costs is implicit in the particular design approaches selected. The hardware effort is closely coordinated with work in modeling, analysis and simulation. The work on homing seekers is complemented by an effort in Terminal Guidance Technology. Both the infrared and radar search and track sensors will be subjected to thorough field validation to establish their characteristics as a subsystem of Army weapons before prototype models are developed. Foreign technology trends are considered in planning and executing this work.

RELATED ACTIVITIES: Prototype sensors are subjected to field testing in the Experimental Systems Technology Area. Terminal homing sensors are validated in flight demonstration programs under Terminal Guidance Technology. Foreign intelligence is considered in the planning and execution of this work. Coordination is with U.S. Navy and U.S. Air Force development activities performing sensor R&D through periodic Department of Defense reviews and continuing discussions/conferences within the development communities.

WORK PERFORMED BY: U.S. Army Missile Research and Development Command, Huntsville, Alabama; Auburn University, Auburn, Alabama; General Electric Company, Philadelphia, Pennsylania; Texas Instruments, Inc., Dallas Texas; Hughes Aircraft Corporation, Canoga Park, California; Sperry Gyroscope, Long Island, New York; Raytheon Inc., Bedford, Massachusetts; Aeronutronics Ford, Newport Beach, California; and other contractors.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments:

In the Infrared Detection and Acquisition (IRDA) System effort, the "track while scan" computer was successfully integrated with the remainder of the signal processing system and Brassboard fabrication of a 60 channel multiplexer and a planned position indicator display was completed. Investigation of a dual-mode radio frequency (RF)/infrared (IR) seeker design was begun. Beam rider encoding/decoding logic directed toward the Countermeasures Hardening of Optical Command Guidance Systems was completed.

Budget Activity #1 - Technology Base

Program Element #6.23.03.A

Project #A214

Technical Area 01

Title Missile Technology

Title Missile Technology

Title Sensors

Thirteen flight tests of modified DRAGON and SHILLELAGH missiles employing three different optical beam rider guidance techniques were completed with Advanced Research Projects Agency and Army funding. In the experimental Array Radar (EAR) effort full power search (100 kilowatt peak) was accomplished with clutter map display presentations out to 24 kilometers in range and airborne targets observed out to 15 kilometers. An evaluation of a quiet radar concept for the short range, low altitude air defense role was completed and basic system characteristics defined. A 20-month two-phase contract was awarded to the Martin Company for development of a multi-environment active radio frequency (RF) seeker. Hughes Aircraft was awarded a contract to determine the feasibility of an active seeker guidance concept.

Detailed design of quiet radar antenna was completed and preliminary testing accomplished. Solid-state device evaluation for radar and seeker applications continued. Development of an advanced signal processor for use in the infrared detection and acquisition system was initiated. Adverse environmental tests of gallium arsenide laser beamrider has continued. Work was continued on long wavelength optical beamrider feasibility. A multi-environmental RF seeker was fabricated and tested.

2. FY 1977 Program: A transmitter exciter for the quiet radar will be designed and contract fabrication begun. Concept of a covert active and passive air defense target acquisition system will be defined. Laboratories and field tests will be conducted to evaluate the infrared detection and acquisition system. Tests of various optical beamrider transmitter designs and coding schemes will be made in countermeasures and other adverse environments. The infrared spiral scan seeker will be completed for captive flight tests. Test and analysis of the multienvironment active RF seeker (MARFS) will be continued. Laboratory and field tests of the radio frequency (RF)/infrared (IR) common aperture seeker will be conducted. Efforts to improve the simulation models of typical IR backgrounds will continue. Simulation models of new IR seekers will be developed to study the effects of countermeasures. Field tests to demonstrate the long wavelength laboratory transmitter and receiver concepts will be conducted. An effort will be initiated to analyze and measure critical hardware performance necessary to suppress anti-air defenses.

3. FY 1978 Planned Program: A measurements/analysis effort will be initiated on the quiet radar. Evaluation of IR detection and acquisition system will continue. Optical command and beamrider spatial encoding techniques and long wavelength infrared guidance link feasibility experimental evaluation will continue. Testing and analysis on non-imaging IR homing sensor, imaging IR arrays and 700 to 1300 NICOM sensors continues. Testing and analysis of the MARFS will continue. Algorithm development for sensors will continue. Slight increase in funding over FY 1977 results from planned field testing of MARFS.

Budget Activity #1 - Technology Base

Program Element #6.23.03.A Title Missile Technology

Project #A214 Title Missile Technology

Technical Area 01 Title Sensors

4. FY 1979 Planned Program: The measurements/analysis effort on the quiet radar will continue. Evaluation of infrared detection and acquisition systems, optical command and beamrider spatial encoding and long wavelength infrared guidance link feasibility will continue. Testing of imaging and non-imaging infrared sensors will continue. Testing and analysis of MARFS and algorithm development for sensors will continue.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	3700	925	4630	4723	5100	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.23.03.A Title Missile Technology

Project #A214 Title Missile Technology

Technical Area 02 Title Guidance Control Technology

Category Exploratory Development Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is to provide the Army with the inertial guidance and control development base for missile weapons. The objective will be accomplished by the synthesization of concepts, definition of requirements, simulation and evaluation, fabrication of hardware, and the flight demonstration of systems to provide advanced guidance and control mechanization that are rugged, reliable, responsive, readily fabricated, adaptable, and as low cost as possible for the Army's present and future requirements. The program also provides for the technical monitorship of the Guidance and Control Information Analysis Center (G&C IAC).

RELATED ACTIVITIES: This effort is closely related to the Sensor Technology, Terminal Homing, and Experimental Systems Technology technical areas. Foreign state-of-the-art trends and potential threats to present and future materiel or systems are considered throughout the research and development cycle Duplication of effort with other Services is avoided by periodic Department of Defense reviews and continuing discussions/conferences among the developing commands. The establishment of the G&C IAC further aids in precluding duplication.

WORK PERFORMED BY: US Army Missile Research and Development Command, Huntsville, Alabama, USAF Special Weapon Laboratory, University of Alabama, and various contractors.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments:

In the Directional Control Antitank (DCAT) effort, 11 accuracy demonstration flights were conducted and a launcher concept was completed. An all-digital automatic tracking system for airborne direct-fire systems was designed. Feasibility of television guidance for artillery missiles was investigated and demonstrations with LITTLE JOHN rockets conducted. A low-cost, multipurpose digital processor was designed and breadboard fabricated, using advanced techniques. The Automatic Tracking System for Airborne Direct Fire and Integrated Fire Control was successfully used to provide laser designation for HELLFIRE type missiles in both self-contained and scout roles. The basic HAWK missile was selected as the best available test vehicle for demonstrating Distance Measuring Equipment (DME). A typical strapdown laser gyro guidance unit and a conventional strapdown unit were procured for evaluation. Computer simulations for both DME and inertial guidance systems were developed.

[illegible] Activity #1 - Technology Base

Program Element #6.23.03.A Title Missile Technology

[illegible] 62214 Title Missile Technology

Technical Area 02 Title Guidance and Control Technology

Design of the four-inch direct fire test bed was completed. Detailed autopilot and control system designs was integrated into the overall system. The multipurpose digital processor was laboratory evaluated. Laser and conventional strapdown gyros continued to be evaluated in the laboratory to determine the capability of strapdown gyros to perform missile guidance and controls functions during prelaunch and flight conditions. A simplified inertial guidance demonstration program was initiated and the following accomplished: Contracts were let for vehicle and guidance systems; comprehensive simulation was developed; sled test hardware was fabricated; and wind-tunnel tests were conducted.

2. FY 1977 Program: Five flyable prototype models of the multipurpose digital processor will be fabricated and tested in the T-6 missile simulator and in five flight tests. Stabilization improvements to the automatic system for Direct Fire and Integrated Fire Control will be made and flight tested. A new Internal Bearing Stabilization concept will be procured and evaluated. Feasibility evaluations of the two-axis laser gyro will be completed. Hardware in the loop simulations and evaluation of flight guidance and control hardware will be accomplished leading to prototype flight testing in FY 1979.

3. FY 1978 Planned Program: The Tri-Service multipurpose digital processor effort will continue. Testing of digital autopilot prototype hardware will be initiated. Flight evaluation of a solid state random scene tracker and an automatic target correlator will continue. Design, fabrication and laboratory testing of accelerometers, gyrocompasses, innovative pneumatic controls, and strapdown ring laser inertial guidance gyros will continue. Methodology effort will continue for improved tactical software. Decrease from FY 1977 results from elimination of flight testing of simplified inertial guidance-demonstration vehicle.

4. FY 1979 Planned Program: The Tri-Service multipurpose digital processor effort will continue as well as flight evaluation and analysis of solid state random scene tracker and automatic target correlator. Laboratory testing of accelerometers, gyrocompasses, and innovative pneumatic controls will continue. Efforts on improving tactical software will continue. Monitorship of the Guidance and Control Information Analysis Center (G&C IAC) will continue.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	4000	435	4530	3846	4340	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.23.03.A Title Missile Technology

Project #A214 Title Missile Technology

Technical Area 03 Title Terminal Guidance

Category Exploratory Development Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: The objective of this work is to provide part of the technology base for improving the terminal accuracy of Army missile and projectile systems. A consideration of countermeasures problems and life cycle costs is implicit in the particular design approaches selected. The effort includes the development, test, and evaluation of homing guidance techniques using laser, television, solid-state imaging, and selected dual-mode sensors. Promising seeker candidates are selected for flight validation in terminal homing accuracy demonstration programs. The seeker development effort is closely coordinated with measurement programs to develop radiative or scattering characteristics of typical targets and environments, and signal processing techniques optimized to these characteristics. The program also provides for an effort in air defense suppression, and sub-missile homing technology.

RELATED ACTIVITIES: This effort is closely related to the Sensor Technology and Inertial Guidance Control Efforts. Foreign technology trends are considered in planning and executing this work. Duplication with other Services is avoided by periodic Department of Defense reviews and continuing discussions/conferences among members of the development community.

WORK PERFORMED BY: US Army Missile Research and Development Command, Huntsville, Alabama and Harry Diamond Laboratories, Washington, DC.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments:

Laboratory techniques for the preparation of holograms were established so that typical terrain scenery can be simulated. A real image correlator was fabricated and is operational in the laboratory. A pure digital model of a laser semiactive seeker was implemented. The program computer for the Terminal Homing Data Bank was completed and a data file search of other government agencies was begun. In the Terminal Homing Accuracy Demonstration (THAD) program, a six-inch airframe was checked out and a four-missile installation on a Cobra helicopter was completed. A missile launched with airborne laser designation was accomplished. In the optical seeker area, a digital signal processing scheme for a rosette scan seeker was designed and fabricated. A digital (six-degree of freedom) computer program was developed for a missile system utilizing laser semiactive guidance. Technical requirements for an advanced television seeker were prepared, and two parallel contracts were awarded to conduct the design, fabrication, and testing of two different seeker concepts. The delivery of the dual-mode laser/television seekers was completed, and testing

Budget Activity #1 - Technology Base

Program Element #6.23.03.A Title Missile Technology

Project #A214 Title Missile Technology

Technical Area 03 Title Terminal Guidance

and evaluation begun. The Laser/infrared (IR) seeker prototype was delivered. The design and fabrication of a new gyro-optical head for the laser seeker was completed. A full-up aerodynamic flight test with nine sub-missiles (without seekers) was conducted and met major test objectives. The experimental air defense laser designator was assembled from a (laser and RAPIER) tracker, and preliminary tests were conducted. Two T-6 missiles with Army laser seekers were tested from a hovering AH-1G helicopter. Testing and analysis on the current optical contrast seeker continued as part of the preparation for flight testing. The three-shoe modified non-tipoff launch rail and 7-inch HORNET missile were tested. Both the Martin and the Hughes advanced television seekers were delivered, and test and evaluation begun. The laser/infrared (IR) seeker was reworked and plans for laboratory and captive flight tests were prepared. Contracts were awarded to Ling-Temco-Vought to conduct extensive tests with several IR seekers in various backgrounds and target environments, and to conduct drop tests that will demonstrate outside-in spiral seeker scan, frequency background interference rejection technique, recovery of seeker packages by parachute, and dropping a new sub-missile airframe with wrap-around fins. Airborne designation systems (SPAL and ALLD) were evaluated for pointing and tracking performance. The airborne measurement system was used to map reflected energy from several tactical vehicles. Means and techniques were investigated to reduce optical scattering from designators. A series of measurements were conducted to assess the IR radiation characteristics of various terrain backgrounds and clutter objects. A comprehensive IR signature exploitation effort was undertaken using the Graph Angle vehicle. A contract has been awarded to design, fabricate, and interface hardware for implementing polarization agility with a 35 GHz short pulse radar and recognizer.

The laboratory and flight tests of the current optical seeker were completed. Procurement packages were prepared for the second phase prototype of the dual-mode laser/infrared seeker and for the solid-state imaging device seeker. The evaluation of the two advanced television seekers in both laboratory and captive flight tests were completed. Preliminary design studies of the Air Defense Suppression concept were initiated. Sub-missile drop and recovery techniques were demonstrated in a successful effort. Background and target signature measurement programs were begun. An active laser seeker breadboard receiver was fabricated. A command guidance system utilizing existing long wavelength laser was devised. Measurements were conducted for an advanced Independent Research and Development (IR&D) 35 GHz seeker, including tower-mounted and airborne data to evaluate tank signatures, background clutter, and false targets. Near-infrared laser and far-infrared imaging measurements were made through battlefield smoke, including camouflage smoke for evaluation of guidance performance.

2. FY 1977 Program: The advanced imaging prototype seeker will be evaluated by means of laboratory, hardware-in-the-loop, and captive flight tests. Fabrication of five flight worthy seekers will be completed. The solid-state optical homing sensor and signal processor will be delivered. The full potential for terminal homing of solid-state imaging devices and microprocessor technology will be investigated in proof of principle tests. Sub-missiles will undergo drop tests and background and target

Budget Activity #1 - Technology Base

Program Element #6.23.03.A Title Missile Technology

Project #A214 Title Missile Technology

Technical Area 03 Title Terminal Guidance

signature measurements will continue. A breadboard active laser hardware will be delivered and evaluated. A laser data link for control of a remotely controlled vehicle will be tested under laboratory conditions. Increased efforts on long wavelength lasers is planned. Operations of the Terminal Homing Data Bank will continue until turned over to the Tri-Service Guidance and Control Information Analysis Center.

3. FY 1978 Planned Program: Bench testing of integrated radio frequency (RF)?millimeter wave components/systems will continue. Continued testing of low light level fire and forget seeker and dual-mode laser/infrared (IR) seeker (second iteration) is planned. Evaluation and testing of baseline long wave IR (2 to 14 micron) as guidance link for active, semi-active, and beamrider guidance schemes is planned. Smoke and clutter measurements testing of IR and RF seekers will continue. Decrease from FY 1979 results from delay of acoustic homing investigations originally planned.

4. FY 1979 Planned Program: Flight testing of integrated radio frequency (RF)/millimeter wave components/systems is planned. Continued testing of low light level fill and forget seeker and dual-mode laser/infrared seeker is planned. Smoke and clutter measurement testing of infrared and radio frequency seekers will continue. Investigations on acoustic homing will commence (principal cause for increase of funding over FY 1978).

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	3300	895	4400	3861	5000	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.23.03.A Title Missile Technology

Project #A214 Title Missile Technology

Technical Area 09 Title Experimental Systems

Category Exploratory Development Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: The objective of this technology area is to explore experimental schemes which advance technology through integration and testing. Areas being explored include fire support, air defense, infantry and helicopter weaponry.

RELATED ACTIVITIES: This work is related to the other technology areas in Missile Technology in that integration of specific technologies occurs in experimental systems. This program also supports on-going efforts at the US Army Armament Research and Development Command, Dover, New Jersey, Harry Diamond Laboratories, and the Navy's China Lake facility. Duplication of effort with other Services is avoided by periodic Department of Defense level reviews and continuing Command level discussions/conferences.

WORK PERFORMED BY: US Army Missile Research and Development Command, Huntsville, Alabama; Test and Evaluation Command, US Army Armament Research and Development Command, Aberdeen, Maryland; US Army Electronics Research and Development Command, Fort Monmouth, New Jersey; White Sands Missile Range, White Sands, New Mexico.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments:

The Artillery Research Missile program was initiated in October 1970 with the purpose of providing a test bed to investigate armor defeating techniques beyond the range of conventional artillery. The test bed design modification and launcher instrumentation was completed and modified LITTLE JOHN missiles were fired in FY 1973 to determine launcher characteristics. Design of a trajectory shaping seeker began. Feasibility of the concept was confirmed. A Free Flight Rocket Technology program was initiated in FY 1974 to improve the accuracy of surface-to-surface free rockets. The areas of investigation included ballistics coefficient, malaim, thrust malalignment, and wind sensitivity. Both step and smooth bore launchers were fabricated for the free flight rocket program. The rail launcher was also fabricated and two firings accomplished. A superior performance - Light Antiarmor Weapon (LAW) replacement weapon was demonstrated. Lighter weight and less costly filament wound fiberglass tube launchers, an improved firing mechanism, optimized precision warhead design parameters and reformation of carborane propellant which uses less of the costly carborane additive were demonstrated. In the fluidic directional control effort, eight rounds, employing the basic HONEST JOHN as a test vehicle, were fired and preliminary data available supported the conclusion that missile accuracy is improved by

Budget Activity #1 - Technology Base

Program Element #6.23.03.A Title Missile Technology

Project #A214 Title Missile Technology

Technical Area 09 Title Experimental Systems

the fluidic control concept. Evaluation testing of distance measuring equipment (DME) hardware was completed. The antitank assault program provided all data and technology to the Improved Light Antiarmor Weapon (ILAW) Project Manager and ILAW entered Engineering Development. Work on a low-cost Advanced Target Missile Program consisted of a study of airborne threats and a literature survey. Under the Antitank Assault Program, a Shoulder-Fired Kinetic Energy Weapon (SKEW) was designed to attain a high single shot kill probability. A penetrator, propulsion unit and projectile was designed. A renovating engagement device to expand the use of the LAW and ILAW was designed, prototyped, and demonstrated. A firing of 18 free flight rockets from tube launchers and five from the rail launcher was conducted to determine spin data and other design parameters. Distance measuring equipment (DME) efforts continued with the initiation of guidance link simulation, test missile modification, telemetering, and system integration engineering. A 15-missile demonstration of a SHILLELAGH Laser Beamrider system was conducted. Effort on an active five-inch radio frequency (RF) seeker and a passive RF acquisition system was initiated. These multi-year programs are to demonstrate feasibility thru laboratory and field testing of breadboard/prototype equipments.

2. FY 1977 Program: Free Flight Rocket efforts will consist of program planning, design, and feasibility studies. Designs will be completed and fabrication initiated for rockets and launchers to be used in the accuracy demonstrations to be conducted in FY 1979. Design and laboratory hardware fabrication of a DME system which will be hardened against countermeasures will be initiated. Six flight demonstrations at White Sands Missile Range will be completed, using Air Force DME ground equipment. The active RF seeker will be demonstrated and work will be completed on the passive acquisition system. Work on the kinetic energy antitank weapon will continue with urban warfare applications optimized. A six-missile firing of a Supersonic Laser Beamrider missile will be conducted.

3. FY 1978 Planned Program: Free flight rocket efforts will become a separate technical area to provide intensified management in support of the accelerated General Support Rocket System (GSRS) program. Captive flight testing and data reduction of electronic countermeasure (ECM) hardened distance measuring equipment (DME) will be completed. The results of quiet radar effort from the sensors technical area will be utilized to form the basis of a controlled signature radar measurements/analysis program. Terminally guided antitank/anti-fortification concepts will be evaluated as well as a remote engagement device for missiles/rockets. Concepts studies for weapons in built-up areas and helicopters will be initiated. Hardware fabrication will be initiated leading to a demonstration of a helicopter launched 20 kilometer guided missile carrying submissiles. The decrease in funding from FY 1977 results from the establishment of the Free Flight Rocket Technology technical area which is designed to provide a focal point for free flight rocket technology in support of the GSRS.

Budget Activity #1 - Technology Base

Program Element #6.23.03.A Title Missile Technology

Project #A214 Title Missile Technology

Technical Area 09 Title Experimental Systems

4. FY 1979 Planned Program: Effort will be continued on the controlled signature radar measurements/analysis program. Terminally guided antitank/anti-fortification concepts exploitation will be initiated. Investigation will continue into remote engagement devices for missiles/rockets.

5. Program to Completion: This is a continuing technology program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	7480	1083	4300	2765	3200	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.26.01.A

Title Tank and Automotive Technology

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	7462	1601	7163	6980	8585	Continuing	Not Applicable
AH91-01	Combat Vehicle Systems	2197	641	2179	2438	2775	Continuing	Not Applicable
AH91-02	Combat Vehicle Survivability	1981	470	1780	765	775	Continuing	Not Applicable
AH91-03	Advanced Tactical Vehicle Systems	1039	175	1250	1145	680	Continuing	Not Applicable
AH91-04	Advanced Military Propulsion Systems	302	70	805	675	2130	Continuing	Not Applicable
AH91-05	Test Simulations Technology	324	120	229	432	450	Continuing	Not Applicable
AH91-06	Component Development	427	96	800	1275	1535	Continuing	Not Applicable
AH91-07	Structure Mechanics	90	29	120	250	240	Continuing	Not Applicable
AH91-08	Advanced Concepts Laboratory	1000	0	0	0	0	Continuing	Not Applicable
AH91-09	Maschienfabrik Augsbury/ Nurnburg Truck	102	0	0	0	0	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program element funds the United States Army's exploratory research and development efforts for future combat, tactical and special purpose vehicles.

BASIS FOR FY 1978 RDTE REQUEST: To investigate and exploit technology for improving the effectiveness of combat vehicles; to provide simulation techniques and prototype hardware for improving combat vehicle survivability; to conduct research to achieve significant reduction in fuel consumption of vehicles and to extend their fuel tolerances; to investigate mechanical and electrical components that will improve the performance of combat and tactical vehicles; and to develop the methodology of synthesizing the vehicle dynamics operating environment in the laboratory for the purpose of accelerating testing and reducing field test costs.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Slight decrease of funds offset by increased effort in PE 6.26.06.A, Advanced Concepts Laboratory.

Budget Activity #1 - Technology Base

Program Element # 6.26.01.A Title Tank and Automotive Technology

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ Employees	102	0	102
(2) Contractor Employees	21	0	21
Total	123	0	123

DETAILED BACKGROUND AND DESCRIPTION: The objective of this program element is to develop the technology base required in land mobility to: (1) produce combat and tactical vehicles with the capability to defeat prospective threats in any specified operational environment; (2) minimize the total cost of development, acquisition and operation of these systems; (3) reduce lead time and risk in new system developments; and (4) increase vehicle survivability. To meet these objectives, seven technical areas have been defined.

RELATED ACTIVITIES: Specific programs related to the technical areas of this program element are: PE 6.11.02.A, Project F22, Research in Vehicle Mobility; PE 6.21.05.A, Materials; PE 6.26.03.A, Large Caliber and Nuclear Technology; PE 6.26.06.A, Advanced Concepts Laboratory; PE 6.27.33.A, Mobility Equipment Technology; PE 6.26.18.A, Ballistics Technology; PE 6.31.02.A, Materials Scale-Up; PE 6.32.01.A, Aircraft Power Plants and Propulsion; PE 6.36.08.A, Tank Gun Development and Tank Ammunition; PE 6.36.21.A, Vehicle Engine Development; PE 6.36.24.A, Mobility; PE 6.27.79.A, Test Measurement and Diagnostic Equipment. Close relationship is maintained with other Services and governmental agencies. Research and development information concerning Combat, Tactical and Special Purpose Vehicles is also being exchanged via data exchange agreements with allied countries. Exchange of technical reports and frequent liaison by all agencies concerned occurs to insure coordination.

WORK PERFORMED BY: US Army Tank-Automotive Research and Development Command, Warren, Michigan, has the responsibility for the implementation of this program. Other Army in-house developing organizations that support this program are: US Army Test and Evaluation Command, Aberdeen, Maryland; Waterways Experiment Station, Vicksburg, Mississippi; Cold Region Research and Engineering Laboratory, Hanover, New Hampshire. Major Contractors participating in the program are: Shock Hydrodynamics, Inc., Sherman Oaks, California; Stevens Institute of Technology, Hoboken, New Jersey; Purdue University, Lafayette, Indiana; General Motors, Detroit, Michigan; Wayne State University, Detroit, Michigan; and National Waterlift Company, Detroit, Michigan.

Budget Activity #1 - Technology Base

Program Element # 6.26.01.A Title Tank and Automotive Technology

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: A computer model for predicting speed, fuel consumption, and payload delivery in cross-country movement was completed and used to support management and technical decision makers in evaluating candidatte vehicles for the Armored Reconnaissance Scout Vehicle, the Heavy Equipment Transport Vehicle, and the 1 1/4-ton truck. Several designs in the 3/4-ton and 4-ton high mobility tactical vehicle program were accomplished with complete engineering data, mobility assessment and production cost information. A laboratory evaluation of "behind-the-plate effects" of anti-personnel and high explosive anti-tank rounds was field tested and verified for insertion into the previously developed armor design model. The concept design for a 8-10 ton high mobility test-bed vehicle was completed and long lead items procured. Validation of the suspension and field test computer model along with the completion of the tire model was accomplished for further development toward synthesizing the vehicle dynamic operating environment in the laboratory.

2. FY 1977 Program: Advanced survivability concepts will be examined for possible test-bed configuration. Other advanced concepts for future vehicles will be considered. Mobility test beds will be supported. Completion of analytical procedure for ballistic design will occur. Continuation of efforts for advanced countermeasures and automatic defense systems. Work on the survivability optimization model will continue. Work will be initiated to fabricate the 8-10 ton high mobility test-bed. Turbine combustion research will continue and the exploratory development of a minimum cooled ceramic component engine will be initiated. Advanced techniques for electrical power systems using micro-processors simplifying electrical and gun control system will begin.

3. FY 1978 Planned Program: Efforts initiated in FY 1977 will be continued and new programs initiated. Ballistic evaluation on new candidate materials for armored vehicle application will be initiated. The in-arm suspension system will be fabricated. Advanced concepts of final drive power transmission system will be addressed. The automatic defense system test-bed will begin fabrication. The 3/4-ton high mobility test-beds will be fabricated. A mini-cooled two stroke diesel engine will begin fabrication. Initiate an automatic data and analysis capability. Work on the armored ammunition resupply vehicle will be moved into advanced development which results in a decrease in funding requirements in FY 78 for exploratory development.

4. FY 1979 Planned Program: Efforts begun in FY 1978 will be continued. Multi-cylinder mini-cooled engines will be fabricated. Analysis of the dependence of survivability levels on vehicle design parameters will be performed and evaluated. Investigate new polymer substances replacement of current rubber based vehicle components. Exploratory development into cybernetic suspension systems will be initiated. The increase in funding is due to the additional costs incurred in fabricating the multi-cylinder mini-cooled engine.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.26.03.A

Title Large Caliber and Nuclear Technology

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT						Continuing	Not Applicable
AH78	Armament Technology				0	0	Not Applicable	Not Applicable
AH18	Large Caliber and Nuclear Technology						Continuing	Not Applicable
AH18-01	Armored Fighting Vehicles (Large Caliber Systems)	750	150	650	1500	1600	Continuing	Not Applicable
AH18-02	Armored Fighting Vehicles (Medium Caliber Systems)	1500	400	1475	2900	2900	Continuing	Not Applicable
AH18-03	Armored Fighting Vehicles (Precision Armaments)	760	203	767	1500	1500	Continuing	Not Applicable
AH18-04	Infantry Armament Systems	800	200	700	1600	1600	Continuing	Not Applicable
AH18-05	Artillery Armament Systems	1600	300	1500	2900	2900	Continuing	Not Applicable
AH18-06	Artillery Closed Loop Fire Control Systems	1100	200	1000	2100	2100	Continuing	Not Applicable
AH18-07	Combat Aviation/Air Defense	400	130	300	800	800	Continuing	Not Applicable
AH18-08	Combat Engineer Armament Support	300	100	200	650	650	Continuing	Not Applicable
AH18-09	Energetic Materials Technology	800	200	700	1400	1500	Continuing	Not Applicable
AH18-10	Weapons Technology	600	130	600	1100	1100	Continuing	Not Applicable
AH18-11	Munitions Technology	700	200	600	1500	1600	Continuing	Not Applicable
AH18-12	Weapons Munitions Interface Technology	500	100	500	1100	1100	Continuing	Not Applicable
AH18-13	Nuclear Technology						Continuing	Not Applicable

Budget Activity #1 - Technology Base

Program Element #6.26.03.A Title Large Caliber and Nuclear Technology

BRIEF DESCRIPTION OF ELEMENT: The objective of this program is to develop and maintain a large caliber and nuclear technology base assuring a solid foundation upon which advanced and engineering development of weapon systems can be initiated and sustained.

BASIS FOR FY 1978 RDTE REQUEST: These funds will support the development and maintenance of a large caliber weapon systems technology base encompassing the technical areas identified above with emphasis on artillery propellant charges, medium caliber anti-armor cannons, shaped charges technology, and target directed fire-and-forget munitions.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The increase reflects a progressive change in scope and emphasis, and it also reflects the results of a restructuring effort in which tasks previously assigned to other program elements were reassigned to this program element.

PERSONNEL IMPACT

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ Employees	332	0	332
(2) Contractor Employees	180	0	180
TOTAL	512	0	512

DETAILED BACKGROUND AND DESCRIPTION: The Large Caliber and Nuclear Technology project performs exploratory development and necessary supporting research in weapons and munitions technology. The product of this effort is used to conceptualize revolutionary weapon and munitions systems as well as define ways of product improving the current systems to extend their useful life. The program scope covers the system oriented technical areas embracing armor, infantry, field artillery, air defense artillery, aviation, combat engineering and the support technologies of energetic materials (explosives, propellants, and pyrotechnics), weapons, conventional munitions, nuclear munitions and weapon/munition interface. The investigations develop both protytypes and analytic tools to assess system performance and identify problem areas. The resulting data base forms the foundation for all subsequent large caliber weapon and munition advanced and engineering developments.

RELATED ACTIVITIES: The single project program elements, 6.26.03.A, Armament Technology; 6.26.17.A, Munitions Technology; and 6.26.15.A, Nuclear Technology, were combined and restructured into single project program elements 6.26.03.A, Large Caliber and Nuclear Technology and 6.26.17.A, Small Caliber and Fire Control Technology. Moreover, efforts conducted in this program element are related to development activities in Ballistics Technology, 6.26.18.A, and numerous other exploratory, advanced,

and engineering development projects. In addition, these efforts are related to similar efforts conducted by the Air Force and Navy. Coordination is accomplished by visits of technical personnel, interagency meetings, and Tri-Service reviews and workshops to encourage cross-fertilization and preclude unnecessary duplication.

WORK PERFORMED BY: Approximately 70% of the work will be conducted in-house at US Army Armament Research and Development Command facilities located at Dover, NJ, Aberdeen, MD, and Edgewood, MD. Contract support is provided by Aircraft Armaments, Inc., Cockeysville, MD; Batelle Memorial Institute, Columbus, OH; Firestone Tire and Rubber, Akron, OH; Sanders Associates, Nashua, NJ; Aeronutronic-Ford, Newport Beach, CA; Raytheon, Bedford, MA; Texas Instruments, Dallas, TX, and numerous other small contractors.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Studies and tests were performed on numerous extended range artillery munition concepts. Medium caliber anti-armor automatic cannons were demonstrated with burst fire which can defeat tank armor. Cannon-launched beam rider projectile components were fabricated and successfully tested which show promise of significantly increasing the probability of hit to a range of Techniques which can significantly reduce propellant ignition delay and variance were demonstrated. Continued ignition progress will make the soft recoil gun concept a real design alternative to be considered for widespread use. Alternate explosive fills for all high use munitions were developed and qualified for use during mobilization. Alternate explosive fills which lessen or eliminate the HMX and RDX explosive components reduced the mobilization production base expansion requirement by nearly one billion dollars.

2. FY 1977 Program: Dispersion testing of the soft recoil and constant recoil medium caliber automatic antiarmor cannon will be initiated. Terminal ballistic performance testing of the high velocity medium caliber kinetic energy projectiles will be completed and propellant additive development will continue to identify materials and techniques to reduce and control barrel wear and erosion. Compressible fluid investigations will be initiated to determine utility for artillery systems. Compressible fluid recoil and equilibrator components may replace costly and complex conventional artillery hydraulic systems. The fire-and-forget artillery anti-armor projectile concept CHAMP (Conard Homing Artillery Modular Projectile), incorporating a sensor and control package that can be readily screwed into a conventional fuze well, will be evaluated at the component level. The other fire-and-forget artillery antiarmor concept, SADARM (Search And Destroy Armor), will undergo sensor sensitivity testing before continuing warhead and platform development. A novel and highly promising direct fire antiarmor projectile called STAFF (Smart Target Activated Fire-and-Forget System) will be vigorously pursued to demonstrate proof of principle that Extended range artillery projectile concepts will be demonstrated for

3. FY 1978 Planned Program: Feasibility demonstrations of SADARM and STAFF will be conducted. The higher risk CHAMP concept will continue development with a feasibility demonstration in FY 1979. The medium caliber antiarmor automatic cannon will undergo

comprehensive testing to demonstrate its credibility as a fully effective antiarmor weapon concept. Analysis and comparison with the Defense Advanced Research Projects Agency antiarmor automatic cannon should provide a solid technology foundation upon which to base a follow-on advanced development program.

A new propellant which is immune to enemy fire will be extensively tested at full scale to determine its ability and its interior ballistic behavior. Propellants which are immune to enemy fire significantly reduce the vulnerability of combat vehicles and aircraft. Nuclear technology efforts will concentrate on contained componentry to adapt nuclear munitions to The 6.0 million dollar increase over FY 1977 is the result of restructuring in which 2.5 million dollars of effort was transferred from Small Caliber and Fire Control Technology, 6.26.17.A; 1.6 million dollars from the Nuclear Technology program, 6.26.15.A; and the remainder from Ballistics Technology, 6.26.18.A.

4. FY 1979 Planned Program: A full scale CHAMP (Conard Homing Artillery Modular Projectile) demonstration will be conducted to assess utility. Automated artillery concepts, investigated in FY 1977 and FY 1978, will be extensively explored in FY 1979. Propellant development which has historically focused alternately on propulsion effectiveness and barrel wear and erosion problems will be integrated with charge design in a major effort to increase gun performance and gun life. Extended range projectile concepts will be reworked to incorporate warhead defeat mechanisms applicable to targets found in zone II (10-35 kilometers behind the forward edge of the battle area).

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.26.06.A **Title** Advanced Concept Laboratory

Category Exploratory Development **Budget Activity** #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	0	1,000	1,500	3,348	Continuing	Not Applicable
A342	Advanced Concept Laboratory	0	0	1,000	1,500	3,348	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This element will fund a contractor operated laboratory, under the management and direction of Government personnel at the Tank-Automotive Research and Development Command, which will review and challenge existing and planned Tank-Automotive research and development programs and perform basic experimental efforts in the area of tracks, power plants, armor design and suspension systems.

BASIS FOR FY 1978 RDTE REQUEST: Continuation of the review, analysis, and evaluation of the Tank and Automotive research program with emphasis on prompt initiation of quick start innovative efforts that will significantly improve the technology base and materiel acquisition programs.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The increase is required to implement those recommendations made in the comprehensive plan, and in some cases perform the research and development work under supplemental agreements to the contract.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	10	0	10
(2) Contractor Employees	15	0	15
Total	25	0	25

Budget Activity #1 - Technology Base

Program Element # 6.26.06.A Title Advanced Concept Laboratory

DETAILED BACKGROUND AND DESCRIPTION: The program to establish, within the Tank and Automotive Research and Development Command, an Advanced Concept Laboratory (ACL) to plan, recommend and in some cases perform new and innovative efforts with the overall objective of significantly and rapidly improving the Tank and Automotive Technology base program. The ACL will be staffed by a mixture of contractor and in-house scientists and engineers working under the direction of a senior in-house leader.

RELATED ACTIVITIES: This program is related to all of the Army's development and product improvement programs connected with tanks, and tactical and special purpose vehicles. This effort was initiated in PE 6.26.01.A, Tank and Automotive Technology, and PE 6.36.21.A, Vehicle Engine Development in FY 1976 for $2000K. Other programs related to this program are PE 6.26.18.A, Ballistics Technology; PE 6.21.05.A, Materials; PE 6.26.03.A, Fire Power Other Than Missiles; PE 6.11.02.A, Project F22, Research in Vehicle Mobility; and PE 6.26.01.A, Tank and Automotive Technology. ACL efforts are closely reviewed by in-house management personnel to insure that there is no duplication of efforts with other government agencies.

WORK PERFORMED BY: The US Army Tank-Automotive Research and Development Command (TARADCOM), Warren, Michigan; Battelle Memorial Institute, Columbus, Ohio; and other sub-contractors as approved by the Commander, TARADCOM.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: A Comprehensive Plan has been developed which recommends what existing or planned tank and automotive research and development efforts should be retained by the government, and what existing or planned government efforts should be redirected and how and where. Additionally, the contractor has identified and begun to perform those efforts in which they have demonstrated expertise.

2. FY 1977 Program: The primary effort for the second year work will be devoted to accomplishing the recommendations of the plan which include developing combat vehicles concepts, and evaluating components for vehicle systems optimization. A portion of the planned program will consist of efforts required to conduct reviews and an annual update of the Comprehensive Plan.

3. FY 1978 Planned Program: Recommendations for additional technical efforts will be made, and exploratory development conducted for selected concepts. Continuation of technical efforts, periodic reviews and an annual update of the Comprehensive Plan will be executed. The increase in funding is due to the development of actual hardware to determine feasibility of ideas.

4. FY 1979 Planned Program: Continue FY 1978 efforts with additional periodic review and an annual update of the Comprehensive Plan. Additional efforts will include initiation of fabrication of the most promising hardware concepts, which results in the additional funding required.

5. Program to Completion: The duration of the contractor's effort up to and beyond FY 1979 is dependent on how well the contractor performs, and his capability to be responsive to the Army's needs for new Tank and Automotive technology.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.26.17.A Title Small Caliber and Fire Control Technology

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	14364	4082	13574	11032	9945	Continuing	Not Applicable
AH19	Small Caliber and Fire Control Technology	14364	4082	13574	11032	9945	Continuing	Not Applicable
AH19-01	Combat Vehicle Armament	2900	900	2800	2875	2000	Continuing	Not Applicable
AH19-02	Aircraft Armament	600	200	500	260	260	Continuing	Not Applicable
AH19-03	Light Weapons	1500	400	1400	900	900	Continuing	Not Applicable
AH19-04	Short Range Air Defense	2500	700	2400	2370	2158	Continuing	Not Applicable
AH19-05	Fire Control Technology	2400	700	2300	1992	1992	Continuing	Not Applicable
AH19-06	Weapons Technology	2000	500	1900	1275	1275	Continuing	Not Applicable
AH19-07	Munitions Technology	2464	682	2274	1360	1360	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The objective of this program is to develop and maintain a small caliber and fire control technology base assuring a solid foundation upon which advanced and engineering development of weapon systems can be initiated and sustained.

BASIS FOR FY 1978 RDTE REQUEST: These funds will support the development and maintenance of a small caliber weapon systems technology base encompassing the technical areas identified above with emphasis on air defense gun and ammunition concepts, vehicle fire-on-the-move technology, and weapons fire control.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The 2.5 million dollar decrease reflects a progressive change in scope and emphasis and it also reflects the results of a restructuring effort in which some of the previously assigned tasks have been transferred to the Large Caliber and Nuclear Technology program.

Budget Activity #1 - Technology Base

Project Element #6.26.17.A Title Small Caliber and Fire Control Technology

PERSONNEL IMPACT

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ Employees	144	0	144
(2) Contractor Employees	75	0	75
TOTAL	219	0	219

DETAILED BACKGROUND AND DESCRIPTION: The Small Caliber and Fire Control Technology project performs exploratory development and necessary supporting research in weapons and munitions technology. The product of this effort is used to conceptualize revolutionary weapon and munition systems as well as define ways of product improving the current systems to extend their useful life. The program scope covers the system oriented technical areas of combat vehicles, aircraft armament, infantry weapons, air defense, and the support areas embracing fire control, weapons and munitions technologies. The investigations develop both prototypes and analytic tools to assess system performance and identify problem areas. The resulting data base forms the foundation for all subsequent small caliber weapon and munition advanced and engineering developments.

RELATED ACTIVITIES: The single project program elements 6.26.03.A, Armament Technology and 6.26.17.A, Munitions Technology, were combined and restructured into single project program elements 6.26.03.A, Large Caliber and Nuclear Technology, and 6.26.17.A, Small Caliber and Fire Control Technology. Moreover, efforts conducted in this program element are related to development activities in Ballistics Technology, 6.26.18.A, and numerous other exploratory advanced, and engineering development projects. In addition, these efforts are related to similar efforts conducted by the Air Force and Navy. Coordination is accomplished by visits of technical personnel, interagency meetings, and tri-service reviews and workshops to encourage cross fertilization and preclude unnecessary duplication.

WORK PERFORMED BY: Approximately 60% of the work will be conducted in-house at US Army Armament Research and Development Command facilities located at Dover, NJ, Aberdeen, MD, and Edgewood, MD. Contract support is provided by Aircraft Armaments, Inc., Cockeysville, MD; Batelle Memorial Institute, Columbus, OH; and numerous other small contractors.

Budget Activity #1 - Technology Base

Project Element #6.26.17.A Title Small Caliber and Fire Control Technology

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976 and Prior Accomplishments: Low Dispersion Automatic Cannon test beds have successfully demonstrated the concept that high impulse automatic guns can be controlled to assure pinpoint burst accuracy. Salvo rifle prototypes demonstrated the relationship between impulse and burst rate permitting more advanced rifles and machineguns to be developed without a trial and error approach. Closed loop fire control techniques were investigated and found to offer substantial gains in gun performance. Several promising methods of reducing the size and cost of small caliber ammunition were identified and demonstrated. Moreover, both the folded and telescoped concepts reduce ammunition storage volume and gun intrusion length.

2. FY 1977 Program: The Low Dispersion Automatic Cannon concept using a constant rate recoil mechanism will be tested with a closed loop fire control device to assess potential. Component development will continue into FY 1978 with testing conducted against stationary and moving targets. Millimeter and laser radars are being investigated in an effort to identify fire control techniques which offer a quantum performance jump over current techniques. Tubular projectiles will be investigated in FY 1977 and FY 1978 to determine if their low drag characteristic is of practical value. Telescoped and folded ammunition concepts, previously demonstrated, will continue in development to correct identified deficiencies. A 30 millimeter semi-automatic grenade launcher and associated ammunition will be demonstrated for infantry representatives to establish utility before continuing exploratory and possible advanced development.

3. FY 1978 Planned Program: The low dispersion automatic cannon project will be completed. The concept will be demonstrated for user representatives before committing the concept to advanced development in FY 1979 or FY 1980. Both millimeter and laser radar fire control utilization investigations will be pursued intensively in FY 1978 and FY 1979 to demonstrate possible performance enhancements of direct fire gun systems in particular and indirect fire systems in general. In addition, a number of automated methods will be explored which show promise of improving accuracy and responsiveness of artillery systems. Tubular projectiles will continue to be evaluated for use in low impulse direct fire guns and high impulse air defense guns. In ground to ground applications, tubular projectiles promise to significantly reduce trajectory drop, thereby reducing requirement for sophisticated range finders and ballistic computers. In ground to air applications, the low drag characteristic reduces projectile time of flight and substantially improves hit probability. Telescoped and folded ammunition designs will be evaluated and considered for incorporation in a new and advanced development gun program. Several new propulsion techniques to include consolidated charge and traveling charge will be considered for possible system integration at the exploratory level in FY 1978 and FY 1979. The program decrease in FY 1978 is the result of restructuring in which 2.5 million dollars of work was transferred to Large Caliber and Nuclear Technology, 6.26.03.A.

4. FY 1979 Planned Program: Much of the FY 1979 program is expected to focus on development and use of the novel ammunition concepts previously identified. In addition, new and continuing efforts in fire control technology will be energized to assure

that ammunition concepts which are committed to advanced development are properly coupled to effective fire control concepts. Within small arms, the salvo concept of propelling several projectiles per trigger pull will be reexamined with a parallel integrated fire-control/day night sight investigation.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.26.18.A Title Ballistics Technology

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	15626	3380	17711	17600	18648	Continuing	Not Applicable
AH80-01	Propulsion Dynamics	1400	300	1695	1700	1800	Continuing	Not Applicable
AH80-02	Launch and Flight Dynamics	1350	450	1500	1500	1548	Continuing	Not Applicable
AH80-03	Warhead Mechanisms Effects	2400	500	2500	2500	2600	Continuing	Not Applicable
AH80-04	Kinetic Energy Projectile Penetration and Blast Effects	2569	250	2180	2850	2850	Continuing	Not Applicable
AH80-05	Vulnerability, Vulnerability Reduction and Lethality	2800	500	2920	2800	2800	Continuing	Not Applicable
AH80-06	Concepts Analysis and Ballistic Modeling	1700	200	1916	2000	2450	Continuing	Not Applicable
AH80-07	Experimental Prototyping and Proof of Concept	1087	500	2100	1600	1950	Continuing	Not Applicable
AH80-08	Special Projects	2320	680	2900	2650	2650	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This objective of this program is to develop and maintain a ballistics technology base assuring a solid foundation upon which advanced and engineering development of weapon systems can be initiated and sustained.

BASIS FOR FY 1978 REQUEST: These funds are required to support the continued development of a sound ballistics technology base and to exploit significant technological opportunities in armor design, shaped charge warheads, and gun propulsion.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Minor decrease relating to experimental prototyping and special projects.

Budget Activity #1 - Technology Base

Program Element #6.26.18.A Title Ballistics Technology

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ Employees	238	0	238
(2) Contractor Employees	242	0	242
Total	580	0	580

DETAILED BACKGROUND AND DESCRIPTION: The Ballistics Technology Program focuses on describing closed system combustion processes (interior ballistics), interactions between the launching mechanism and projectile (transitional ballistics), dynamics of projectile flight (exterior ballistics), and the coupling of the projectile and target (terminal ballistics). The ability to comprehensively describe ballistic phenomena is of critical importance to the successful prosecution of advanced and engineering development of weapon systems. State-of-the-art concepts can be identified, developed and evaluated without resorting to costly and time consuming trial-and-error methods. In addition, the Ballistics Technology Program develops vulnerability assessment techniques which are used by Army-wide developmental activities to identify system weaknesses and appropriate design changes prior to production. This formalized vulnerability assessment/vulnerability reduction effort has led to improved survivability of recently developed Army materiel. Equally important, it pinpoints and quantifies weaknesses in enemy equipment which are exploited by weapons designers.

RELATED ACTIVITIES: Ballistic technology efforts conducted in this program element are related to developmental activity in Large Caliber and Nuclear Technology, 6.26.03.A; Small Caliber and Fire Control Technology, 6.26.17.A; Tank and Automotive Technology, 6.26.01.A; and Fuze Technology, 6.26.16.A. In addition, Ballistics Technology efforts are related to similar efforts conducted by the Air Force and Navy. Coordination is accomplished by visits of technical personnel, interagency group meetings, and Tri-Service workshops to encourage cross-fertilization of ideas and preclude unnecessary duplication of efforts.

WORK PERFORMED BY: Approximately 65% of the work is conducted in-house at the US Army Armament Research and Development Command facilities located at Dover, NJ, Aberdeen, MD, and Edgewood, MD. Other Army participating facilities are the US Army Missile Research and Development Command, Huntsville, AL, and the US Army Test and Evaluation Command, Aberdeen MD. Contract support is provided by Falcon Research and Development, Denver, CO; New Mexico Institute of Mines and Technology, Socorro, NM; Systems, Science, and Software Corporation, La Jolla, CA; Lawrence Livermore Laboratories, Energy Research and Development Administration,

Budget Activity #1 - Technology Base

Program Element #6.26.18.A Title Ballistics Technology

San Francisco, CA; Southwest Engineering Institute, San Antonio, TX; Aircraft Armaments, Inc., Cockeysville, MD: Drexel Institute, Philadelphia, PA; Oakridge National Laboratory, Oakridge, TN; and others.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Although several interesting accomplishments were made in interior and exterior ballistics technology, two achievements stand alone. First, the development of

Second, and of nearly equal importance,

2. FY 1977 Program: The joint Service investigation program, HAVE NAME, will be completed in mid-FY 1977 and reviewed by Office, Secretary of Defense, for decision to continue. The Low Vulnerability Ammunition (LOVA) effort will explore methods of achieving previously demonstrated LOVA performance using less costly explosive components. High and hyper velocity gun and ammunition concepts will be initiated to explore air defense and lightweight antiarmor applicability.

3. FY 1978 Planned Program: The LOVA concept previously demonstrated will be fully evaluated using less costly and readily available explosive components before commitment to a 6.3 development program for combat vehicle applications. High and hyper velocity gun and ammunition exploratory concepts will be continued. The critical and pacing problem area of propulsion will be intensively investigated. A propulsion breakthrough could revolutionize antiarmor and air defense gun systems by reducing projectile time of flight substantially, increasing probability of hit, and improving terminal effectiveness of kinetic energy projectiles. Particular attention will be devoted to development of the traveling charge concepts with parallel efforts in developing propellants which exhibit good barrel wear and errosion characteristics.

4. FY 1979 Planned Program: High and hyper velocity gun concepts will be prototyped and tested at the component level. The more promising concepts will be prototyped and evaluated as a system in late FY 1979 or 1980.

Budget Activity #1 - Technology Base

Program Element #6.26.18.A Title Ballistics Technology

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.26.22.A

Title Chemical Munitions and Chemical Combat Support

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	4269	970	4121	3832	3544	Continuing	Not Applicable
A554	Chemical Munition and Chemical Combat Support	4269	970	4121	3832	3544	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: To conduct exploratory development of smoke, flame and incendiary, binary, lethal, incapacitating, civil disturbance and tactical irritant weapon systems.

BASIS FOR FY 1978 RDTE REQUEST: To continue search for means to exploit a binary intermediate volatility and thickened lethal agents and assess protective clothing burden on personnel; to continue the search for safe, quick acting, physically incapacitating agents and exploit a selected agent in an effective weapon system; to evolve new and improved principles and concepts for multi-spectral smoke/aerosol screening, dissemination devices and delivery means; complete feasibility studies of a larger caliber flame projectile and continue search for optimized flame agents; to continue search for more effective, quicker acting riot control agents and complete concepts studies of munitions for internal security and convoy protection missions.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The decrease in funds represent a reprogramming to satisfy higher priority efforts.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	41	0	41
(2) Contractor Employees	22	0	22
Total	63	0	63

Budget Activity #1 - Technology Base

Program Element #6.26.22.A Title Chemical Munitions and Chemical Combat Support

DETAILED BACKGROUND AND DESCRIPTION: This program element supports the entire Department of Defense (DOD) chemical technology base on which development of deterrent/recaliatory and combat support chemical weapons depends. It addresses in-depth exploratory investigations in the following areas: (1) Lethal Chemical Agents/Weapons: Encompasses applied research activities associated with physical and analytical chemistry of potential lethal chemical systems; exploratory development of binary lethal chemical agents of various degrees of volatility to be used with a variety of munitions types with a resultant capability for air or ground delivery using standard and advanced weapons systems; applied research leading to an understanding of phenomena which enhance the threat and effectiveness of these agents; (2) Incapacitating Chemical Agents/Weapons: Includes searches for new, more potent, shorter onset time, shorter effects duration, percutaneously active, and very safe to handle incapacitants; effective means for exploitation of these agents; the physical and chemical characteristics of these agents; (3) Chemical Combat Support Systems: Includes accelerated search for improved multi-spectral smoke/aerosol screening materials and delivery systems to cover the visual through microwave regions of the electromagnetic spectrum; and provides for large area screening capability with minimum logistics burden. Also included are the discovery and evaluation of chemical compounds for riot control agents flame and incendiary materials, development of concepts for their use and the establishment of feasibility of munitions responsive to the concepts. This effort originally consisted of 6.26.19.A, Chemical Combat Support and 6.26.20.A, Chemical Munitions Technology.

RELATED ACTIVITIES: Investigations under this project provide the essential exploratory effort in lethal, incapacitating, and riot control agents and munitions and the total technology base for the entire Department of Defense; no comparable work is done by the other Services, and coordination is maintained with them to assure provision of the technology essential to their development needs. Close coordination is maintained between the investigative groups to preclude duplicative effort through joint working and coordinating groups. Coordination and cooperation is maintained with the United Kingdom (UK), Canada, and Australia.

WORK PERFORMED BY: US Army Armament Research and Development Command (ARRADCOM), Edgewood, MD; University of Oklahoma, Norman, OK; Ivy Research Laboratory, Philadelphia, PA; Georgia Institute of Technology, Atlanta, GA; General Electric Corporation, Pittsfield, MA; Dugway Proving Ground, Dugway, UT; and White Sands Missile Range, White Sands, NM.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Over the past 20 years, virtually no systematic exploratory effort was expended in screening smoke materials. In contrast to this inactivity, a variety of flame and incendiary, lethal chemical, and riot control agent (RCA) munitions systems have been developed and fielded. Two incapacitating agent munitions were developed and fielded. In the late 1960's, the binary concept, to enhance safety and security in the field, has been applied successfully to development of artillery chemical projectiles. Searches for an intermediate volatility agent using the binary concept are now being conducted. In the incapacitating agents and weapons area, a compound (EA3834) which is quick acting at low concentrations has been found.

Based on assessment of the expected threat, a high urgency was placed on development of new multi-spectral large area smoke/aerosol screening agents. In 1976 and 197T, a five-year program for this purpose was prepared and initiated. Test facilities were

modified to enable measurement of screening characteristics of standard and new screening agents. All US standard smokes were characterized and tests of promising new materials for infrared screening were begun. New techniques for area screening and rapid dissemination started. Several unique foreign smoke formulations have been evaluated. Feasibility studies of establishing a computerized smoke technical data bank were completed. Work was started to measure the refractive index of known smoke ingredients.

2. FY 1977 Program: Complete screening of candidate multi-spectral agents. Develop methodology for evaluating candidate agents against threat sensor systems. Evaluate foreign smoke technology and conduct chamber characterization of known foreign formulations. Investigate the toxicity of candidate screening smokes. Investigate new concepts for large area screening. Conduct study of new concepts for improved armored vehicle protection. Review approach to microwave screening, other than Chaff, to establish theoretical potential of proposed methods within logistical constraints. Provide remaining exploratory support for the 8" binary VX round. Complete exploratory design on proposed binary intermediate volatility agent (IVA) projectile. Continue search for other binary lethal agents with greater effectiveness through clothing. Provide exploratory support needed to exploit the agent of choice for an improved incapacitating agent/weapons system. The search for new volatile sensory irritants continue. Continue exploitation of new volatile riot control agent (EA4923). Complete acquisition of test data for cost and operational effectiveness analysis of a Large Caliber Flame Round.

3. FY 1978 Planned Program: Establish feasibility of prototypes for improved Armored Vehicle Protective System. Validate concept for new large area screening system. Search for new microwave screening formulations. Apply theoretical base in laboratory studies leading to optimized multi-spectral screening systems. Exploit means of binary intermediate volatility agent of choice, to include data on reaction kinetics, preliminary reactant compatibility and stability, and detailed effects of engineering parameters on binary synthesis. Refine and apply analytical methodology for assessing protective clothing burden. Continue search for safe, quick-acting, percutaneously active, physically incapacitating agents. Complete exploratory support for exploitation of EA 3834 as agent of choice for improved incapacitating agent/weapons system. Investigation of riot control agents with greater effectiveness and increased duration of effects will continue. Complete toxicity studies on CS1, CS2, and EA4923. Evaluations of improved, new and modified flame and incendiary agents and materials will continue. Decrease in funds is due to reprogramming to higher priority efforts.

4. FY 1979 Planned Program: Conduct feasibility studies for obscuration and screening by Artillery, Mortars, and Rocket Systems. Explore foreign smoke technology. Conduct agent toxicology studies. Provide laboratory data necessary for field evaluation of screening smoke effectiveness. Complete technology studies of thickened agent and publish recommendations as to exploitation. Complete evaluations of intermediate volatility agent projectiles and air-to-ground rockets. Develop reactive simulants for selected IVA and new clothing penetration agents to permit both simulant evaluation of inflight reaction and hot agent dissemination. Conduct studies with incapacitating agents to establish their feasibility in munitions. Conduct research on current and proposed riot control agents to include methods of synthesis, identification, decontamination and demilitarization. Complete the

Budget Activity #1 - Technology Base

Program Element #6.26.22.A Title Chemical Munitions and Chemical Combat Support

investigation of concepts for munition prototypes for internal security and convoy protection. Search for new and improved flame agents will continue. Investigate methods and techniques of dissemination and dispersion of new agent formulations. Decrease in funds is due to reprogramming to support higher priority efforts.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.01.A

Title Communications-Electronics

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	2670	950	4028	4982	4502	Continuing	Not Applicable
AH92B1	Automatic Data Processing	1243	371	1270	1402	1285	Continuing	Not Applicable
AH92C1	Electromagnetic Compatibility Technology	340	85	355	383	300	Continuing	Not Applicable
AH92F1	Signal Processing Technology	418	154	188	400	352	Continuing	Not Applicable
AH92M1	Multichannel Communication Technology	556	289	2215	2697	2465	Continuing	Not Applicable
AH92S1	Systems Technology	16	7	0	0	0	Continuing	Not Applicable
AH92T1	Terminal Devices Technology	97	44	0	100	100	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program element supports exploratory development efforts associated with the communications-electronics portion of the technology base. Future generations of tactical communications systems will be required to provide a better grade of service than those of today and will operate in a more active and sophisticated electronic warfare environment. The burgeoning use of computer controlled weapon and combat support systems imposes severe performance demands on new communication systems. This program element is aimed at development of new techniques to significantly improve tactical communication system performance, while offsetting the adverse effects of enemy countermeasures.

BASIS FOR FY 1978 RDTE REQUEST: Major contractual effort will evaluate recent technical advances in fiber optics for Army needs in the area of reduced cost, high capacity communication cable systems. Evaluation of ruggedized optical fiber cable systems for both local distribution within Command Posts and for high capacity 40 to 60 kilometer (km) communication systems will be accomplished. Specifically, these efforts are aimed at increasing optical fiber tensile strength, decreasing attenuation and connector losses and increasing optical source and detector lifetimes. Army systems having a need for fiber optics include the TRI-TAC AN/TCC-39 Automatic Switch, the 26-pair (copper) local distribution cable system and the 18.75 megabit per second long haul (40-60 km) communication system. In addition, tactical computer softness techniques will be evaluated to improve communication system performance by utilizing the tremendous capabilities of microprocessors.

Budget Activity #1 - Technology Base

Program Element #6.27.01.A Title Communications-Electronics

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The increase in funding level results from initiation of manufacturing methods and technology investigations for long lengths of ruggedized high tensile strength optical fibers and from fabrication of exploratory development models of local distribution and long haul systems. Work will also be initiated on air layable cable techniques. In addition, the FY 1978 program will stress investigation of advanced capabilities through use of interactive devices for display systems.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (Research, Development, Test and Evaluation), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	40	0	40
(2) Contractor Employees	54	0	54
Total	94	0	94

DETAILED BACKGROUND AND DESCRIPTION: Technical areas: Automatic Data Processing Technology—develop and apply improved technologies/methods to support future tactical computer systems; Electromagnetic Compatibility—develop technologies applicable to electromagnetic compatibility and interference so as to avoid problems by proper design, rather than after the fact remedial measures (Includes design standards and measurement/instrument techniques); Signal Processing Technology—state-of-the-art improvement in processing and transmission of data and voice to achieve increased channel capacity, reduced digital error rate, greater reliability, and reduced vulnerability of enemy intercept; Multichannel Communication Technology—development of new multichannel transmission techniques including optical, millimeter and microwave methods so as to reduce system size, weight, set-up time and jamming vulnerability with increased reliability, communication range and information transmission capacity; Systems Technology—develop mathematical, statistical and other methodology to opetimize communication system performance on a system-wide basis; Terminal Devices Technology—apply new techniques for the conversion of written, typed, and other graphic information into electrical form for transmission over communication systems; to improve the match and productivity of operational personnel to computer driven communication systems.

RELATED ACTIVITIES: This program provides the exploratory development effort needed to support the following programs; Program Element 6.37.07.A (Communications Development); Program Element 6.37.22.A (Tactical Operations System); Project 6.37.23.A D101 (Integration of Army Tactical Data Systems); Program Element 2.80.10.A (Joint Tactical Communications Program (TRI-TAC)); Program Element 6.37.03.A (Automatic Data Processing Equipment Developments); Program Element 6.32.07.A, Aviation Electronics (AVIONICS). Other related exploratory development and studies performed by the Air Force and Navy which are evaluated in formulation program content are 62721N (Navy Command and Control Technology) and 62702F (Air Force Communications Command and Control). Coordination

is accomplished by reviews conducted by Department of Defense, through preparation and update of the Technology Coordinating Papers, and the exchange of technical reports and attendance at scientific meetings and conferences.

WORK PERFORMED BY: Softech Inc, Waltham, Massachusetts; Harris Corp, Melbourne, Florida; Charles Stark Draper Laboratory Inc, Cambridge, Massachusetts; Insco System Corp, Neptune, New Jersey; Stanford Research Institute; Menlo Park, California; System Develop Corp, Santa Monica, California; AEL Service Corp, Colmar, Pennsylvania; Signatron, Boston, Massachusetts; The Singer Co, Glendale, California; Sperry Research Corp, Sudbury, Middlesex, Massachusetts. Contract monitoring and in-house development is by US Army Electronic Command, Ft Monmouth, New Jersey.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Developed a very low power frequency synthesizer for application to manportable/hand-held battery operated tactical radios; new optical communication techniques for application to weapons control and combat support systems requiring lightweight, immunity to the electromagnetic effects of nuclear bursts and high capacity; completed simulation models for tropospheric scatter and other radio channels in order to conduct repeatable laboratory analyses of these radio paths without the expense of repeated actual measurements; identified the potential of a low probability of intercept radio; completed the design of a new tactical computer language which promises to greatly simplify programming mechanics and has been standardized for use throughout the Army; developed the framework for a softwear engineering experiment to aid in the standardization of Army tactical computer program structures; evaluated range and intercept improvements achievable by radio frequency energy spreading for application to future satellite, multichannel and combat net radio systems; analyzed an architecture for a new family of tactical computers to reduce proliferation and duplication while increasing performance and enhancing standardization; completed feasibility studies for a long haul, high capacity optical fiber communication system.

2. FY 1977 Program: Apply microprocessor technology to communication terminals and continue development of memory devices to make tactical communication systems adaptive to a changing radio transmission environment; continue evaluation of new electromagnetic compatibility criteria and techniques for susceptibility testing; evaluate new signal encoding/decoding schemes to make transmittal information less sensitive to the effects of radio channel degradation; initiate evaluation of time-spreading techniques for transmission of radio signals in order to decrease susceptibility to enemy intercept; evaluate techniques for the detection of undesired taps on fiber optic cables and protection of information carried by these systems; initiate evaluation of techniques for rapid payout of high strength optical fibers for application to remotely-piloted-vehicles and wire-guided missiles; continue evaluation of small millimeter-wave radio systems operating at 60-70 gigaherz for application to short range (approximately 3 kilometers), high capacity tactical communication system requirements where signal-hiding and low-probability of intercept is critical.

3. FY 1978 Planned Program: Complete evaluation of tactical computer memory techniques; initiate investigation of interactive display techniques for application to command and control information systems and tactical communication systems; continue development of new electromagnetic compatibility criteria and susceptibility testing; evaluate the improvement realized from application of radio signal time-spreading techniques to multiple-user communication schemes; initiate development of a laboratory capability

to simulate spread spectrum radio channels to aid in the evaluation of this technique under varying radio transmission conditions; continue evaluation of techniques for rapid payout of very high tensile strength optical fiber cables; evaluate exploratory development models of long haul and local distribution fiber optic components; a secure fiber optic system and hybrid millimeter wave radio components; explore techniques for handprint inputs to communication systems; multiple message copy generation and reduced bit rate facsimile. The increase in FY 1978 over FY 1977 is due to initiation of interactive display technology investigation and the fabrication of exploratory development models of local distribution, long haul and air layable optical fiber components.

4. FY 1979 Planned Program: Formalize a software engineering discipline; develop effective higher order language programming tools and determine feasibility of generalized data-base management. Develop microprocessor architecture for distributed systems and develop miniature information display techniques. Continue work on electromagnetic compatibility (EMC) standards, measurement techniques and instrumentation. Continue work on exploratory development models of local distribution and long haul fiber optic systems, secure fiber optic cables and both air layable and high strength rapid payout fiber optic systems. Continue exploratory development of millimeter wave radio, multiple copy messages and reduced bit rate facsimile. The decrease in FY 1979 from FY 1978 is due to reductions in work on advanced modulator/demodulator techniques.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.27.03.A Title Combat Surveillance, Target Acquisition and Identification

Category Exploratory Development Budget Activity # 1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	6619	1000	4356	4277	5276	Continuing	Not Applicable
DH93-01	Weapon Location	2910	435	1300	1000	1050	Continuing	Not Applicable
DH93-02	Personnel & Vehicle Detection	805	120	500	400	806	Continuing	Not Applicable
DH93-03	Ranging, Designation & Tracking	1545	238	1380	1000	1200	Continuing	Not Applicable
DH93-04	General Laser Technology	405	129	500	1110	1200	Continuing	Not Applicable
DH93-05	Radiac	100	38	100	100	120	Continuing	Not Applicable
DH93-06	Identification Friend/Foe	0	0	76	125	200	Continuing	Not Applicable
DH93-07	Data Transmission	720	40	500	542	500	Continuing	Not Applicable
DH93-08	Photographic Techniques	134	0	0	0	200	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Exploratory development is performed in the following areas of technology; weapons location; personnel and vehicle detection; general laser and radar technology; ranging, designating, and tracking; data transmission; photography; measurement of nuclear radiation and bursts; and identification friend or foe (IFF). This program provides the technology base for advanced systems as well as new concepts for the solution of presently unsolved surveillance, target acquisition, and identification requirements and identifies the most promising alternatives to fill existing operational gaps in the Army's battlefield integrated surveillance, target acquisition and identification capability.

BASIS FOR FY 1978 RDTE REQUEST: Work will be performed on completion and extension of passive weapons location using the flash-detection principle; development of effluent-detection universal-laser radars; finalization of 1st generation laser modules for ranging, designating and tracking; exploration of 2d generation, universal-laser modules for total battlefield integration; and evaluation of advanced concepts for noncooperative identification friend or foe. Work will continue on fixed target detection with radar; with emphasis on signal and data processing techniques. A program will be initiated for development of an airborne radar capable of detecting targets through heavy foliage. Work will continue on vulnerability reduction and survivability of radar systems in a sophisticated battle environment; developing charge-coupled-device (CCD) signal processing techiques to improve performance, reduce cost and power consumption of future radar systems; developing a technology base to support the Army in its efforts to develop a battlefield surveillance and target acquisition radar to meet the needs of the artillery and military intelligence communities; and developing a cooperative battlefield IFF system that will enhance the survivability of friendly forces on the battlefield and increase the probability of destruction of enemy forces. Finish testing of the gamma dosimeter module for the Miniature, Multipurpose Radiac Device.

Budget Activity # 1 - Technology Base

Program Element # 6.27.03.A Title Combat Surveillance, Target Acquisition and Identification

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Decrease in effort on Personnel and Vehicles Detection; Ranging, Designation and Tracking; and Weapon Location.

PERSONNEL IMPACT: The average number of employees supported with requested FY 1978 funds (RDTE and Procurement) is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ Employees	62	0	62
(2) Contractor Employees	60	0	60
TOTAL	112		112

DETAILED BACKGROUND AND DESCRIPTION: This project funds the exploratory development performed by the Combat Surveillance and Target Acquisition (CSTA) Laboratory. Major areas of emphasis are the development of multifunctional laser systems and laser wavelength diversification leading to universal, common laser modules; weapons location techniques with emphasis on a fixed target radar and an airborne flash detection system; improved surveillance radars, particularly a system to operate at ranges of 5-10 kilometers; development of a family of radiological detection and measuring equipments; development of small-format tactical photo equipments and of photo processing and exploiting equipments; and air-to-ground data transmission systems. This project also addresses improvements to current systems; for example, an investigation of techniques for hardening radar antennas, and the use of low cost, expendable cartridges in laser rangefinders.

RELATED ACTIVITIES: Related development is performed by the Navy and Air Force. Work is coordinated during reviews conducted by the Office of the Director of Defense Research and Engineering through technical reports, inter-laboratory visits and communications, attendance at specialized scientific meetings and conferences, inter-Service liaison, the annual and the biennial Department of Defense Laser Conference, the Annual Tri-Service Radar Symposium. Additionally, the Army and the Defense Advanced Research Projects Agency (DARPA) are participating in a joint five year program to find new or improved solutions to the hostile weapons location problem.

WORK PERFORMED BY: In-house work is performed by the US Army Electronics Research and Development Command (ERADCOM), Fort Monmouth, NJ. Contractors include Honeywell Incorporated, Minneapolis, MN; Texas Instruments, Dallas, TX; Northrup Research and Technology Center, Hawthorn, CA; University of Southern California, Los Angeles, CA; United Aircraft, Norwalk, CT; Rockwell International, Anaheim, CA; Georgia Institute of Technology, Atlanta, GA; General Atronics, Philadelphia, PA; Raytheon, Boston, MA; Hughes Aircraft, Culver City, CA; MSH Industries, Los Angeles, CA.

Budget Activity # 1 - Technology Base

Program Element # 6.27.03.A Title Combat Surveillance, Target Acquisition and Identification

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T and FY 1976 and Prior Accomplishments: Prior development of 5 lb Handheld Laser Rangefinder technology led to an engineering development (ED) expected to enter production in FY 1977. Work on designators and tracker technology led to an ED program which provides a basis for production in FY 1978. Work towards miniaturized low cost/short range rangefinder components was largely completed. Conducted investigations that led to the development and fielding of the Radar Set AN/PPS-15. Developed and tested an experimental multi-purpose, lightweight mortar location radar. Developed radar discontinuity modulation effect (DIMODE) techniques for detecting military targets that are moving or essentially stationary. Developed an environmental radar simulator for evaluating radar designs and reducing the need for extensive field testing. Developed portions of the technology needed to demonstrate the concept of an air-to-ground advanced data link. Developed digital display ratemeter and fallout dose circuits for miniature radiac meter. During FY 1976 and FY 197T, demonstrated advanced laser transmitter cartridges fulfilling low cost production requirements. Feasibility of two 3.8 and 10 micron laser systems was established. Progress was made in injection laser and materials for laser detectors. Initiated development of an airborne millimeter radar for remotely piloted vehicles. Finalized plans for a passive artillery location system (PALS) addressing an airborne and ground based version. Made progress towards integration of flash detection with a low cost electro-optical platform which provides required line-of-sight. In the laser components area, state-of-the-art was extended leading to higher efficiency/lower cost systems. Programs addressing wavelength diversity and multifunctionality have been successful and will be realized in forthcoming contractual efforts. A flight test program was carried out with the Air Force to obtain radar signatures of various targets in the clear and in various types of ground clutter. Progress was made in testing and evaluation of a lightweight, experimental foliage penetration radar; development of charge-coupled-device (CCD) radar signal processing technology; development of environmental radar operations simulator which will provide means of evaluating radar designs prior to development and reduce costly field testing; development of key millimeter wave components for use in future radar equipments to enhance the lethality and survivability of armored vehicles. Fabricated and tested prototype models of the radiac digital display ratemeter and fallout dose modules. Continued work aimed at technology for data link.

2. FY 1977 Program: Additional quantitative data on ground based foliage penetration (FOPEN) system will be acquired and investigation of airborne FOPEN system will be initiated. Charge-coupled-device signal processing will be integrated with radar systems and its effectiveness evaluated. Complete development; initiate in-house testing of prompt-neutron and gamma-dose modules for the Miniature Multipurpose Radiac Device. Continue acquiring technology for secure air-to-ground data link.

3. FY 1978 Planned Program: Complete position and attitude monitor development to interface with mini-balloon/German KIEBITZ platform. Explore laser radar/radar hybrids to take advantage of the excellent scanning properties of radars and the precision target location and weapons delivery capability of lasers. Definitions of 1st generation universal laser modules will be completed and development of 2d generation modules (providing wavelength diversity and multifunctional performance) will continue. Laser/radar technology integration will be addressed (imaging/processing), source development opening the submillimeter frequency regime will be developed, and concomitant hardware produced. Contracts will be placed for the further development of: (a) laser detectors/receivers; (b) 10 micron rangefinder/designators and beacons; (c) the laser module with laser cartridges; (d) laser

hybrid breadboard; and (e) submillimeter source development. The unstable resonator will be tested as candidate for common universal laser designator transmitter applications. The effort of variable pulse length on target signature characteristics will also be studied. Continue efforts to improve the Army's capability to detect, classify and destroy fixed targets on the battlefield through enhancement and processing radar returns; develop and perfect radar designation and homing techniques which will permit effective operation in fog, smoke, dust, night or periods of inclement weather; reduce the vulnerability of our radar weaponry through the use of electronic radar camouflage techniques; develop, test and evaluate the performance of an experimental, airborne foliage penetration radar that will detect and locate hostile targets; apply technology to existing and future radars; improve radar systems performance, reliability, reduce size, cost and power consumption. Develop a technology base in target detection, tracking and classification which will effectively support the Army in the development of cost effective radar systems that will enhance its target detection, location and destruction capability. Demonstrate the advanced data link concept. Complete definition of the Advanced Surveillance, Target Acquisition and Night Observation Data Link (ASDL). Initiate advanced development of the Miniature Multipurpose Radiac Device. Initiate exploratory development of self-contained "desk top" processing, viewing and printing equipment for small-format aerial photography obtained from an RPV. Decrease in funding over FY 1977 is on personnel and vehicle detection; ranging, designation and tracking; and weapon location.

4. FY 1979 Planned Program: Continuation of FY 1978 program. Funding increase from FY 1978 will accelerate efforts on weapon location; personnel and vehicle detection; ranging, designation and tracking.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.04.A

Title Military Environmental Criteria Development

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	0	3000	3040	4311	Continuing	Not Applicable
AF25-01	Analytical Systems Technology	0	0	1060	770	392	Continuing	Not Applicable
AF25-02	Standards Development	0	0	1065	1210	1860	Continuing	Not Applicable
AF25-03	Decontamination Technology	0	0	875	1060	2059	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: To review existing technology, or develop new technology through research, which will permit reduction or elimination of contamination on or migrating from selected military installations; conduct research on analytical methods for performing analysis of contaminated water, soil and structures; perform research to characterize contaminants and determine their toxicities to a variety of life forms; develop scientific data base for determining environmentally acceptable levels of contamination, and establishing standards by appropriate regulatory agencies; evaluate available containment/decontamination processes and conduct research into new processes; perform pilot plant feasibility studies of containment/decontamination processes, and determine cost effectiveness and engineering and process design criteria preliminary to the conduct of large scale operations at specific sites.

BASIS FOR FY 1978 RDTE REQUEST: Funds requested in FY 1978 are essential: To continue efforts to improve analytical methodology; to continue piloting the Rocky Mountain Arsenal (RMA) interim containment/treatment system which will reduce or eliminate contamination migration off the installation in demonstration of compliance with the State of Colorado Cease and Desist Orders; and to continue toxicity studies on DIMP (Diisopropylmethyl Phosphonate), DCPD (Dicyclopentadine), and the organic sulphur compounds identified as migrating in the ground water system.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Minimal increase due to cost growth.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	16	0	16
(2) Contractor Employees	23	0	23
Total	39	0	39
	141		

Budget Activity #1 - Technology Base

Program Element #6.27.04.A Title Military Environmental Criteria Development

DETAILED BACKGROUND AND DESCRIPTION: Increasing public and national interest in the environment, coupled with the progressive encroachment of civilian communities to the borders of previously isolated Army installations have created growing concern about the potential threat posed by the steady migration of ground contaminants to the borders of the installations. As the result of military, Congressional and public interest in such contamination at Rocky Mountain Arsenal (RMA), direction was provided by the Assistant Secretary of the Army (Installation and Logistics) (ASA(I&L)) to establish a comprehensive program of rectification. Responsibility for this program was assigned to the Project Manager for Chemical Demilitarization and Installation Restoration (PM /CDIR) and a charter approved by the Secretary of Army in August 1975. An overall plan of approach to the problem was developed by PM/CDIR, which includes three principal phases: Installation Assessment, Technical Base Development, and Operations. The RDTE funded part of this plan applies only to the Technical Base Development phase. Other phases of the plan will be accomplished with Operation and Maintenance, Army (OMA) and Military Construction, Army (MCA) appropriations. The Technical Base Development phase, in turn, includes three R&D technical areas of effort: Analytical Systems Technology, Standards Development (environmentally acceptable levels of tolerance for each contaminant), and Decontamination Technology. Initially, RDTE funding was provided for execution of this work in FY 1975, FY 1976 and FY 197T under Program Element 6.27.20.A. A detailed plan for addressing problems at RMA was established and work is progressing against this plan, with emphasis placed on containment and treatment of migrating contaminants.

RELATED ACTIVITIES: Program Element 6.27.04.A was initiated in FY 1977; funding in FY 1976 and 197T was provided from Program Element 6.27.20.A. The conduct of the Installation Restoration (IR) program involves extensive interface with a significant number of other Government agencies. These include, but may not be limited to, Departments of State, Health, Education and Welfare, Agriculture, Transportation, and Interior; US Nuclear Regulatory Commission; Environmental Protection Agency; National Academy of Sciences; Department of Defense (DOD) Explosive Safety Board; and state and local governments in addition to the military services and organizations. Under date of 23 July 1976, the ASA(I&L) and Deputy Director of Research and Engineering (DDR&E), designated the Department of Army as the lead service for the compilation and refinement of applicable technology, and the development of new or improved technology and criteria or standards for the DOD restoration program as it relates to all contamination, including chemical, biological and radiological. This assignment was delegated to the PM/CDIR. A concept plan has been developed for the coordination of required effort among the Army, Navy and Air Force.

WORK PERFORMED BY: In both FY 1977 and FY 1978, approximately 40 percent of the RDTE program dollars is assigned to the Army Surgeon General (TSG) for toxicological testing of chemical contaminants leading to the establishment of standards; approximately 25 percent of the dollars is assigned to US Army Armament Research and Development Command (ARRADCOM) Edgewood, Maryland, primarily to assist in developing advanced techniques for sampling, analyzing, handling and storage of contaminated samples. The balance of the RDTE program resources (35 percent) are primarily for development of decontamination process technology. Much of TSG's program is accomplished through small contracts, and several other contracts are expected to be awarded in FY 1978 by other performers. It is estimated that approximately 53 percent of the total program in FY 1978 will be in contracts, five percent will be assigned to Government agencies outside the Army, and 42 percent will be used for in-house effort.

Budget Activity #1 - Technology Base

Program Element #6.27.04.A Title Military Environmental Criteria Development

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: The early part of this period was characterized by establishing organization, policies, procedures and priority objectives. A detailed plan for Rocky Mountain Arsenal (RMA) decontamination was prepared in August 1975 and updated in April 1976. An Analytical Systems Committee, composed of chemists from other Army agencies was established to recommend analytical schemes, a Quality Control Plan (QCP) and analytical instrumentation needed. The effort by the Army Surgeon General to develop data needed to recommend standards included evaluation of sixteen top priority compounds and a study of six additional compounds. Typical of contaminants identified in the RMA ground-water were three sulphur compounds, all associated with production of Planavin (herbicide) which had been discontinued early in 1975. The Surgeon General's coring and analysis program involved the taking of 500 soil and 50 vegetative samples, and was completed in FY 1976. Chemistry and toxicity effort included mammalian, aquatic, wildlife and vegetative toxicity studies were required, and much of this work was and is performed by the Surgeon General contractors. Acute and subacute toxicity studies on Diisopropylmethyl Phosphonate (DIMP) and Dicyclopentadine (DCPD) were completed and chronic toxicity studies were continued. The Surgeon General recommended interim standards for DIMP and DCPD to the National Research Council in August 1976. Decision is pending by Federal regulatory agencies. Design criteria were established for an interim containment system for Rocky Mountain Arsenal, Colorado, consisting of walls, a Bentonite barrier, a carbon coagulation water treatment facility and a recharge pond. Laboratory and field studies indicate that such a system will reduce DIMP, DCPD and the sulphur compounds to trace quantities.

2. FY 1977 Program: A Problem Definition Study has been initiated for recently identified migrating compounds. In addition, to DIMP and DCPD, toxicity studies have been initiated on the three sulphur compounds found migrating in the RMA groundwater in order to develop a data base for environmental standards. Analytical methods are being developed for 15 water and 10 soil compounds, with related Quality Control standards. Elements of an interim containment/treatment system are being designed, installed and pilot-operated at RMA to determine process efficiency. Research will continue to identify new technology for water treatment. An example of a process which is being evaluated is an ultraviolet light/ozonization treatment system, which has the advantage of no contaminant by-products. Source treatment technology development has been initiated with the objective of removing water pollutants from their known or potential sources. Examples of processes being piloted include physiochemical treatment such as aeration, ion exchange, Ph adjustment, increased concentration in the leachate, vegetative uptake and transformation by bioactivity.

3. FY 1978 Program: During FY 1978, analytical methods to quantify both soil and water contaminants at Rocky Mountain Arsenal will be developed for nine known compounds which cannot be addressed in FY 1977. Methods are required on another four compounds in FY 1979, and the program includes provision in both years for a modest effort for identification of any additional migrating contaminants. In the Standards Area, effort to complete toxicity studies on DIMP and DCPD will continue, and both chemistry and toxicity studies begun in FY 1977 on three sulphur contaminants, will be continued. The program also includes initiation of chemistry and toxicity studies on three new contaminants in FY 1978. The interim water containment/treatment system installed at the North boundary of RMA will be operated and tested in FY 1978-1979, with the objective of installing a final system by FY 1980. Research will also continue into new water and industrial waste treatment techniques. The minor increase in FY 1978 funds over FY 1977 is due to cost growth.

Budget Activity #1 - Technology Base

Program Element #6.27.04.A Title Military Environmental Criteria Development

4. FY 1979 Planned Program: Pilot work on promising techniques will be aimed at determining the most feasible system for application at Rocky Mountain Arsenal (RMA) to treatment of North boundary groundwater, as well as to sources contributing to off-post migration of contaminants. This work will provide technology partly applicable to the treatment of sludge and contaminated soil. Studies started at RMA in FY 1977 of the contaminated sludge in Basin F, as well as the sludges in Basin A, will be subjected to more intensive laboratory study. Pilot work will initially be oriented toward sludges resulting from North boundary groundwater treatment system. Longer term pilot work will support source elimination studies. Laboratory studies of contaminated soil treatment will address both excavated and in place treatment and the feasibility of such techniques as thermal processing and chemical fixation. The increase in FY 1979 funds over FY 1978 is accounted for as follows: Initiation of chemistry and toxicity studies on three additional contaminants which were unfunded in FY 1978; significant increase in level of research effort for water, soil and sludge treatment; and initiation of preiously unfunded research into leachate and pollutant transport, vegetative uptake of contaminants, and conversion of contaminants by biological activity.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.05.A Title Electronic and Electron Devices

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	10208	2958	11211	15022	14647	Continuing	Not Applicable
AH94-01	Integrated Electronics	2342	702	2588	N/A	N/A	Not Applicable	Not Applicable
AH94-12	Integrated Assemblies				1791	1791	Continuing	Not Applicable
AH94-13	Integrated Circuits				1440	1440	Continuing	Not Applicable
AH94-02	Microwave Semiconductor Devices and Circuits	1270	406	1466	2336	2323	Continuing	Not Applicable
AH94-03	Reliability	1068	262	1160	1380	1215	Continuing	Not Applicable
AH94-04	Displays & Peripherals	485	145	439	750	788	Continuing	Not Applicable
AH94-05	Electron Tube Techniques & Circuits	800	228	1035	1425	1382	Continuing	Not Applicable
AH94-06	Microwave Tubes & Subsystems	1085	297	976	1325	1245	Continuing	Not Applicable
AH94-07	Frequency Control	888	284	880	1348	1258	Continuing	Not Applicable
AH94-08	Microwave Transmission & Acoustic Devices	838	170	910	1040	1084	Continuing	Not Applicable
AH94-09	Wire & Cable	524	195	585	792	758	Continuing	Not Applicable
AH94-11	Power Sources & Systems	908	269	1172	1395	1363	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This exploratory development program in electronic device and related materials technologies focuses on resolving critical component barrier problems which limit performance, cost, size, weight and reliability of specific Army Communications-Electronics (C-E) equipments. The objective of this program is to establish performance feasibility of new device concepts thereby expanding the technology base and providing systems designers with the necessary technical guidance and risk assessment to configure improved electronic systems for minimum total life cost of ownership.

Budget Activity #1 - Technology Base

Program Element #6.27.05.A Title Electronics and Electron Devices

BASIS FOR FY 1978 RDTE REQUEST: The integrated electronic program must continue to develop high density low power large scale integrated (LSI) circuits to effect 10-100 times improvements in size, cost, and speed of low power digital electronics for secure communications, command and control in expected intense electronic warfare environment for hostile weapons locations, and tactical signal analysis to determine nature and deployment of adversary forces. Microwave integrated circuits and high power transistors have to be developed to permit radio relays to function in jamming environments and to reduce the cost of lightweight phased array radars to affordable levels. A major effort is required to develop low cost millimeter wave Radio Frequency (RF) components for short range, secure highly mobile battlefield communications, mini Remotely Piloted Vehicle (RPV) radars, target designators, and broadband electronic warfare receivers and jammers. The major effort in the microwave power tube area is to reduce costs and improve efficiency and reliability beyond levels which currently severely limit the development of cost effective expendable jammers and airborne platform weapons location systems. Millimeter tube efforts will be initiated and pulse devices developed for millimeter wave radar and long wave length lasers to support means for seeing through smoke. Techniques are being pursued that will produce, store, and deliver large amounts of energy in short time intervals to insure an adequate pulse power technology base for the new and promising high energy weapon concepts. The display program will develop high contrast, computer interface displays applicable to the constrained space in mobile fire control of various systems. The major emphasis in power sources centers on the new lithium battery systems to achieve high energy density and operation over a wide temperature range; the thermoelectric generator for silent, maintenance free operation and advanced high precision lightweight power supplies. Fiber optic cable and multiplexing techniques must be developed to improve the tactical mobility, data capacity and to reduce the vulnerability of present cable systems in battlefield command and control centers.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The planned mission is required to meet urgent new component needs using "lessons learned" from the October 1973 Mideast War and recent analysis of the Soviet Radio Electronics Combat Doctrine. This mission is also in response to Director of Defense Research and Engineering, Office of the Secretary of Defense guidance to program an increase in the Electronic Devices area in order to reverse the dangerous programmatic trend in this area which is so vital to future progress in electronics. Temporary reductions in this program in FY 1975/FY 1976 have seriously eroded the contractual base which must now be restored to meet original targets.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	265	0	265
(2) Contractor Employees	161	0	161
Total	426	0	426

Budget Activity #1 - Technology Base

Program Element #6.27.05.A Title Electronics and Electron Devices

DETAILED BACKGROUND AND DESCRIPTION: This program represents the Army's prime source of funds for solving critical electronic component deficiencies in combat equipment/systems. Specifically, the program encompasses the development of the basic building blocks of all electronic equipment/systems including integrated circuits, solid state devices, microwave tubes, power supplies, frequency control, display devices and the development of electronic materials and processing innovations. Development is based on devices that are economical, durable and simple to operate, adjust and maintain. The program objective is to establish cost and performance feasibility of new device concepts by extension of the state of the art to form a basis for advanced system development and better reliability. Device feasibility thereby established is basic to orderly development planning and the expanded technology base provides systems designers with the necessary technical guidance and risk assessments to configure improved electronic systems for minimum total life cycle cost of ownership. Such coupling is provided for specific system needs in the application areas of electronic warfare, night vision, communications, avionics, data processing, combat surveillance and target acquisition, guidance and fire control, navigation and position location, and missile technology.

RELATED ACTIVITIES: Coordination is achieved with other Government agencies through the Department of Defense Advisory Group on Electron Devices (AGED) and the Interagency Advanced Power Group. Inter-service coordination and program cooperation are also directly derived from joint preparation of the Technology Coordinating Paper on Electron Devices which assesses the technical program, goals and potential pay-off from the Tri-Service total investment of electronics technology base funds. Funds previously in this program for Test Measurement and Diagnostics Equipment (TMDE) have been transferred to Program Element 6.27.79.A, TMDE Technology. Starting in FY 1978, AH94-01 has been divided into AH94-12 and AH94-13.

WORK PERFORMED BY: USA Electronics Research and Development Command (ERADCOM), Fort Monmouth, New Jersey. ERADCOM is scheduled to use approximately 50 percent of the program funds in-house. The principal contractors are: P.R. Mallory, Burlington, Massachusetts; Watkins Johnson, Palo Alto, California; RCA, Burlington, Massachusetts; Somerville, Camden, Princeton, New Jersey; Power Conversion, Inc., Mt. Vernon, New York; TRW, Redondo Beach, California; Hughes, Fullerton, Torrance, California; Northrop, Des Plaines, Illinois; EG&G, Salem, Massachusetts; Varian, Beverly, Massachusetts; Raytheon, Waltham, Massachusetts; E-Systems, Falls Church, Virginia; Stanford, Menlo Park, California; General Electric Syracuse, Schenectady, New York; Rockwell International, Anaheim, California; Westinghouse, Baltimore, Maryland; and Texas Instruments, Dallas, Texas.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: A new semiconductor technology (closed complementary metal-oxide-semiconductor) was developed, capable of producing high density, low power, high speed Large Scale Integrated (LSI) circuits required for frequency synthesizers for antijam data links and radio transmission security. Dielectric waveguide 60 Giga Hertz (GHz) receivers for low cost artillery and command post interconnections have been designed and fabricated. The projected manufacturing cost of $600 represents a ten times reduction over conventionally constructed equivalents. The new concept has led to the commercial manufacturing of 95 GHz receivers which can be used for commercial communications and fog penetration radar as well as military terminal homing and all weather high performance radars. Lightweight high energy pulse forming network designs were developed for

the US Army Missile Research and Development Command for use as the energy storage system for a multi-megawatt average power system where reduced size and weight of modulator components are essential for a practical system. A 256 character flat panel display was demonstrated utilizing a thin film transistor array to address an electroluminescent display media. Its reduced power dissipation and weight compared to a plasma panel are particularly important for tactical handheld use such as the Digital Message Devices and possible use for flat panel television monitors for mobile and airborne applications. The feasibility of low-cost crossed-field amplifier tubes that incorporate low-cost, laser-cut substrates; a five pound mini-Traveling Wave Tube (TWT) transmitter package; and over 30% efficiency, high-frequency microwave tubes utilizing multi-stage depressed collectors have all been demonstrated. These devices are particularly applicable to electronic warfare systems. Eight electron beam semiconductor Radio Frequency (RF) amplifiers have been operated without failure for a combined total of 200,000 hours the excellent life combined with high gain (25 dB); and high efficiency is expected to reduce the life cost of electronic warfare, identification of friend or foe (IFF) and radar equipments significantly. The electrical and mechanical design of a gunhardened microcircuit temperature compensated voltage controlled crystal module was completed, capable of surviving artillery launched terminal delivery vehicle environments with minimal frequency changes as required for narrow band sensor systems. An S-Band line source antenna has been developed which has considerable potential for use in lightweight, compact, low-cost phased arrays permitting cost savings of 25 to 30 percent and size reductions of 30 percent over conventional antenna designs. Significant improvements have been made in the lithium cell this past year, particularly in improved operational safety and reduced potential for electrolyte leakage. Hermetic sealing has virtually eliminated electrolyte and corrossive sulfur dioxide leakage. Prototypes of lithium inorganic electrolyte cells with energy densities at least three times that of the magnesium cell in current Army use have been constructed and found to supply a fifty percent improvement in energy density over the best organic electrolyte cell.

2. FY 1977 Program: Principal thrusts of this program are directed into four areas. The first is integrated electronics, microwave and millimeter wave semiconductor devices for applications in secure communications; devices for fast frequency hopping for non jammable communications; low-cost signal processing for radar and communications; reliable memories for data systems equipment; lower cost devices for microwave communications, radar, and battlefield interconnect transceivers. Concurrent with the above, emphasis is directed to increase field reliability of Communications-Electronics (C-E) systems. Secondly, microwave tubes with low initial and operating costs for use in Electronic Warfare (EW), radar, and communications transmitters with ancillary protective devices to limit system interruption to a single pulse; use of reliable, module design of transmitters; exploitation of novel concepts for microwave tubes with higher efficiency and equipment simplification for radar, Electronic Warfare (EW), digital communications and identification of friend or foe (IFF) applications; optimization of display technology, and development of special devices for X-ray, laser and radiac applications. The third area is frequency control and signal processing devices to minimize jamming susceptibility and probability of intercept of low level receivers; increase precision, usable channel capacity, and signal detection of lightweight tactical communications and navigation receivers; enhance radar target detection range and velocity discrimination; provide higher Signal/Noise (S/N) ratio, data capability and longer operational life for remote sensors; low cost passive microwave devices and subsystems; increase tactical mobility and reduce vulnerability of wire transmission

facilities; major simplification of logistical support of Army Communications-Electronics (C-E) systems through automatic test equipment and last, power sources (primary and secondary batteries, energy conversion systems and power processing) are directed to low cost, long life, high density capability and full reliable performance over military environments for use in aircraft, mobile weapons and C-E equipment. Provide lightweight reliable power processors for C-E systems and militarized digital equipment.

3. FY 1978 Planned Program: The integrated electronics program will continue to develop high density, large scale integrated cells and complete establishment of a design automation center for computer-aided-design of custom large scale integrated circuits. Extensive work will be directed toward development of charge coupled devices for signal processing and secure communications. Improved millimeter wave devices and low cost transmission line technology will be developed to provide affordable transmitters and receivers. Microwave integrated circuits will be developed to improve the power and reliability of driver amplifiers for very high power tubes for radio relays, troposcatter communications equipment and airborne radars. The new construction designs of microwave tubes will be continued so as to significantly reduce the cost of transmitter tubes for phased array radar. Development of high power pulsed and continuous wave millimeter wave transmitting tubes will be pursued. Lightweight, compact, electron beam semiconductor devices will be developed for electronic warfare jammers and signature analysis applications. Low cost, plastic clad, rugged fiber optic cables with attenuation under 20 dB/km will be developed for transmission distances from 100 meters to one kilometer. The development of the lithium battery will be pursued as a high use general purpose primary battery and high temperature secondary battery. The increase of FY 1978 funds over FY 1977 is due increased contractual efforts to support the FY 1978 planned program especially in the areas of Integrated Electronics; Microwave Semiconductor Devices and Circuits; Reliability; Electron Tube Techniques and Circuits, Microwave Tubes and Subsystems; and Frequency Control.

4. FY 1979 Planned Program: Higher frequency, large scale integrated circuit prototypes will be developed for secure communications, weapons locating and obstacle avoidance radars. Combinational schemes for millimeter wave sources will be developed to provide higher power levels for use in Remotely Piloted Vehicle (RPV) radars. The new construction designs of microwave tubes will be continued so as to significantly reduce the cost of transmitter tubes for electronic warfare and phased array radars. The new pulse power technology will continue to stress development and application of compact system life-time components and high power nanosecond pulsers for projected high energy systems. Complete development of the 1 cubic inch, 250 milliwatt vibration resistant crystal oscillator necessary for the airborne clock synchronization of the global positioning system. Complete development of a miniaturized CO_2 molecular frequency standard in a size of 20 cubic inches. Optimum design time ordered tactical navigation and position locations systems require atomic or molecular frequency standards as master clocks which are too large and costly to be considered. Ultra low-loss, high strength, optical fiber communication assemblies and payout devices for data transmission up to 20 megabits per second for distances up to 8 km without repeaters will be developed. Development of the lithium battery as a high use general purpose primary battery will be completed and fielded in the FY 1979/FY 1980 time frame. Decrease in FY 1979 from FY 1978 will reduce the contractual efforts which support this program in the areas of reliability, Electron Tube Techniques and Circuits, Micro Wave Transmission and Acoustic Devices and Frequency Control.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.06.A

Title CB Defense and General Investigations

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	11820	3053	12774	12114	10893	Continuing	Not Applicable
A553	CB Defense and General Investigations	11820	3053	12774	12114	10893	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program supports all Department of Defense exploratory development (XD) in chemical/biological agent alarm and detection principles; sampling and identification techniques; individual protection against respiratory and percutaneous hazards; collective protection; decontamination and chemical safety investigation. It also supports efforts in the civil disturbance, combat support, and chemical offensive programs.

BASIS FOR FY 1978 RDTE REQUEST: Fundamental research will be continued in search of new concepts in alarms and samplers. Complete feasibility study for improved vehicle decontamination system, continue search for optimal nonpersistent and persistent agent training simulants, complete chemical agent water test kit feasibility studies and continue search to find rapid remote biological agent detection and identification systems. Continued effort will emphasize the initial toxicity screening of all new compounds, including new smoke materials. Potentially promising submunition systems will be designed and evaluated for correlation with analytical predictions.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Slight decrease in overall program due to lesser study and test efforts.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	217	0	217
(2) Contractor Employees	91	0	91
Total	308	0	308

Budget Activity #1 - Technology Base

Program Element #6.27.06.A

Title CB Defense and General Investigations

DETAILED BACKGROUND AND DESCRIPTION: This program element provides the entire Department of Defense chemical and biological defense technology base and addresses in-depth exploratory activities in the development of a broad spectrum of equipment concepts for: point sampling and area chemical agent warning systems and detection, sampling and identification equipment; individual and collective protection against respiratory and percutaneous chemical agent hazards; filtration and purification of air and water; personnel and equipment contamination prevention and decontamination; chemical attack defense training; improvement of safety in military chemical industrial-type operations; airborne biological agent sampling, fractionation; and concentration for point sampling and area scanning-type agent detection and alarm systems; physical protection against and decontamination of biological agents. Program also include investigations supporting both defensive and offensive development in chemical dispersion and dissemination techniques, chemical agent systems process chemistry and pilot operations; and searches for potential chemical agents and toxicology of chemical agents.

RELATED ACTIVITIES: No comparable work is done by the other Services. Coordination is maintained with the other Services to assure provision of the technology base to meet their advanced and engineering development needs, adoption of joint service requirements where practicable, and preclude duplicative efforts. Coordination and cooperation is maintained with the United Kingdom, Canada, Australia, and with the North Atlantic Treaty Organization (NATO).

WORK PERFORMED BY: In-house by US Army Armament Research and Development Command, Edgewood, MD. Contractors include John Hopkins University, Baltimore, MD; University of Nebraska, Lincoln, NE; University of Delaware, Newark, DE; Survival Technology, Bethesda, MD; Ivey Research Institute, Philadelphia, PA; Calspan Corporation, Buffalo, NY; Southern Research Institute, Birmingham, AL; Stanford Research Institute, Menlo Park, CA; International Latex, Dover, DE; Physical Science Laboratory, University Park, NM; Southwest Research Institute, San Antonio, TX; Geomet Incorporated, Rockville, MD; Organon Diagnostics Corporation, El Monte, CA; and Midwest Research Institute, Kansas City, MO.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS.

1. FY 197T, FY 1976, and Prior Accomplishments: Feasibility studies were conducted on ionization and enzyme detectors to provide an improved multi-agent point sampling alarm. Attention was given to search and feasibility studies for a Chemical Attack Warning Transmission System for troop use. Progress was made on a simple automatic detector for the threat posed by thickened liquid nerve agents. Seach for improved materials for the faceblank of the new protective mask continued and humidity sensors to enable evaluation of the mask in high relative humidity environments were obtained. The protection capability of standard US and United Kingdom protective clothing systems against chemical nerve agent GD was investigated and the total protection time of charcoal overgarments was established. Efforts were made to improve the response separation between biological groups for identification. Theoretical feasibility of remote detection of biological aerosols in the atmosphere has been indicated and a contract was awarded to further establish the capability of remote detection using intrinsic fluorescence. Methodology was

developed to determine the spread of thickened liquid when released from a massive warhead and an acceptable sampler material for determination of on-the-ground concentrations was found. Laboratory and bench scale processes for new binary, incapacitating, and riot control agents and their intermediates were studied.

2. FY 1977 Program: The FY 1977 program will include complete feasibility studies on Chemical Attack Siren and Advanced Point Sampling Alarm. Select optimum detector grid configuration for Automatic Liquid Agent Detector and complete concept studies of vehicle mounted decontamination apparatus utilizing the vehicle exhaust and reach decision on future work. Search for simple means for differentiating GD from GB nerve agents. Complete survey and identify potential simple physical methods of detection for use as detector kits. Complete studies on candidate impregnants, sorbents, and associated theoretical analysis for data reduction. Investigate high volume sampling techniques for air and extraction methods for soil, water, brine and salt samples. Evaluate the effectiveness of lactic acid for disinfection of biological aerosol cloud. Continue evaluation of foreign chemical offensive and defensive concepts and materiel. Perform acute inhalation and intravenous toxicity studies on selected intermediate volatility agents candidates and their chemical components. Biologically screen new compounds for use as lethal, incapacitating, riot control, or training agent simulants; and binary components and reaction products.

3. FY 1978 Planned Program: The FY 1978 program will include complete feasibility of decontamination system for tactical equipment. Studies will be completed on new reagents for broadened detection capabilities of the M8 alarm. Continue biomedical evaluation of candidate chemicals for the training system. Evolve simple group identification techniques for biological agents suitable for use in a field all clear kit. Develop and improve new bioassays for detection of behavioral, mutogenic, and carcinogenic effects of chemicals. Initiate a program to evaluate the threat of thickened liquids from aerial bombs and artillery and initiate methods for studying and selecting simulants for thickened nerve agents and mustard agents delivered by aerial bombs and by artillery shells using the explosive projection technique.

4. FY 1979 Planned Program: The FY 1979 planned program will include demonstrating the feasibility of simplified collective protective system to include new concepts for solving the entry/exist problem. Continue to assess effectiveness of US detection system, against all potential threat agents in all service environments. Continue process studies on training agents. Complete design; fabrication; and testing of a remote sampling and analysis system. Maintain a continuing program for assessing the potential of foreign agents. Conduct studies into techniques for increasing the burning rates of pyrotechnic/agent systems. Continue to synthesize sufficient quantities of compounds of interest to the various programs for advanced toxicological, chemical and weaponization studies. Funds were decreased because of higher priority projects.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.07.A

Title Mapping and Geodesy

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES/PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	3270	880	3188	4656	4116	Continuing	Not Applicable
A855-01	Geodesy and Positioning Technology	843	228	979	1101	1120	Continuing	Not Applicable
A855-02	Topographic Mapping Technology	1106	239	778	1075	1360	Continuing	Not Applicable
A855-03	Military Geographic Analysis Technology	1321	413	1431	1623	1636	Continuing	Not Applicable
A855-04	Army Terrain Information System	-	-	-	857	-	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Program element includes exploratory development in geodetic and topographic mapping technology and military geographic analysis. The objective of the mapping and geodesy program is to investigate and develop methods and equipment that will provide the Field Army and Department of Defense with a more responsive, cost-effective capability for collecting, processing, displaying and disseminating geodetic, topographic and military geographic data and products. Objectives addressed by this program include: Rapid production of near real time topographic information data and combat intelligence, reduction of geodetic and geophysical error, improve production and management technology and collection and processing of image data from remote sensors.

BASIS FOR FY 1978 RDTE REQUEST: Technology development in FY 1978 in support of Defense Mapping Agency needs include: Continued development of a vehicle-mounted rapid gravity survey system; development of digital techniques for imagery data extraction and elevation determination; and use of holographic and other coherent optical techniques for image data extraction. The FY 1978 program in support of the Field Army includes: Investigation and exploratory development in gyroscopic azimuth devices for forward observer application; low cost inertial techniques for rapid collection of accurate positional data; and development of special map products.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Increase due to: (1) Reprogramming of funds from PE 6.37.12.B, Mapping and Geodesy, in accordance with Deputy Chief of Staff for Research, Development and Acquisition (DCSRDA) guidance to reflect work that has not progressed to a Letter of Agreement (LOA) and (2) increased costs of research. Additional funds will be used for contractual support to solve unique technical problems associated with processing and display of topographic data, most of which is being collected and stored in digital form.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement, is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	52	0	52
(2) Contractor Employees	22	0	22

Budget Activity #1 - Technology Base

Program Element #6.27.07.A Title Mapping and Geodesy

DETAILED BACKGROUND AND DESCRIPTION: Program involves the development of new or improved means for rapid acquisition, processing, and dissemination of positional information, mapping data and military geographic information. Methods developed are responsive to the operational needs (i.e., all-weather, secure and precise) of the intended users. End items will directly support future map production activities and future strategic and tactical deployment of forces, weapons systems and crises management. This program/project covers the areas of Geodesy and Point Positioning, Mapping, and Mapping Geographic Analysis, and provides exploratory development portion of the technology base for both the Army and Defense Mapping Agency (DMA). Techniques and equipment developed include: (a) Improved position-location data for long-range weapons employment; (b) Improved mapping of critical world areas; and (c) mapping, military geographic information (MGI) and terrain analysis for Army tactical operations to include contingency, limited war, general war and rescue operations.

RELATED ACTIVITIES: This program applies the results of basic research performed under Project 4A161102B52C, Mapping and Geodetic Research. Both the Air Force and Navy have related mission-oriented research, which is coordinated with the Army's program by the DMA and the Director, Defense Research and Engineering (DDR&E). Team efforts are undertaken with the Air Force's Rome Air Development Center and Cambridge Research Laboratories, with the Office of Naval Research and the Marine Corps. Advanced and engineering development of techniques and equipment resulting from this program are accomplished under the following program elements: DMA Program Element 6.37.01.B, Mapping, Charting and Geodesy Investigation and Prototype Development; DMA Program Element 6.47.01.B, Mapping, Charting and Geodesy Engineering Development and Test; Army Program Element 6.37.12.A, Mapping and Geodesy; and Army Program Element 6.47.16.A, Mapping and Geodesy.

WORK PERFORMED BY: Approximately 60 percent of the work is accomplished in-house at the US Army Engineer Topographic Laboratories (USAETL), Fort Belvoir, VA. The balance is performed by contract under the direction of USAETL. Major industrial contractors include: Litton Systems, Incorporated, Woodland Hills, CA; Goodyear Aerospace Corporation, Akron, OH; Boeing Corporation, Seattle, Washington; the Itek Corporation, Lexington, Mass; Control Data Corporation, Minneapolis, Minn. Major university contractors are: University of Rochester, Rochester, NY, and the University of Kansas, Lawrence, KA. Other Government agencies funded to support this program include: The Army Research Institute; the US Geological Survey and Army Computer Systems Command.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: A prototype-model Rapid Gravity Survey System (RGSS) using advanced inertial measuring techniques was developed and obtained accuracies of 1 meter and 1.5 arc second in elevation and deflections-of-the-vertical, respectively. Equipment requirements for a Remotely Piloted Vehicle (RPV) Exploitation Facility were identified, and commercially available items procured, installed and tested. A study of Map Reproduction technology was completed which defined performance characteristics needed for a quick-reaction/limited-quantity reproduction capability in both the baseplant and the field. A prototype Electrostatic Image Reproducer (EIR) was developed for high-speed, large-format, multicolor reproduction of maps. The initial operational phase of the in-house digital image processing facility was completed with the installation of the CDC 6400 Computer. The capabilities for utilizing the Recording Optical Spectrum Analyzer (ROSA) for image classification and pattern recognition were successfully demonstrated. The prototype Automated Imagery Data Extraction System (AIDES) was employed in tests for camouflage

detection (in support of the Army Camouflage Program) and as a test bed for terrain analysis and photo interpretation experiments which could eventually be deployed in both the field and the baseplant. Two experimental map viewing devices were fabricated, field tested and evaluated. A major accomplishment was the development and demonstration of an interactive digital image processing capability using COMTAL and Textronix input/display devices interfaced with a CDC 6400 Computer. A study contract in map reproduction technology produced a matrix showing the relationships between the technological capabilities, cost, and present/future requirements. A contract was completed for the design and fabrication of a brassboard instrument that would enable stream width and velocity determination from remote sites for tactical planning (intelligence) purposes. The initial phase has been completed on an effort to demonstrate the potential capabilities of the Pockel's Readout Optical Modulator (PROM) for near-real-time pattern recognition.

2. FY 1977 Program: Field testing of the Remotely Piloted Vehicle (RPV) Exploitation Facility are being completed and results evaluated. In-house and contractor efforts are being performed to evaluate airborne and ground gradiometers for improved collection of deflections-of-the-vertical. In-house and contractor studies are being conducted in connection with the design and fabrication of a brassboard (feasibility) model Miniaturized Gyrocompass. A draft Letter of Agreement (LOA) is being prepared for follow-on advanced development (6.3A). In-house investigations are continuing aimed at identifying promising, low-cost approaches for forward area surveying in support of Position and Azimuth Determining System (PADS) and other advanced survey systems. Software and procedures for interactive feature extraction using the US Army Engineer Topographic Laboratories Digital Image Processing Facility are being developed. New digital correlation methods and algorithms are being sought for high-speed accurate image matching of multisensor imagery (radar, optical, IR). Technology base efforts in map reproduction included investigations of electron beam recording (EBR), cathode ray tube (CRT) recording, and laser printing. A survey is being made of environmental data (LANDSAT) user requirements in terms of types of data, quantity, formats, and outputs. Based on the survey findings, software and processing routines are being developed. A major action involves the demonstration of conceptualized (mathematical) terrain models which subsequently will be incorporated into advanced development Army Terrain Information System (ARTINS). Necessary documentation is being prepared to support follow-on advanced development (6.3A) work. A contract is being awarded for development of a prototype Pattern Recognition System using the PROM and matched filtering techniques. In the development of Product Test Methodologies, planned efforts include the completion of studies on vegetation, drainage, and culture symbology and an investigation of production inks, screens and type styles, the objective of which is to obtain improved interpretability. A contract is planned to obtain university support in the development of a Hybrid Optical/Digital Radar Simulation Technique.

3. FY 1978 Planned Program: Fabrication, testing and evaluation of the prototype Rapid Gravity Survey System (RGSS) will be completed, and a proposal for 6.3 advanced development will be submitted for Defense Mapping Agency (DMA) funding. Phase III of the gradiometer development will be completed, and design of the integrated inertial/gradiometer system will be initiated. The prototype model Remote Stream Measuring Device will be developed. In the development of Multi-Image Interpretation Techniques, a hardware update contract will be completed on the Texture Analysis/Image Processing Module. Work will begin on developing procedures for analog/digital processing of Factor Map Overlays as required for special products and terrain analysis operations. Work will be completed on the generation of a new symbol file, which could be incorporated into the advanced development graphics. Radar simulation studies will include a contract for analysis of Operational Performance of a Hybrid Radar Simulation Technique. Increase in funding required for: (1) Support of prototype items for which Letters of Agreement are in preparation but not currently approved; and (2) increase costs of research.

Budget Activity #1 - Technology Base

Program Element #6.27.07.A Title Mapping and Geodesy

4. FY 1979 Planned Program: An integrated Rapid Gravity Survey System (RGSS)/gradiometer system will be designed and evaluated through use of computer simulation. If results are promising, development of the integrated system (6.3 funded) will be proposed. Studies will continue into applications of Advanced Gyro Technology that show the greatest promise for future applications. Contractual efforts will be performed to fabricate and test a prototype advanced gyro. After coordination with potential user(s) a Letter of Agreement (LOA) will be drafted and staffed. In-house efforts will continue in the development of Digital Data Extraction Techniques, to include advanced digital correlation methods and techniques for matching dissimilar images. Additional software will be procured, modified and tested on the US Army Engineer Topographic Laboratories Digital Processing Facility leading to an all-digital pass point selection system which would be independent of a particular image scanner and not dedicated to a specialized output. Fabrication of the prototype Remote Stream Measuring Device (Non-optical) will be completed, and testing and evaluation will commence. Work will be completed on expanding the automated image data extraction capabilities of the Automated Imagery Data Extraction System (AIDES), enabling the system to operate in a parallel processing mode. Advanced radar scene simulation studies will be performed in-house and by contract to demonstrate the feasibility of new hybrid (optical/digital) processing techniques. Decrease in funding due to prototype items moving to 6.3 Advanced Development stage with approved Letters of Agreement.

5. Program to Completion: This is a continuing program.

...am Element #6.27.09.A Title Night Vision Investigations

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	6930	1491	5149	5246	5063	Continuing	Not Applicable
DN95-E1	Engineering Studies and Investigations	293	0	0	0	0		
DN95-FL	Far Infrared	1914	386	1102	1284	1250	Continuing	Not Applicable
DN95-M1	Image Intensification and Semiconductor Laser Illuminators	2374	394	1292	1282	1090	Continuing	Not Applicable
DN95-VL	Visionics Studies	2080	605	1555	1329	1423	Continuing	Not Applicable
DN95-A1	Concept Development and Validation	269	106	1200	1351	1300	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This effort covers exploratory research and development of components and techniques to improve combat operations under conditions of darkness. Studies in the basic and applied field of visionics are conducted to optimize the design of new generations of image intensifiers and far infrared viewing systems.

BASIS FOR FY 1978 RDTE REQUEST: Research and exploratory development to improve performance effectiveness, reduce sophistication and life cycle cost of future night vision systems. Major thrusts will be: Far Infrared - Establish a technology base for Second Generation Infrared Systems which will have greatly improved performance over present systems; Visionics - Development of tactical search models, incorporating atmospheric (fog, smoke, and camouflage) effects, to determine the least costly technique of satisfying a night vision requirement; Image Intensification - Concentrated on third generation tubes which will have approximately ten-fold sensitivity over present devices.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The increase in FY 1978 funding over FY 1977 is due to the increased use of evaluation facilities to determine operational parameters for third generation Image Intensification tubes, increased efforts to evaluate far infrared detectors and the physical make-up of their materials, and computer simulation for identification of the best design for an automatic tracking sensor.

Budget Activity #1 - Technology Base

Program Element #6.27.09.A Title Night Vision Investigations

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	66	N/A	66
(2) Contractor Employees	77	N/A	77
Total	143	N/A	143

DETAILED BACKGROUND AND DESCRIPTION: This effort covers exploratory research and development of components, techniques, man/machine models and environmental data bases essential for both significant cost reductions and performance improvements in night vision electro-optical devices. Third Generation image intensifier tubes and charge transfer device vidicons are major programs in the Image Intensification field. The Visionics Program is primarily concerned with the development of tactical effectiveness models, the establishment of a target signature data base, and the exploitation in brass board configurations of new sensor ideas and concepts. Far Infrared technological effort is directed towards the reduction of cost and complexity. The Far Infrared Program emphasizes the exploration of highly sensitive detectors and low cost uncooled thermal imaging techniques for pyroelectric vidicon and solid state imaging systems. Because of the noncommercial aspects of night vision technology, it is essential to maintain internal activities in these technology areas.

RELATED ACTIVITIES: The Army's Night Vision Laboratory has been assigned the responsibility to coordinate all night vision technology based programs within the three services to avoid duplication and to ensure that maximum use is made of resources and capabilities within the DOD community. Additionally, active international technical interchange is maintained with NATO through Panel VI (Combat Intelligence) of the NATO Army Advisory Group (NAAG), and with Commonwealth countries through Sub-Group J (IR) of the Technical Cooperation Program.

WORK PERFORMED BY: Work is performed by the US Army Night Vision Laboratory, Ft. Belvoir, VA, with contractor assistance. Representative contractors include: Radio Corporation of America, Lancaster, PA; International Telephone and Telegraph Corporation, Fort Wayne, IN; Varian Associates, Palo Alto, CA; Texas Instruments, Inc., Dallas, TX; Department of Electrical Engineering and Materials Research Laboratory, University of Illinois, Urbana, IL; United Aircraft Corporation, East Hartford, CT; Philips Laboratories, Briarcliff Manor, NY; and Aeronutronic Ford Corporation, Newport Beach, CA.

Budget Activity #1 - Technology Base

Program Element #6.27.09.A Title Night Vision Investigations

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976 and Prior Accomplishments: First and second generation image intensifier tubes for night vision goggles and small starlight scopes were developed. Gallium arsenide photocathode technology for third generation intensifiers was explored with a demonstrated increase in detection sensitivity. A pyroelectric vidicon facility was established to begin exploratory development of a low cost, uncooled, far infrared detector for moderate performance night vision systems. An advanced pyroelectric vidicon with a 250% resolution improvement over prior devices was demonstrated. Gallium arsenide lasers were developed which have potential for lightweight manportable pulse gated night vision viewing systems. Programs for low cost thermal sights, advanced pilots' goggles, and Second Generation thermal imagers were initiated. Additionally, the development of thermoelectrically cooled detectors advanced to where the design of a new class of lightweight systems is feasible.

2. FY 1977 Programs: Programs within the three prime Night Vision technologies are: Image Intensification (I^2). The development of Third Generation 18mm wafer I^2 tubes with an approximately ten fold sensitivity increase, improved shelf life, and compatibility with existing housings; Far Infrared. Interface special infrared chips which will form the basis for Second Generation thermal imagers. Two approaches, monolithic extrinsic silicon detector arrays and hybrid lead-tin-telluride infrared detector arrays, will be followed; Visionics. Developing a man-machine search model, completion of a model for thermal viewing devices, and the development of a preliminary medium clutter model for intensifier and TV systems. A Technology Handbook on target search will be published.

3. FY 1978 Planned Program: Image Intensification. Concentration on completion of the technological base for third generation tubes, and development of charge collection device sensors incorporating third generation cathodes for remotely piloted vehicle (RPV) type applications; Far Infrared. Demonstrate low cost second generation infrared chips for manportable and combat vehicle applications, develop high density silicon sensor arrays for long-range airborne applications; Visionics. Completion of the medium clutter model, continuation of search and thermal models. Funding increase in FY 1978 over FY 1977 is to enable completion of this stage of development for improved I^2 tubes and several thermal devices.

4. FY 1979 Planned Program: Image Intensification. Demonstrate feasibility of a 500 line CCD wafer tube with a Gallium-Arsenide Photocathode, and a miniature high resolution flat panel display; Far Infrared. Design and fabrication of thermo-electrically cooled focal plane sensors and intrinsic detector arrays. Evaluation of extrinsic detector materials for monolithic arrays; Visionics. Effectiveness models will be transformed into completely general DOD target acquisition models, visible through the microwave spectrum.

5. Program to Completion. This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.15.A Title Tactical Self Protection Electronic Warfare Technology

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	1202	260	1210			Continuing	Not Applicable
A042	Tactical Self Protection Electronic Warfare Techniques	1202	260	1210	-	-	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: New techniques, devices and systems are investigated and exploratory development models simulated or fabricated. Selected technologies are exploited to neutralize or deceive enemy weapons. Techniques and systems are studied to improve on the Army's capability to collect and identify the signal environment and in turn to better understand the enemy electronic threat. The threat information is used to formulate countermeasure programs The vulnerability information is used to improve our own use of the electronic spectrum in a hostile electronic countermeasures (ECM) environment.

BASIS FOR FY 1978 RDTE REQUEST: Investigate develop/improve vulnerability test methodology for electro-optic (EO) systems and missiles, provide electronic counter-countermeasures (ECCM) protection for line of sight - ultra high frequency (LOS-UHF) trunk communications and voice links. Provide development of techniques and investigations in EO to: develop optimized countermeasures approaches from simulations and signature measures; develop sources, spoofers, and target discrimination methods for incorporation in optical augmentation (OA) systems; develop counterfire techniques for suppression of hostile laser systems; and improve optical detection techniques particularly in ultraviolet (UV) and in the mid and far infrared (IR) regions. Provide faster, more reliable signal detection, analysis and processing capability by use of more efficient processing algorithms, applying use of new large scale integration (LSI) chips, charge coupled devices (CCD's), surface acoustic wave (SAW) devices and newer fast fourier transform (FFT) techniques. Continue development of expendable electronic support measures/electronic countermeasures (ESM/ECM) for communications and radar, conduct systems analysis for development of improved radio location systems, develop applications, improve other ECM adjuncts such as chaff and improved power management techniques.

Budget Activity #1 - Technology Base

Program Element #6.27.15.A Title Tactical Self Protection Electronic Warfare Technology

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: In depth reviews of the Army electronic warfare (EW) exploratory development program by a PERM Group, an Independent panel, and Director of Defense Research and Engineering (DDRE) revealed that expansion and improvement in the technology base is required for the total Army EW effort. In addition to averting marginal funding in electro-optics (EO), expendable development, and signal processing; the areas of electronic counter-countermeasures (ECCM) for trunk communications, missile and surveillance target acquisition and night vision (STANO), systems engineering in electronic support measures (ESM) and electronic countermeasure (ECM) areas, and greater emphasis on development of ECM sources, methods and subsystems will be pursued more vigorously.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	21	0	21
(2) Contractor Employees	40	0	40
Total	61	0	61

DETAILED BACKGROUND AND DISCUSSION: The objective of this program is to develop new and improved electronic counter-countermeasures (ECCM), ESM, active and passive ECM, communications jamming, deception techniques and detection techniques to increase the effectiveness of electronics countermeasures as tactical weapons systems in support of the combat commander. New and improved methods will be determined for harassing, confusing, neutralizing and otherwise denying the enemy the use of his electronics systems for effective command control and for enhancing intelligence collection and active jamming through the judicious application of ECM/ESM. The resulting methods and techniques will provide a base for the development of ECM and ESM equipments. Foreign state-of-the-art trends will also be studied and evaluated in terms of their relationship to ongoing work under this program. The vulnerability of these techniques to potential foreign threats will also be considered.

RELATED ACTIVITIES: This work is in direct support of the Program Manager for Aircraft Survivability Equipment (ASE) and of projects 6.37.45.A, D251, Protective Electronic Warfare Systems, and Project 6.37.45.A, D905, Division Tactical Electronic Warfare Systems. Work on the development of ECCM technology supports a number of Army communications electronics systems in the area of communications and radar. Tri-Service technical efforts in electronic warfare receive extensive review as a result of participating in Joint-Service Technical Programs (JSTP), Electronic Counter-Countermeasure Workshops (ECCW) and Joint Technical Coordinating Groups (JTCG) which all help reduce duplication among the Services.

Budget Activity #1 - Technology Base

Program Element #6.27.15.A Title Tactical Self Protection Electronic Warfare Technology

WORK PERFORMED BY: US Army Electronics Command, Fort Monmouth, NJ. Supporting effort is being provided by US Army Armament Research and Development Command located at Aberdeen, Maryland. Contractors include: Varo, Inc., Garland, Texas; Arnold Research Organization, Tullohoma, Tennessee; Rockwell International, Anaheim, California; Hughes Aircraft Company, Culver City, California.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Scanning Optical Augmentation Locator completed and field tested. Results applied to advanced development of an airborne optical augmentation (OA) system for aircraft self-protection and expandable electronic support measures/electronic countermeasures (ESM/ECM) equipment fabricated. Contract awarded for a modified night vision sight capable of imaging laser radiation. Signal processing test bed completed. Multiwavelength laser receiver/processor modified and used in data base collection.

2. FY 1977 Program: Electronic counter-countermeasure (ECCM): Continue to apply new solid state advances to ECCM applications for communication-electronic (C-E) equipments. Continue development of advanced circuits for ECCM, including improvements to net-radio FFH. Improve FFH waveform to permit simpler circuit design. Award contract for external work in this area.

Electro-optics ESM/ECM: Complete data reduction on signature measurements and field tests. Examine adaptive optics spoofing to establish positioning and cross-section. Provide high efficiency laser sources with selectable wavelength over visible and mid-infrared sources. Examine enemy capability for night combat, and identify projected night vision systems. Award contracts for laser sources and ECM against Laser Pointing and Tracking. Optics ESM: Primary effort on Scanning Optical Augmentation Location System (SOAL) will be transitioned to advanced development. Exploratory development equipment will be modified to allow more wavelength flexibility and implement desirable changes for the advance development equipment. Signature data base will be expanded and ECM effects studied in more detail. Test facilities will be improved in preparation for the advanced development effort. Signal ESM/ECM: Complete and evaluate Walsh and moving fast fourier transform (FFT) machines.

Anticipate and solve critical design problems for expendable receiver jammer which transitioned to advanced development. Perform concept study and analysis for Unattended/Remotely Piloted Vehicles (RPV) ESM and ECM payloads; perform analysis and design of critical components for selected approaches.

Budget Activity #1 - Technology Base

Program Element #6.27.15.A Title Tactical Self-Protection Warfare Technology

3. FY 1978 Planned Program: Electronic counter-countermeasure (ECCM):

Signal electronic support measures/electronic countermeasures (ESM/ECM): Continue development of large scale integration (LSI) modules for dedicated signal processing functions to achieve distributed, parallel processing and development of unattended remotely piloted vehicles (RPV) ESM/ECM payloads. A systems analysis of the next generation radio location systems will involve in-depth analysis of some of the subsystems to be considered in the systems analysis. Development of communications time distance of arrival (TDOA) techniques will be started. Development of jamming sources for unattended/expendable and lightweight airborne jammers for the low centimeter and high millimeter bands will be started. techniques for new threats will be started. The tech base for electronic warfare (EW) has been underfunded in the past thus an increase in funding is required to increase the level of effort required to meet the demonstrated threat in the area of electronic warfare.

4. FY 1979 Planned Program: ECCM: Programs will be continued to apply ECCM techniques to multichannel applications, to develop voice compression techniques for added antijam protection. will be continued. The update of missile test instrumentation development will be continued.

Signal ESM/ECM: Signal processing developments will be applied to systems requirements/developments in high data rate radar reception including the processing of exotic emitters. Exploratory development of radio location subsystems, communications time distance of arrival (TDOA) techniques, jamming sources, deception measures modulation analysis and unattended/remotely piloted vehicle (RPV) payloads will be continued. Increase in funding is required to raise the level of effort required to meet the increasing threat.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.16.A Title Human Factors in Military Systems

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES/PROJECT LISTING: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	4009	1150	3863	5505	6622	Continuing	Not Applicable
AH 70	Army Human Factors Engineering	4009	1150	3863	5505	6622	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The Army uses thousands of different items of equipment, often under the most adverse environmental and combat conditions. Objective of this program is to assure that equipment is designed so that the soldier can fight effectively without fighting the equipment. Specific purposes are: (1) provide knowledge of the soldier's mental and physical performance capabilities and limitations; (2) guide the application of that knowledge in the development of Army weapon systems so that the soldier can mentally and physically operate and maintain; (3) combine human task performance with machine performance to achieve the most effective, efficient and reliable combination.

BASIS FOR FY 1978 RDTE REQUEST: The US Army Human Engineering Laboratory (HEL) has developed outstanding expertise in performing new weapon system concept feasibility analyses, and total weapon system effectiveness evaluations. Laboratory and field evaluations reveal error sources; components inefficiently operated by the typical soldier are identified and recommendations made to achieve greater effectiveness through equipment redesign and procedural improvements. FY 78 work will guide developments in artillery, infantry, aviation, armor, and military operations in built-up areas.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Increase is for new effort to reduce human error in armor and anti-armor operations under realistic field conditions, for work on crew capabilities in future high mobility armored vehicles and for soldier guidelines for military operations in built-up areas. Approximately $650,000 of the increase represents a consolidation of funding for human engineering detachments at development activities within the US Army Materiel Development and Readiness Command (DARCOM). Begun in FY 76, this management consolidation of human factors engineering within DARCOM will be completed in FY 79.

Budget Activity #1 - Technology Base

Program Element 6.27.16.A

Title Human Factors in Military Systems

PERSONNEL IMPACT

The average number of employees supported with requested FY 1978 funds (RDTE & Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	118	0	118
(2) Contractor Employees	20	0	20
Total	138	0	138

DETAILED BACKGROUND AND DESCRIPTION: Significant findings from this program have driven the development of such equipment as the Battery Level Computer for the Fire Direction Center for artillery, the Advanced Light Infantry Assault Weapon, new infantry body armor and helmets, an integrated one-handed flight controller for helicopters, fire control equipment for tanks, target acquisition and control systems for conventional artillery, mounting anti-tank weapon systems (DRAGON) on the M113 Armored personnel vehicle, and providing protection for the gunner of a second anti-tank weapon system. Results of this program directly influence the design of Army materiel.

RELATED ACTIVITIES: Joint services actions such as publication of Military Specification MIL-H-46855A, Human Engineering Requirements for Military Systems, Equipment and Facilities; Military Standard MIL-STD-1474A(MI), Noise Limits for Army Materiel, and Military Standard MIL-STD-1472B, Human Engineering Design Criteria for Military Systems, Equipment and Facilities. Among the services, infromation on current programs and completed results is exchanged to preclude duplication of effort. A Human Factors Engineering Information Data Bank used by all Department of Defense agencies and contractors is maintained by this program. Related Program Elements are: 6.27.57N, Training and Human Engineering Technology; 6.37.01.N, Human Factors Engineering Development.

WORK PERFORMED BY: In-house agencies: US Army Human Engineering Laboratory (HEL), Aberdeen Proving Ground, MD, and Human Factors Engineering Detachments at each of the US Army Materiel Development & Readiness Command (DARCOM) Subordinate Commands and Development Centers. Contract organizations whose contracts exceed $25,000 are: Bolt, Beranek & Newman, Inc., Cambridge, MA; and Aircraft Armament Corporation, Cockeysville, MD, and Food Machinery Corporation, San Jose, CA.

Budget Activity #1 - Technology Base

Program Element 6.27.16.A Title Human Factors in Military Systems

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 76, and Prior Accomplishments:

Human Factors Engineering design handbooks, standards and specifications were published. Human factors engineering data bank established, containing the results of approximately 30 years of research. Field evaluation showed that conventional artillery was ineffective in engaging moving ground targets. Through use of a new laser designator system and a new automated Fire Direction Center, conventional artillery engagement of moving ground targets became extremely effective. Tests yielded effectiveness data on air-to-ground and ground-to-air engagements. Integrated flight control was designed which combines two helicopter flight controls into one control. Control frees one of the pilot's hands for other functions such as firing of guns. Field experiments with the 81-mm mortar reduced the number of rounds of ammunition to get on target, and reduced time to get on target, thus increasing mortar-system efficiency and reducing ammunition and training costs. Program supported development of proposed new infantry helmet and body armor through laboratory and field trials involving approximately 1500 infantry soldiers to assure the best shape, sizing, protection, and compatibility with other equipment. Feasibility of firing rocket-type anti-tank weapons from enclosures and bunkers was demonstrated. Results are guiding preparation of combat operational guides. US Army Human Engineering Laboratory successfully mounted the DRAGON anti-tank weapon on the M113 armored personnel vehicle. Gunners achieved 100% hit probability against stationary targets, and 93% against moving targets. This mount is presently being procured in large numbers for operational use. As a spin-off of an error measuring device development for artillery gun crews, the potential for use as a training device was immediately recognized. This device could save the Army millions of dollars in artillery ammunition, POL, and gun tube wear annually, in artillery gun crew training. Feasibility of use in training is being examined.

2. FY 1977 Program:

Artillery and Mortars: Field tests continued to investigate techniques, equipment and procedures for reducing the remaining human error sources in artillery and mortar firing. Program was initiated to examine the infantry operations such as mechanized, air mobile, and Military Operations in Built-up Areas (MOBA), and the interaction of weapons and equipment as they affect the performance of the infantry soldier. Objective is greater compatibility between new infantry materiel items and to increase the combat infantryman's effectiveness. There is now no systematic human factors assessment of problems associated with military operations in urban warfare. Research was initiated to isolate problems in city fighting and to assess the advantages and limitations of current weapons in such an environment

Budget Activity #1 - Technology Base

Program Element 6.27.16.A Title Human Factors in Military Systems

3. FY 1978 Planned Program:

(a) Continue and extend human engineering work contributing to optimum future infantry, armor, and anti-tank weapon systems; (b) Develop human factors design criteria for a future, optimum light-weight mortar system based on previous evaluations; (c) Complete design test, and transition of the one-handed flight control for Army helicopters into the next phase of development; (d) With the Army user, determine optimum weapons and procedures for fighting in urban areas.

4. FY 1979 Planned Program:

(a) Initiate an integrated Human Factors Engineering R&D Program in support of Army Helicopter development; (b) Extend Military Operations in Built-Up Area (MOBA) R&D to include determining the feasibility of new weapon concepts in village and city fighting; (c) Complete the establishment of HEL Detachments at all of the DARCOM Development Centers and Test Centers - a total of 51 personnel. This accounts for the increase in funds requested.

5. Program to Completion: This is a continuing project.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.17.A Title Army Personnel and Manpower Technology

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES/PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	2354	285	2375	4077	4539	Continuing	Not Applicable
A766	Manpower Systems Management	604	90	1000	1205	1380	Continuing	Not Applicable
A767	Technology for Increasing Soldier Productivity	1750	195	1375	1200	1300	Continuing	Not Applicable
A779	Techniques of Organizational Effectiveness and Management Training	0	0	0	1600	1712	Continuing	Not Applicable
A785	Systems Development and Evaluation	0	0	0	72	147	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program develops methods and procedures useful in Army officer and enlisted personnel management which increase the quality and competence of the individual soldier and maximize mission/combat readiness of units. Included are development of: New, more cost-effective techniques for acquisition of productive soldiers and reduction of first-term attrition; better assignment and career management methods; improved personnel retention capability in critical military specialties; integrated training feedback systems; new capabilities for increased utilization of women; new leadership training and development processes for officers and non-commissioned officers to meet new job demands; and technology to support the Army Officer and Enlisted Personnel Management Systems, and the Army organizational effectiveness program.

BASIS FOR FY 1978 RDTE REQUEST: Emphasis in FY 1978 is on development of methods and procedures which increase the quality and competence of the individual soldier, and the Army personnel management capability to maximize unit mission performance and combat readiness. Work will continue in support of major Army personnel management systems and programs and in support of related advanced development efforts. Especially critical are areas of new personnel accessioning techniques to ensure personnel quality of the officer and enlisted forces, utilization of women, unit personnel capability and readiness problems, and military occupational performance standards. There is an urgent operational need for work in Organizational Effectiveness to provide the technological and methodological data base for improving unit and organizational management and problem solving. This is not to imply that the Army is not an effective organization. Although Army organizational units are effectively accomplishing a variety of constantly changing missions, there is an urgent need to improve the effectiveness of leaders and supervisors in doing business, in dealing with changing organizational problems, and in better understanding management techniques for handling projected reductions in Army headquarters and support elements with attendant increases in combat elements. Optimum use will be made of organizational effectiveness and organizational development techniques already validated in commercial industry which are applicable to the military work environment.

Budget Activity #1 - Technology Base

Program Element #6.27.17.A Title Army Personnel and Manpower Technology

BASIS FOR CHANGE IN FY 1976 OVER FY 1977: A new program will develop tools, methods and techniques to enable major Army commands and individual units to identify organizational problems and implement and evaluate solutions. Work will be directed toward experimental evaluation of modern industrial management organizational effectiveness techniques to determine usefulness in the Army; development of new military techniques for: job enrichment and job redesign, group coordination and problem solving procedures, diagnosing organizational climate and specific problems, improved communication up, down, and across chain-of-command; and diagnostic/implementation/evaluation methods to deal with other Army unit issues (such as increased proportion of women, individual training in units, low aptitude levels, high turnover rates in units and heavy unit workloads). The Army has a high priority requirement for the development of organizational effectiveness as a major capability to improve each Army organization's mission and combat readiness. This new thrust provides the technology to support this requirement.

PERSONNEL IMPACT: The average number of employees supported with requested FY 1977 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	50	0	50
(2) Contractor Employees	21	0	21
Total	71	0	71

DETAILED BACKGROUND AND DESCRIPTION: Exploratory development of an automated computer-based, enlisted personnel accessioning system has shown marked promise for Army and coordinated effort with the Navy and Air Force was initiated. Substantial progress has been achieved in use of new biographical data for prediction of soldier failures in training, and effort is underway to determine usefulness of these data for predicting later attrition. Continued development of officer accessioning techniques and officer career progression model has provided a data base for career development alternatives, assignment criteria, and computer-assisted procedures for the Officer Personnel Management System. This work provides confidence that an officer career development system can be formulated for providing optimum fit between individual careers and projected officer force qualitative requirements. Work continues on determining impact of uniquely military roles and environments on productivity of women soldiers.

RELATED ACTIVITIES: This work is coordinated with that of the Air Force Personnel Utilization Technology (6.27.03.F) and Navy Personnel Support Technology (6.27.63.N) through ODDRE Selection and Classification Topical Reviews, annual participation in the Military Testing Association, and ODDRE Budget and Apportionment Reviews.

WORK PERFORMED BY: In-house work is performed by the US Army Research Institute, Arlington, Virginia. Contractors include: Fein-Marquart Associates, Incorporated, Baltimore, Maryland 21212; Human Resources Research Organization, Alexandria, Virginia 22314; Educational Testing Service, Princeton, New Jersey 08540; Personnel Decisions, Incorporated, Minneapolis, Minnesota 55402; American Institutes for Research, Washington, D.C. 20016; Teachers College, Columbia University, New York, New York 10027. There will be approximately three additional contractors for a total dollar value of $300,000.

Budget Activity #1 - Technology Base

Program Element #6.27.17.A Title Army Personnel and Manpower Technology

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Results were achieved in several parts of this program. Computer assisted testing demonstrated a potential new technology for handling Army selection and classification testing. Performance tests, when combined with biographical data analysis, provided a new approach for detecting potentially unsuitable soldiers. Effective simulated tactical exercises were developed for Reserve Officer Training Corps (ROTC) leadership training and longitudinal evaluations of Army leadership training programs were developed. Officer military jobs and duties were analyzed in support of the Officer Personnel Management System. Surveys were developed to evaluate Army race relations and equal opportunity programs. Work was initiated on the expanded utilization of women soldiers.

2. FY 1977 Program: Key tasks include efforts in support of the ROTC career commitment model, initiation of an integrated personnel accession, development, and career management system in support of the Officer Personnel Management System (OPMS). This [illegible] will address qualitative standards and requirements, skill potential, formal training at Army Service School, on-the-job [illegible] in combat and combat support units, and job progression in officer, non-commissioned officer and enlisted career fields. [illegible] career progression system will be field-tested to validate and refine the concept for full scale implementation. Computer [illegible] testing technology will be refined and extended to include recruiting information and vocational planning information. [illegible] tion of job task analysis will be investigated to meet the needs of the US Army Training and Doctrine Command. Efforts in this area interface with work on role, selection, assignment, and utilization of women in the Army. Initial evaluation of techniques for measuring organization performance variables will be completed.

3. FY 1978 Planned Program: Methodology for operational requirements will be provided for such needs as: (a) evaluation of content and methods of leadership development, (b) recruitment and career commitment process in ROTC, (c) optimum combinations of hands-on and other methods of group and self paced instruction in cadet and officer development, (d) computer-assisted accessioning system, (e) prediction of long-term military performance of enlisted personnel, (f) evaluation of organizational performance and readiness in relation to organizational structure and officer/NCO job performance.

4. FY 1979 Planned Program: It is projected that techniques, instruments, and methodologies will have progressed sufficiently by FY 79 to allow evaluation of validity and impact on problems relating to soldier productivity, including leadership training, recruitment screening and classification, readiness to perform, career retention of qualified personnel, career progression and job requirements, organizational effectiveness, computer-aided testing, and impact of military environments; separate or parallel research to determine ways to improve productivity of women and other minority soldiers with respect to all of these factors will continue.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.19.A

Title Military Construction and Engineering Technology

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	3715	875	2812	4855	5027	Continuing	Not Applicable
AT40-01	Weapons Effects and Protective Structures	2210	480	1806	2211	2300	Continuing	Not Applicable
AT40-02	Lines of Communications and Mobility Engineering	1210	285	899	1759	1820	Continuing	Not Applicable
AT40-03	Geoscience Techniques and Methodologies	295	110	107	355	370	Continuing	Not Applicable
AT40-04	Field Validation	0	0	0	530	537	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: (1) Investigate the response of structures and facilities to nuclear and conventional weapons for targeting and defensive operations to assure system effectiveness; (2) develop technology for terrain mobility to assure that terrain is used to maximum advantage; and (3) increase effectiveness and reduce cost of construction of military facilities to support functions of the Army worldwide.

BASIS FOR FY 1978 RDTE REQUEST: Emphasis will be on maximizing technology transfer to users. Development of improved techniques for using non-nuclear explosives for barrier, channel, and breakwater construction will be expanded. Criteria for improved theater of operations protective structures will be developed, and the reliability of underground hardened facilities to withstand explosive shock will be increased. Lines of communication engineering will concentrate on ground vehicle mobility including terrain vehicle interaction, stabilization of soft soils for river crossings access and egress and over the shore logistics. Work on military airfields is limited to adapting existing technology to meet military needs. A new technical area concerned with field validations and demonstrations of protective structures designs and lines of communications operational concepts will be initiated.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: $800,000 was added to this program element to support the doctrine of Field Manual 100-5, Operations, within the approved program to fully capitalize on developments in the ground mobility and weapons effects information areas. $700,000 was reprogrammed from Program Element 6.37.34.A, Military Construction and Engineering, to retain work in the technology base that does not result in development work for hardware prototypes and procurement. $530,000 was added to support necessary field validations. The remainder of the increase is the normal cost growth wedge.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	116	0	116
(2) Contractor Employees	10	0	10

Budget Activity #1 - Technology Base

Program Element #6.27.19.A Title Military Construction and Engineering Technology

DETAILED BACKGROUND AND DESCRIPTION: Specific objectives are: To protect troops, material and equipment, and provide permanent hardened structures against nuclear and non-nuclear threats; to improve explosion effects capability and delineate employment modes for remotely delivered and preemplaced nuclear munitions; to develop, improve and apply engineering technology to support Army mobility and the use of terrain in combat and Army lines of communication; and to develop and improve the identification of physical properties and behavior of earth materials important to engineering and construction activities.

RELATED ACTIVITIES: Program Element 6.11.02.A, Project AT22, Research in Soil and Rock Mechanics. The Navy, Air Force, Defense Nuclear Agency, Defense Civil Preparedness Agency, Department of Interior, Department of Transportation, and the Energy Research and Development Administration have related mission-oriented research. Formal coordination is through annual technical reviews, the Joint Services Civil Engineering Research and Development Coordinating Group and joint interagency activities. Informal coordination is through individual contacts.

WORK PERFORMED BY: Approximately 91 percent of the work is in-house. The US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, serves as the managing laboratory and is the primary performing activity. A portion of the work is performed by the US Army Construction Engineering Research Laboratory, Champaign, Illinois. The Lawrence Livermore Laboratory, Livermore, California is a non-Army participant. There are 11 contractors participating in this work with no one contract exceeding $50,000.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Prediction techniques and design criteria for earth cover systems to defeat point detonating munitions were formulated. A metal fighting hole cover design was developed, tested and recommended for field use. The effectiveness of explosion-produced water plumes for destroying bridges and of earth-penetrating warheads for neutralizing airfield runways was demonstrated. The feasibility of using fiberglass reinforced-plastic materials for buried-arch shelters used to store ammunition was demonstrated. Three nuclear simulation test series were conducted at Fort Polk, Louisiana, to obtain data necessary to predict the response of typical surface and buried structures to nuclear blast. Two different prototype, fabric-covered underground shelters were field tested and their ability to resist high-explosive shock was determined. A concept for repair of bomb craters in airfield runways and taxiways using regulated-set cement was developed and the feasibility of the procedure was demonstrated by repairing a large crater in one hour without failure.

2. FY 1977 Program: Data collected on three nuclear simulation tests will be analyzed to establish Army doctrine relating to subsurface explosions and their effectiveness against surface and underground structures. Explosion effects research will concentrate on extracting and analyzing the data obtained from ESSEX (Effects of Subsurface Explosions) experiments. Design methods for metal-framed, fabric-covered underground shelters will be developed. Efforts will be initiated to develop criteria for using sand confinement systems for construction purposes and enhancement of shoreline trafficability. A new major thrust area in ground vehicle mobility in support of the Army's battlefield dynamics doctrine will be initiated. Beginning research will focus on refining the existing Army Mobility Model and associated data bases and improving the understanding of terrain attributes critical to ground vehicle performance. Previous work in expansive soils will be geared to foundation support.

3. FY 1978 Planned Program: The ESSEX (Effects of Subsurface Explosives) experiments will be completed and documented in appropriate field manuals. Tests with commercial bulk explosives will be conducted to determine their cratering effectiveness as anti-tank barriers and their ability to meet military bulk explosives requirements. A first version of a comprehensive computerized system for weapons effects information and analyses will be made operational. Scale-model breakwater construction tests will be conducted through the use of underwater commercial explosives as a first step in providing expedient and rapid techniques to protect ships engaged in over-the-beach operations. Hardness and demolition criteria for various urban structures that can be used during conventional warfare in built-up areas will be developed. Criteria necessary to provide rapid construction techniques and materials for approaches to bridges across extremely soft ground will be developed. Tests will be conducted on confinement systems to stabilize beach sands for over-the-shore operations. Ground mobility research will concentrate on developing computer-aided terrain mapping procedures and a methodology for predicting specific engineer support performance. Work formerly conducted under Program Element 6.37.34.A, Project DT08, Military Construction and Field Engineering Development, on field validations and demonstrations of protective structures designs and lines of communications operational concepts will continue under this project beginning this fiscal year. A methodology for selection of specific protective structures will be verified and a final design for an improved airmobile assault bunker will be validated. A computer based methodology for utilizing assault and support bridging in theater of operations will be validated. Field tests and employment techniques for the Bulk Explosive System under development by US Army Armament Research and Development Command, Dover, NJ, will be carried out.

4. FY 1979 Planned Program: The study of commercial explosives to accomplish a variety of military missions will be continued. The weapons effects package in the comprehensive computerized system for weapons effects information and analysis will be updated and expanded. Criteria will be developed for easily transportable field fortifications of bagged soil and earth-covered structural fabric materials. The response of engineer materials used for protective construction to the effects of shaped charge, large fragmentation, and fuel-air-explosion munitions will be determined. Methods of predicting the blast and shock environment within protective works will be developed. Design and analysis methods will be developed for shallow-buried shield slab protected structures subjected to aerial bombs and for deeply buried facilities subjected to nuclear weapons effects. Criteria for the use of fiberglass reinforced plastic materials for protective structures will be developed. The effects of soil and geologic conditions and backfill methods on the survivability of underground utility cables and connections will be determined. Field tests on confinement systems to stabilize beach sands in over-the-shore operations will be expanded to include other soils and confinement systems. The applicability of updated mobility terrain mapping methodology to selected combat engineering support activity will be demonstrated, and a methodology for predicting specific engineer support performances will be validated. Potential solutions to fixed installation camouflage will be investigated for feasibility and cost effectiveness. Efforts to upgrade hydrological support capability in military operations will begin. Field validations and demonstrations of protective structures designs and lines of communications operational concepts will continue.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.20.A

Title Environmental Quality Technology

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	11804	2937	12120	10360	10749	Continuing	Not Applicable
D048	Environmental Quality Research and Development	4542	855	3038	3725	3903	Continuing	Not Applicable
A835	Military Medical Environmental Quality Research	5307	1367	6072	3974	3589	Continuing	Not Applicable
A896	Environmental Quality for Construction and Operation of Military Facilities	1955	715	3010	2661	2757	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Exploratory development is conducted in air and water pollution control, noise abatement, solid waste recovery and disposal and management of hazardous materials to provide the technology base required to support Army compliance with Federal, state and local regulations for environmental quality protection. Areas of research include: Studies for establishment of health and environmental standards for Army unique pollutants, development of techniques and processes for abatement of munitions/explosives waste and cost effective methods for controlling pollution from Army installations and facilities.

BASIS FOR FY 1978 RDTE REQUEST: The funds requested in FY 1978 will permit continuation of research toward development of improved methods and procedures for aiding the preparation of comprehensive Environmental Impact Assessments/Statements; continuation of chronic toxicity research in air pollutants resulting from manufacture of munitions/explosives; continued development of processes for safe reuse of field hospital wastewater and processes for recovery/reuse treatment or disposal of munitions/explosive manufacturing wastes. Limited research will be initiated in occupational health aspects in the manufacture of munitions/explosives and recovery and reuse of depot wastewaters and industrial process waters.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The decrease in FY 1978 funds results from completion of some toxicity research and a reduction in the planned scope of effort in occupational health research relating to Army munitions/explosives manufacture.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	108	0	108
(2) Contractor Employees	1085	0	1085
Total	1193	0	1193

Budget Activity #1 - Technology Base

Program Element #6.27.20.A Title Environmental Quality Technology

DETAILED BACKGROUND AND DESCRIPTION: The objective of this research program is to provide a portion of the technology base necessary for the Army to meet environmental quality requirements as related to military operations, material and facilities in a timely and cost effective manner. The program addresses research in air pollution, water pollution, noise abatement, solid waste, hazardous materials and land management with emphasis on developing health standards for Army unique pollutants, assessment and measurement procedures, methodology and instrumentation, and development of improved and cost effective pollution control systems and processes. The projects under this program element consolidate the research of the three Army commands responsible for environmental quality activities: Project A835, Military Medical Environmental Quality Research, of the Surgeon General is concerned with health and welfare aspects of those pollutants and operations unique to or of special concern to the Army; Project A896, Environmental Quality for Construction and Operation of Military Facilities, of the Chief of Engineers deals with techniques, processes and equipment to reduce or eliminate pollution from military installations and facilities; and Project D048, Environmental Quality Research and Development, of the Army Materiel Development and Readiness Command addresses the environmental quality aspects of explosive/munition manufacture and material development.

RELATED ACTIVITIES: The Navy, Air Force, Environmental Protection Agency (EPA), Department of Health, Education and Welfare, Department of Interior, National Aeronautics and Space Administration, National Science Foundation and the Atomic Energy Commission support related activities. Within the Department of Defense (DOD) coordination is achieved through the Area Coordination Paper, on Environmental Quality, a formal coordinating document. Portions of the program are reviewed by a National Research Council Advisory Committee. Coordination is maintained between agencies conducting related activities by means of meetings, visits and joint programs in areas of mutual concern. This effort is related to and in direct support of pollution abatement projects funded by Procurement of Equipment and Missiles, Army (PEMA), Military Construction, Army (MCA), and Operations and Maintenance, Army (O&MA) appropriations.

WORK PERFORMED BY: Approximately 44 percent of the work is accomplished in house at: Cold Regions Research and Engineering Laboratory, Hanover, NH; Construction Engineering Research Laboratory, Champaign, IL; Waterways Experiment Station, Vicksburg, MS; US Army Armament Research and Development Command (ARRADCOM), Edgewood, MD; Natick Research and Development Command, Natick, MA; Mobility Equipment Research and Development Command, Fort Belvoir, VA; Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD. The remainder of the program is conducted through contracts, grants, and transfer-of-funds with industry, non-profit and educational institutions and other government agencies. Contractors having contracts over $25,000 include: University of North Carolina, Chapel Hill, NC; Stanford Research Institute, Menlo Park, CA; Mid West Research Institute, Kansas City, MO; Water and Air Research, Incorporated, Gainesville, FL; Southwest Research Institute, San Antonio, TX; University of Illinois, Champaign, IL; Life Systems, Incorporated, Cleveland, OH; General Electric Company, King of Prussia, PA; Envirex, Incorporated, Milwaukee, WI; Hydronautics, Incorporated, Laurel, MD; and Scott Environmental Technology, Incorporated, San Bernadino, CA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976 and Prior Accomplishments: Research protocols for environmental toxicology and aquatic bioassay studies were developed and approved by the National Academy of Science and EPA. Acute and subacute mamalian toxicology studies were completed on five critical munitions plant water pollutants. Environmentally safe incineration conditions were determined for disposal of organophosphorous pesticides were identified. Acute and subacute mammalian toxicity studies were completed on dinitrotolune (DNT) isomers, glyceryl trinitrate, nitrocellulose and white phosphorous. Similar studies were also completed on five air pollutants

associated with munitions manufacture. Fabrication and preliminary pilot plant studies were completed on the Medical Unit Self-contained Transportable (MUST) wastewater processing unit. Research has been completed on various physical, chemical and biological methods for treatment or recovery of waterborne waste products from munitions manufacture. Improved methods for TNT purification have been investigated to reduce pollution by products of the process to give better TNT yields. Foam separation, carbon adsorption, polymer coagulation and ion exchange methods have been evaluated for potentially cost effective physical treatment methods for removal of explosive materials from waste streams. A process for and the economics of converting nitrocellulose waste to plant fertilizer has been developed. A process for enzymatic conversion of cellulosic waste to glucose was developed and demonstrated. Instrumentation was developed to monitor acid mist air pollution at Army ammunition plants. Prior research in environmental impact analysis resulted in DA Pamphlet 200-1 to provide procedures and guidance for preparation of Environmental Impact Assessments and Statements (EIA/S). The research led to development of a computer-aided concept for EIA/S preparation; software programs and matrices have been developed for nine functional areas of Army activity; four of these functional areas have been field tested and user manuals prepared. Research has also been performed into development of procedures for acquisition of environmental baseline data to support EIA/S preparation and noise prediction models for blast and helicopter noise have been developed and evaluated; specialized noise monitoring and analysis equipment was developed and field tested to enable collection of accurate noise spectrum data at Army installations.

2. FY 1977 Program: Chronic toxicity studies initiated in FY 1975 on waterborne munitions are being completed. Final environmental standards will be recommended to the Environmental Protection Agency for nitrocellulose, dinitrotoluene, glyeryl trinitrate, white phosphorous and "pink" water. Test and evaluation of the MUST wastewater reuse pilot plant is in progress and will be completed. Research on chronic toxicity of munitions waste compounds started in FY 1976 is being continued. Limited research efforts are also being pursued into occupational health factors in manufacture and handling of munition propellants and fuels unique to military use. Studies are being completed on the environmental safety aspects of land fill disposal of lithium batteries and the development of methods for reducing oxygen demand in the effluent from mobile photo labs. Pilot process evaluation of an improved method for TNT purification that is less polluting is in process and will be completed. Continued research is being carried out to identify effective chemical, physical or biological methods for control, treatment or disposal of waterborne munitions wastes; research is also continuing on new methods and processes for recovering useful waste materials from munitions plant effluent streams for reuse in the manufacturing process. Evaluation of instrumentation techniques for realtime monitoring of munitions waste streams is being continued. Joint efforts with the Navy to develop suitable watercraft sewage containment and contentation techniques is continuing. Software development and field evaluations of additional functional areas of Army activity are being completed for the computer-aided system for EIA/S preparation. Field demonstrations and initial technology transfer efforts are being carried out on the procedures developed for environmental baseline data acquisitions. Research efforts are being initiated toward development of quantitative methodology for assessment of environmental impact. Efforts are being continued on development of design parameters for use of land treatment of wastewater by military installations. Research efforts are being continued on noise prediction. A limited effort has been initiated to aid military installations to adopt new and cost effective technology for pollution control and management by demonstration of commerically available equipment and techniques.

Budget Activity #1 - Technology Base

Program Element #6.27.20.A Title Environmental Quality Technology

3. FY 1978 Planned Program: Research will be continued for field hospital wastewater reuse to extend monitoring techniques and process capability for drinking water quality output. Chronic toxicity studies will be continued toward development of environmental standards for air pollutants associated with munitions manufacture. Limited efforts will be continued on occupational health factors associated with manufacture and handling of munitions, propellants and fuels unique to military use. Studies will be completed on procedures for separation of TNT isotrioil into components for recycle into the production process. Research will also be completed on the economics in the use of resins versus carbon for removal of munitions wastes from water. Studies on the correlation of toxicity levels of munitions wastes with current standards for water quality will also be completed. Research will be continued on identification and evaluation of cost effective chemical, physical and biological processes and systems for treatment, recovery/or disposal of munitions and depot wastes. Development of monitoring instrumentation for TNT, DNT and WP will be initiated. Studies of recovery and reuse of depot wastewaters and methods for treatment of industrial process waters will be initiated. Research and field tests of the computer-aided system for preparation of environmental impact assessments/statements (EIA/S) will be completed; research on waste characterization and procedures for acquisition of environmental baseline data will be completed and field tested. Studies for development of a quantitative impact assessment capability will be continued. Research efforts to develop a noise prediction capability for military installations will be continued and field evaluations performed. Studies of solid waste recovery and recycle techniques applicable to Army installations will be continued. Demonstration of and design parameters for vehicle washrack wastewater recycle systems and studies of oil pollution control methods for Army installations will be completed. Demonstration of commercially available pollution control equipment will be continued. A decrease in funds for the FY 1978 program over FY 1977 results from a reduction in the planned scope of research in occupational health aspects of munition, propellant and fuels manufacture and handling.

4. FY 1979 Planned Program: Research will be continued in wastewater reuse with emphasis on monitoring, chronic toxicity studies for development of environmental standards for munitions air pollutants, water and wastewater disinfection and military occupational health. Research will be continued toward identification of physical, chemical or biological treatment, recovery/disposal methods and processes for dealing with pollutants resulting from munitions manufacture, depot operations and field materiel. Development of effective monitoring techniques will be continued to enable effective abatement and control of pollution. Pilot plant operations will be undertaken of promising processes to confirm economic feasibility. Research will continue toward development of quantitative environmental impact assessment techniques and noise prediction capability. Noise mitigation research will provide guidance to installations for abatement of noisy operations. Research for development of guidelines for land use planning will be completed and implemented at installations.

5. Program to Completion: This is a continuing program.

FY 1978 MUTE DESCRIPTIVE SUMMARY

Program Element #6.27.20.A

Title Environmental Quality Technology

Project #AB33

Title Military Medical Environmental Quality Research

Category Exploratory Development

Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: The objectives are: (a) to provide a research base from which environmental quality standards can be developed for unique Army pollutants of air, water, and land and direct wastewater reuse; (b) to develop criteria for pollution control processes and systems, and (c) to develop analytical techniques and improved monitoring methods for pollutants and potable water. The effort supports the Army Surgeon General's responsibilities to monitor the health and welfare aspects of environmental pollution, to provide health and medical guidance, and to contribute to the development of abatement policies and corrective measures.

RELATED ACTIVITIES: Army studies related to this project are performed under Program Element/DA Project 6.11.02.A/BB04, Identification and Health Effects of Military Pollutants. The Army, Navy, Air Force, Environmental Protection Agency (EPA), National Aeronautics and Space Administration (NASA), National Science Foundation (NSF), Atomic Energy Commission (AEC), and Departments of the Interior, Agriculture, and Health, Education and Welfare support related activities. Coordination and program review is accomplished by a National Research Council Advisory Committee and includes participation by representatives from other activities listed above. Frequent contacts are maintained with all agencies conducting related activities by means of visits and joint programs in areas of mutual interest.

WORK PERFORMED BY: The in-house work is being performed at the US Army Medical Bioengineering Research and Development Laboratory (USAMBRDL), Fort Detrick, MD. Approximately 14 percent of the effort is in-house. Contracts and grants with industry, non-profit and educational institutions and transfer-of-funds to other government agencies make up the balance. Contracts over $100,000 are with: University of North Carolina, Chapel Hill, NC; Stanford Research Institute, Menlo Park, CA; Mid-West Research Institute, Triangle Park, NC; University of Illinois, Champaign, IL; Life Systems, Inc., Cleveland, OH; Southwest Research Institute, San Antonio, TX; National Research Council, Washington, DC; and Scott Environmental Technology, Inc., San Bernadino, CA. There are currently 76 active research efforts (nine in-house and 67 extramural). Approximately 20 percent of the extramural funds is utilized in joint contracts and to support research at other government laboratories.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976 and Prior Accomplishments: Program was started in FY 1973. Research problem definition investigations were conducted on disposal of Army pesticides, disposal of wastewater on land at Army installations, the handling and disposal of Army hospital solid wastes, and on water pollutants from Army munitions facilities. Research protocols for environmental toxicology and aquatic bioassay studies were developed and approved by the National Academy of Sciences and the Environmental Protection Agency. Detailed chemical characterization and critical review of toxicity information were completed on "pink" water and nitrocellulose and nitroglycerine wastewaters. Also completed were an improved method for determining the free available chlorine residual in water, standard methodology for evaluating water pollution sampler equipment, an effective tracer used to validate air pollution diffusion

mathematical models, and improved methods for starting operation and handling overloads to biological wastewater treatment systems. Acute and subacute mammalian toxicity and laboratory aquatic life studies were completed on the water contaminants related to the five most critical pollutants from munitions manufacture. Effective, simple methods of chemical detoxification for certain organophosphorous pesticides were identified. Environmentally safe incineration conditions have been determined for the disposal of surplus organochlorine pesticides. New procedures and analytical methods have been developed which will improve the accuracy of airborne TNT and RDX dust collection and monitoring. The field capability of producing water which satisfies EPA interim drinking water standards, from hospital wastewaters in a direct reuse mode, has been successfully demonstrated. An on-line, organics-in-water detector that is much simpler, has a much lower cost, and is capable of detecting organics in very low concentrations, has been developed. Completed studies on the fate of heavy metals and pesticides contained in wastewaters that are applied to soils at land wastewater application sites. Completed aerosol generating characterization of spray irrigation machinery used for land application of wastewater. Acute and subacute mammalian toxicity studies were completed on dinitrotoluene (DNT) isomers, glyceryl trinitrate, nitrocellulose, and white phosphorous. Acute and subacute mammalian toxicity studies and aquatic life systems screening studies were completed on "pink" water fractions, and primer compounds. Acute toxicity studies on air pollutants including tetranitromethane, emthylnitrate, and three isomers of mononitrotoluene were completed. Acute and subacute laboratory tests on aquatic life systems for nitrocellulose, nitroglycerine, white phosphorous, RDX and HMX and their decomposition products were completed. Preliminary toxicity studies were conducted to set threshold limit values for occupational exposures to trinitrotolume, nitroglycerine and RDX-HMS. Fabrication and preliminary pilot plant studies on the Medical Unit Self-Contained Transportable (MUST) water processing element were completed. Continued studies on the kinetics of the reactions and relative effectiveness of chlorine, bromine and an electro-chemical system for water and wastewater disinfection.

2. FY 1977 Program: Chronic toxicity studies started in FY 1975 on water pollutants from munitions manufacture will be completed while the studies started in FY 1976 will continue for an additional year. Environmental standards will be recommended for nitrocellulose, dinitrotoluene, glyceryl trinitrate, white phosphorous and "pink" water. Limited studies will continue in the areas of engineering control of hazards and control of hazardous and toxic substances in the occupational health field with emphasis on the munitions, fuels and propellants unique to the military departments. Studies will continue on the kinetics of the reactions and on relative effectiveness of ozone, chlorine, bromine, chlorine dioxide, and an electro-chemical cell as a bacteriocide and virucide. Research efforts will continue to support US Army Environmental Health Agency (USAEHA) for upgrading of surveillance and survey techniques for pollution monitoring. Testing of the MUST wastewater reuse pilot plant will be completed and the system will be ready to move into the prototype phase.

Budget Activity #1 - Technology Base

Program Element #6.27.20.A Title Environmental Quality Technology

Project #4A835 Title Military Medical Environmental Quality Research

3. FY 1978 Planned Program: Research will continue in the reuse of wastewater with particular emphasis toward obtaining drinking water from wastewater by extending monitoring technology to real-time quality information of those parameters critical to drinking water. Chronic toxicity studies for the development of air pollution standards for unique emissions associated with munitions manufacturing will continue. Limited studies will be continued in the areas of engineering control of hazards and control of hazardous and toxic substances in the occupational health field with emphasis on the munitions, fuels and propellant areas unique to the military departments. Decrease in FY 1978 funds from FY 1977 results from completion of toxicology studies of waterborne munitions wastes and deferral of planned scope of effort in occupational health research.

4. FY 1979 Planned Program: Research will continue in the following categories: Wastewater reuse with emphasis on monitoring technology, chronic toxicity studies for the development of air pollution standards for munitions manufacturing wastes, water and wastewater disinfection, and military occupational health problems. In addition, joint studies will be conducted with the Corps of Engineers to ensure that health aspects are integrated into the development of design criteria for upgrading wastewater pollution abatement systems at Army installations. Decrease in FY 1979 funds from FY 1978 results from completion of toxicity research on some munitions waste compounds.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	5307	1367	6072	3974	3589	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.20.A

Title Environmental Quality Technology

Project #D048

Title Environmental Quality, Research and Development

Category Exploratory Development

Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: In FY 1974 and prior years, US Army Materiel Development and Readiness Command's (DARCOM's) research in pollution abatement and environmental control technology (PAECT) was carried as Task 10 under various projects. In FY 1975 these tasks were consolidated under this project to provide better management control over pollution abatement research. Applied research and exploratory development are performed under this project to find new and improved methods, processes and equipment for the control of air, water, solid waste, hazardous material and land pollution resulting from the manufacture, handling, and disposal of explosives and munitions, the military application of organic materials, fuels, packaging, resource recovery, and environmentally acceptable methods for the development, maintenance, supply and disposal of Army materiel.

RELATED ACTIVITIES: The Navy, Air Force, and Environmental Protection Agency (EPA) have complementary programs in one or more of these areas. Coordination within the Department of Defense is achieved through the Environmental Quality Area Coordinating Paper (ACP-42). Within the Army, related and supporting research and development activities are carried out by the Surgeon General, the Corps of Engineers, and DARCOM, each within their assigned areas of responsibility. Coordination in areas of mutual interest is accomplished by visits, technical reports and review of program documentation. A five-year plan has recently been published.

WORK PERFORMED BY: Approximately 70 percent of the work is accomplished in-house at US Army Armaments Research and Development Command (ARRADCOM), Edgewood, MD; US Army Mobility, Equipment Research and Development Command, Fort Belvoir, VA; Natick Research and Development Command, Natick, MA; US Army Electronics Research and Development Command, Fort Monmouth, NJ; US Army Test and Evaluation Command, Dugway Proving Ground, UT. ARRADCOM coordinates the Project as DARCOM's Lead Laboratory for PAECT. Contracts over $25,000 that are supported by this project are: Southwest Research Institute, San Antonio, TX; General Electric, King of Prussia, PA; Envirex, Inc., Milwaukee, WI; Hydronautics, Incorporated, Laurel, MD; IIT Research Institute, Chicago, IL; Johns Manville, Incorporated, Denver, CO; New York Polytechnic Institute, New York, NJ; Hercules, Incorporated, Radford, VA; CPC International, Chicago, IL; Orion Research, Incorporated, Cambridge, MA; and American University, Washington, DC.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976 and Prior Accomplishments: Sulfur emissions from Army turbine engines were determined for various operating conditions; the effects of heavy hydrocarbon fuel components on exhaust emissions were determined; and emission spectra from engines run on synthetic crudes were recorded and analyzed as part of the fuels and emissions research effort under this Project. Studies of munition waste treatment methods have determined the completeness of the biodegradation process for nitroglycerine by identifying compounds in the effluent of the activated sludge. Reduction of nitrates in waste streams was studied in several possible systems along with techniques to maximize the degradation process. Cost effective physical treatment methods were investigated including foam separation, carbon adsorption, polymer coagulation, ion exchange resins and various ways to separate and regenerate the filter media. Improvements to the trinitrotoluene (TNT) production process have examined the selective reduction of dinitrotoluene (DNT)

isomers, the substitution of ammonium or magnesium sulfite for sodium sulfite in the purification process and various forms of recycling to increase yield and reduce waste discharge. The process and economics of converting nitrocellulose wastes into useful fertilizer were determined. Studies of wastes from other Army industrial processes have eliminated the use and discharge of mercury from crack tests in brass cartridge cases by development of a liquid crystal test; development of an electrolytic decomposition method for cyanide in waste streams from metal finishing operations; and improved development of the silver recovery and waste discharge from mobile photo labs. Other areas of pollution abatement study have developed the enzymatic/fermentation process for converting cellulosic waste to useful chemical feed stocks, developed sewage collection and holding systems for human wastes aboard small Army watercraft with methods to concentrate the waste and dispose of the residue at shore installations. Instruments have been developed to monitor acid mists in the air at ammunition plants and criteria were determined for other automatic detection of Army unique pollutants. Ecological survey methods and environmental impact assessments of Army installations and research projects have been prepared.

2. FY 1977 Program: Munition waste studies aimed at pollution elimination are advancing the trinitrotoluene (TNT) purification process change from laboratory evaluation of ammonium and magnesium sulfite to pilot plant trials and procedures are being developed for separating TNT isotrioil into its components for recycling to produce higher yields, more economical product and less waste for disposal. Munition waste studies aimed at pollution reduction by physical treatment are evaluating cost effective methods for disposal of sludges generated by carbon adsorption and polymer coagulation units. Liquid-liquid extraction studies and catalytic oxidation processes are being evaluated. Foam separation techniques are being explored for munition wastes other than TNT and powdered carbon is being studied for its adsorption efficiency and regeneration ability. Biological methods aimed at munition waste reduction are being employed in the bioconversion of waste discharge using radio-actively tagged explosives which can be traced through the metabolic processes. Fluidized bed denitrification processes are being optimized and studied for their response to operational changes, and alternate carbon energy sources for these and other biodenitrification methods are being sought. Soil degradation of waste explosives is undergoing analysis for the fate and toxicity of breakdown products. Similar analytical studies are attempting to optimize the rate and completeness of the biodegradation of nitroglycerine in the effluent of activated sludge. Munition waste studies aimed at control procedures are developing correlations of the various oxygen use values such as biological oxygen demand, chemical oxygen demand, and total organic carbon. An economic analysis is comparing the use of exchange resins versus carbon as adsorption media for explosive wastes. Chemical characterization of waste stream effluents continues to define the scope of abatement problems to be addressed and the effectiveness of procedures. Reduction of solid waste material is completing studies on the disposal of lithium batteries in land fills and the development of methods to reduce the oxygen demand in the effluent from mobile photo labs. Analyses of activated sludge systems are determining whether toxic materials buildup to cause additional pollution problems. Studies on the elimination and reduction of sewage wastes from small Army watercraft evaluate microfiltration techniques, membrane separation mechanisms, trace organometallics, and use of enzymes in contracts jointly funded with the Navy. Industrial technology with application to field and watercraft sewage disposal is being closely monitored as is commercial progress in fuel emission studies that have application to military vehicles. Monitoring and assessment technology is addressing instrumentation required for detection of pollutants in air and water. An acid mist monitor is being evaluated in field trials and a conductivity and organic nitrate monitor is being built. Studies of industrial operations aimed at pollution elimination are completing the

procedures for a liquid crystal test to reduce mercury in the brass cartridge case stress test. Decomposition of cyanide and chromate wastes from metal finishing operations are being optimized and tested in depot operations. A systems analysis of manufacturing operations is being conducted to define further research and development studies required and to recommend the most effective pollution abatement procedures.

3. FY 1978 Planned Program: Research will be continued in twenty-eight areas of the thirty-four funded in FY 1977 and eight new work areas will be initiated requiring an increase in funds. Studies will be completed on procedures for separation of trinitrotoluene (TNT) isotricil into its components for recycle into the production process giving less waste discharge. Physical treatment studies will be performed to provide recommended methods for disposal of sludges resulting from carbon adsorption and polymer coagulation processes. Utility of powdered carbon and carbon regeneration techniques will be further evaluated. Liquid-liquid extraction and catalytic oxidation methods will be optimized. Foam separation techniques, if useful for munition wastes other than TNT, will have procedures defined and the limits established. New studies on the reduction of TNT on resin beds and contacting methods in physical, chemical, and biological treatment methods will become the basis for improving procedures and increasing cost effectiveness. Study of biological treatment methods for munition waste reduction will determine the nature of metabolites from bioconversion processes and their acceptability for discharge. Denitrification techniques will be optimized and evaluated in practical applications for the limits of operational changes. Alternate sources for carbon energy in the biological processes will continue to be screened for widest application and soil degradation of additional explosive materials will be analyzed. Biodegradation of nitroglycerine in the effluent of activated sludges will be evaluated in practical applications. Studies on the control of munition wastes will expand characterization and analysis efforts to become as inclusive as possible at munition plants and verify effectiveness of improved abatement procedures. Studies of toxicant buildup in activated sludge systems will be pursued. Jointly funded contract efforts will explore new microfiltration techniques, reverse osmosis membrane separation and fouling mechanisms and vacuum filtration for collection and concentration of human wastes aboard small Army watercraft. Industrial technology will be continuously monitored for its application to field and watercraft problems and vehicle emission studies. Monitoring and assessment technology studies will evaluate the conductivity and organic nitrate (CONTOC) monitor and begin development of TNT, dinitrotoluene (DNT) and white phosphorus (WP) monitoring instruments if prior studies indicate feasibility. Studies of industrial operations aimed at pollution elimination will complete cyanide electrolytic decomposition procedures and advance methods for chromate reduction. The systems analysis of manufacturing operations will further define pollution abatement requirements and fit solutions to specific applications. New studies will address recovery and reuse of depot waste waters and treatment of industrial process waters including extraction of metal salts from electroplating wastes.

4. FY 1979 Planned Program: Thirty-two research areas of the thirty-six planned for FY 1978 will be continued into FY 1979 with approximately 10 new studies planned for initiation requiring an increase in funds. Munition waste studies aimed at pollution elimination will focus on additional TNT process redesign and recycle to increase product yield and reduce polluting effluents. Physical treatment studies to reduce munition waste will concentrate on various catalytic oxidation processes and optimization of process equipment with determination of waste removal effectiveness. Foam separation and precipitation techniques will be studied for the widest application and most suitable economics. Various carbon regeneration methods will be completed and a final report on physiochemical unit processes will be prepared. Studies of contracting methods in physical, chemical, and biological treatment

methods will determine settling characteristics of generated solids, system design criteria will be optimized, and be economically compared to other methods. Biological treatment studies will continue to analyze products of the bioconversion processes under consideration to determine the most effective method for each potential application. Pilot plant studies will provide scale-up data and permit economic analyses. Characterization studies of munition plant effluents will determine effectiveness of newly applied technology. Watercraft sewage collection and treatment methods will be evaluated and their application to field situations determined. Industrial technology and developments will be monitored closely for potential utility. Vehicle emission techniques will be applied to military engines as required to determine compliance with applicable standards. Monitoring and assessment technology studies will complete the evaluation of the conductivity and organic nitrate (CONTOC) monitor and proceed with evaluation of other specific monitors that should become available. Studies of industrial operations aimed at pollution reduction will investigate recovery and reuse of depot wastewater and develop treatment and recycle procedures for industrial process waters.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	4542	855	3038	3725	3903	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.27.22.A

Title Army Training Technology

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES/PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	3106	1086	3876	4967	4819	Continuing	NA
A764	Training & Education	1983	748	2276	1767	1651	Continuing	NA
A765	Human Factors in Syst Dev & Opn	1123	338	1600	1500	1435	Continuing	NA
A777	Indv Training Technology	0	0	0	1700	1733	Continuing	NA

BRIEF DESCRIPTION OF ELEMENT: Development of a technological and methodological base for the improvement of individual and unit proficiency and battlefield weapon and information system effectiveness through advances in training methods, performance assessment techniques, instructional systems, and man-machine-mission synergism (total effect greater than sum of independent effects). For FY 78 and FY 79, part of research formerly comprising Project A764 has been transferred to Project A777.

BASIS FOR FY 1978 RDTE REQUEST: Continue exploratory development to insure that the technology for more efficient and effective training and melding of the soldier with his job, equipment or system is available to enable exploitation of the potential of hardware technology which will be necessary to meet the challenge to "fight outnumbered and win" and "win the first battle".

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Expanded emphasis on performance oriented skill development and evaluation, and training program design which can be implemented on an individual, team or unit basis at a duty station, and the need to develop and implement principles and methods for conducting training cost-effectiveness analyses.

PERSONNEL IMPACT: The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	69	0	69
(2) Contractor Employees	24	0	24
Total	93	0	93

DETAILED BACKGROUND AND DESCRIPTION: Human factors in systems development and operation provides methodological and mission oriented technological advances in support of the development, assessment, and application of improved doctrine, work methods and system design concepts for enhanced operator/user performance in military systems and contexts. The focus is on more effective utilization and extension of human perceptual, motor and cognitive abilities in the processing and utilization of information, the control

and management of system resources, and in the configuration of organizational and system elements.
Individual training technology provides the base for development of more effective individual job training, more valid measures of job performance and training program effectiveness, models for predicting learning and retention of skills, and training information feedback systems to relate field performance to instructional system requirements.
Training and education provides technological and methodological advances to support development of predictive models of training devices and media effectiveness, games/simulations to maximize transfer of training for more cost effective training of command group personnel and teams, criterion referenced measurement for evaluating weapon crew and tactical unit proficiency, engagement simulation technique for combat unit effectiveness analysis and combat developments testing, collective training concepts for armor weapons systems, flight simulation requirements for predicting trainee success and optimizing flight training programs.

RELATED ACTIVITIES: 6.37.43.A, Training and Utilization in Military Systems; 6.27.57.H, Training and Human Engineering Technology; 6.22.05.F, Training and Simulation Technology. The Integrated Department of Defense Plan for Research and Development on Computers in Education and Training provides for non-redundant complementary and supplementary effort in this area among the three services and Defense Advanced Research Projects Agency.

WORK PERFORMED BY: Science Applications, Inc., Arlington, VA; System Development Corp., Santa Monica, CA; University of Texas, Austin, TX; Perceptronics, Woodland Hills, CA; Applied Psychological Services, Wayne, PA; Human Resources Research Organization, Alexandria, VA; American Institutes for Research, Pittsburgh, PA; Applied Science Associates, Valencia, PA; Galler Associates, Arlington, VA. There will be approximately six additional contractors for a total dollar value of $500,000. In-house organization responsible for program is U.S. Army Research Institute for the Behavioral & Social Sciences, Arlington, VA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments Techniques were developed which provided the basis for the extremely realistic, motivating training method for small combat arms units known as REALTRAIN. The feasibility of using automated tactical data systems in the field for training a variety of military skill was demonstrated and led to a current advance development effort for using TACFIRE as a self trainer. A model which includes man as an integral component in formation handling systems was developed as a tool to examine relative effectiveness of alternative system options under a variety of conditions. Nap-of-the-Earth (NOE) navigation performance data were obtained for helicopter pilots and utilized to diagnose deficiencies and identify training needs. Methods were developed to teach low mental ability personnel to function more effectively in the military environment. Principles for synthetic testing were developed to guide determinations of the degree to which testing can depart from operational conditions and for selecting tasks appropriate for synthetic testing. A preliminary version of an adaptive computer training system module for electronic trouble shooting has been developed and demonstrated. Data from Field and Command post exercises have been analyzed and form the basis for feasibility determinations regarding the benefits of micro processor technology in battle simulations. The relative value of color as a coding dimension in computer-driven graphic displays of tactical information has been initially determined and rules for use hypothesized.

2. FY 1977 Program: Training media evaluation model will be integrated with the advanced development model for predicting train-

ing device effectiveness and evaluated in terms of feasibility for optimum device/media combination selection. Courseware/software for evaluating adaptive instruction technology in an operational environment will be completed. A preliminary model for combined arms communication performance will be evaluated in engagement simulation exercises. Design and tryout alternative feedback techniques for Army Training and Evaluation Programs. Comparative skill analyses of the M60A1, M60A1AOS, XM1 and M48A5 tank systems will be performed. Prototype synthetic tests of representative perceptual-motor tasks will be developed. Various approaches for interfacing a user with automated displays will be examined for efficacy. Shared initiative concepts for tactical data input and retrieval will be developed. Experiments on the efficacy of mnemonic coding under mental load stress will be conducted. Feasibility of developing a predictive model or assessing the impact of doctrinal changes on battle staff functional relationships will be determined. Programs which can be conducted at duty stations to achieve and maintain performance-based skills and knowledges will be developed. Other efforts will emphasize: development of mission-specific simulated performance tests; methods for determining proficiency standards and verifying skill levels; training strategies for lateral job entry; methods for predicting the effectiveness of performance-based job and training literature; individual performance-based evaluation and feedback; models for measuring and optimizing cost benefit characteristics of individual extension training systems for combat arms Military Occupational Specialities.

3. FY 1978 Planned Program: A new project will focus on technology for performance-based skill development and evaluation which can be conducted at duty stations, and for valid cost and training effectiveness methodologies which offer the potential for major improvements in job performance and maximum economy in achieving these improvements. Other effort includes optimizing multi-media training delivery systems, developing guidelines for instructional systems design aids, validating model incorporating training device/media components for early prediction of efficacy; developing commanders handbook for battle simulation training need diagnosis; documentation and integration of team training strategies with instructional system design; formulating application guidelines for training technology transfer assessment; developing specialized materials for incorporation of improved feedback techniques and identification of training program design requirements to support Army Training Evaluation of automated information integration and interpretation techniques; design of test bed for assessment of data base purge alternatives; refinement of model of battle staff organizational functions; determination of optimum display requirements for helicopters.

4. FY 1979 Planned Program: Continuing technolgy development will include experimental procedures for computer-aided-instructional system development; model for training technology transfer assessment; model for developing command staff battle simulations; casualty expectancy model for unit engagements; tactical performance measures for use in cost and training effectiveness analyses. Criterion referenced test model to establish test length and cut score; optimal training strategies for acquiring, retaining, and updating critical job skills; methodologies for design of efficient instructional and evaluation systems at duty stations; training information feedback system for improved training policy and procedures, development and revision of training programs, and distribution and utilization of personnel; requirements for field exercise control and evaluation systems; user optimized dynamic and static display needs; model for control of man/machine allocations in air defense systems; principles of military organizational design and operation; influence of information properties on though processes and inference.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.27.23.A

Title Clothing, Equipment and Packaging Technology

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	2,672	551	2,406	3,450	3,934	Continuing	Not Applicable
AH98	Clothing, Equipment and Packaging	2,372	467	2,041	3,140	3,534	Continuing	Not Applicable
AH98-01	Clothing and Equipment	1,720	259	1,215	1,896	2,186	Continuing	Not Applicable
AH98-02	Vunerability Protection	42	0	201	215	215	Continuing	Not Applicable
AH98-03	Materials	610	208	625	1,029	1,133	Continuing	Not Applicable
A427	Tactical Rigid-Wall	300	84	365	310	400	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program includes the exploratory development of individual combat protective clothing and equipment to increase combat efficiency and provide protection for the combat soldier against battlefield hazards and the natural environment. It includes field service equipment, field shelters, rigid-wall shelters, and packaging for ammunition, general supplies or other commodity items.

BASIS FOR FY 1978 RDTE REQUEST: Continue exploratory development effort with emphasis on research on textile fibers and fabrics for ballistic and chemical protection, on vulnerability reduction for munitions packaging, and on development of improved field and a family of rigid-wall shelters. Development will also continue on energy conservation through lightweight clothing and equipment systems, response of materials to high energy sources, eye protective devices and design criteria for packaging containers. Exploratory development begins on a system of combat vehicle crewman's clothing.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Increased funding is for development of chemical defensive materials, plus other protective devices, which are more effective against projected battlefield threats and for initiating development of a combat vehicle crewman's clothing system.

Budget Activity #1 - Technology Base

Program Element # 6.27.23.A Title Clothing, Equipment and Packaging Technology

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ Employees	79	0	79
(2) Contractor Employees	5	0	5
Total	84	0	84

DETAILED BACKGROUND AND DESCRIPTION: This program element (PE) is to increase human performance, environmental protection, and personal comfort; reduce the weight of soldier clothing and equipment; upgrade levels of protection against chemical agents, flame and fragmentation weapons, investigate countermeasure systems that provide camouflage against electro-optical devices; conduct investigations designed to develop improved personnel armor; and explore materials and designs to protect the eyes against nuclear flash, laser, and ballistic threats. Also included are studies to improve field service equipment, field life facilities, rigid-wall shelters, and the development of design criteria for field shelters. Packaging technology includes the improvement of packaging for ammunition, general supplies and other commodity items to increase protection and lighten the soldier's load.

RELATED ACTIVITIES: Related research is conducted by coordination with each of the other Services who develop their own Service-related clothing and equipment items. Coordination and liaison with industry is accomplished by US Army Natick Research and Development Command (NARADCOM) personnel. The exploratory development efforts performed under this PE move to advance development under PE 6.37.47.A, Soldier Support/Survivability and engineering development under PE 6.47.13.A, Combat Feeding, Clothing and Equipment; and PE 6.47.17.A, General Combat Support.

WORK PERFORMED BY: In-house efforts are performed by the US Army Natick Research and Development Command, Natick, MA; US Army Armament Research and Development Command (ARRADCOM), Aberdeen, MD; and the US Army Aero-Medical Laboratory, Fort Rucker, AL. Contracts include Battelle Columbus Labatories, Columbus, OH; Moleculon, Cambridge, MA; Aerotherm, San Diego, CA; Georgia Tech, GA; Arthur D. Little, Cambridge, MA; IIT Research Institute, Chicago, IL; Lehigh, Allentown, PA; Gentex, Carbondale, PA; Sierra Engineering, Sierra Madre, CA; Southwest Research Institute; and J.P. Stevens, New York, NY.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS

1. FY 197T, FY 1976, and Prior Accomplishments: Clothing and equipment technology efforts include completion of exploratory development of the following items: nylon and ceramic armor vests; tropical combat uniforms; heated handwear; flame protective clothing; improved designs for personnel camouflage; and experimental helmet and personnel body armor prototypes. Packaging technology resulted in increased moisture protection and fire resistant treatment for ammunition packaging, and instrumentation to

record environmental data during transportation and storage of packaged items. New clothing insulating concepts were developed which provide a significant increase in low temperature tolerance time. A power activated electro-optical protection device which provides nuclear flash protection was proven feasible. Wind tunnel tests of fabric and air-supported shelters were completed. A prototype accordian-type field shelter was evaluated. A manufacturing method to directly mold expanded polyurethane outsoles onto combat boot uppers was developed under contract. Body measurement data representing 50,000 women was collected. Developed new methods of camouflage printing on uniforms and piece-dyeing of nomex. Established the theoretical basis and design of flexible materials for control of infra-red emittance. Successfully prepegged and laminated Kevlar fabric with a water-repellant treatment.

2. FY 1977 Program: Continue exploratory development of: textile fibers and fabrics for chemical protection by studying activated carbon and other approaches; effects of fragment/yarn interactions upon ballistic performance of Kevlar unlaminated and laminated materials; effectiveness of various polymeric systems against a variety of thermal sources; most promising approaches to achieving novel porous sheets to replace woven and knitted fabrics; relationship of chemical structure of dyes to their effects on physical and chemical properties of various fabrous substrates; materials for reduction of thermal emittance and investigate pigments and formations used in camouflage of equipment; selection and evaluation of material to be used in eye protective devices; problems associated with present field tentage and space heaters; design studies of women's field uniforms; improved hardware for tactical shelters; and alternate methods of shelter construction.

3. FY 1978 Planned Program: Continue exploratory development by using novel textile structures containing activated carbon or other sorbent material to improve chemical protected clothing; continue ballistic protective studies by determining actual danger due to transient deformation plus internal injuries; continue studies of the response to high energy sources; evaluate novel porous sheets in end items as replacements for woven fabrics; study fundamental photochemical process involved in fading of dyes; continue research on an integrated adaptive camouflage system; investigate photosensitive compounds for flashblindness protection; continue to develop a new generation of field tentage and improve field heaters and bath/laundry systems; utilize data from women survey to adequately size women's clothing and equipment; and continue studies to define and develop methods of shelter construction. Initiate development of a combat vehicle crewman's clothing system. Increase in funding due to expanded efforts to improve chemical protective clothing and to develop combat vehicle crewman's clothing system.

4. FY 1979 Planned Program: Continue exploratory development of: chemical and ballistic protective materials which will provide increased levels of protection and be less bulky and lighter weight; fiber technology; clothing dyes and camouflage patterns which will aid in concealing the soldier from detection by surveillance devices; structural designs and materials for vulnerability protection in packaging/containers; studies in field service equipment; eye protection devices which provide protection against laser, ballistic and nuclear hazards; materials and designs for shelters; materials for protection against high energy sources; and combat vehicle crewman's clothing system. The funding increase is due to the increased level of research in passive countersurveillance, studies in field service equipment, and textile fiber utilization technology.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.23.A

Title Clothing, Equipment, and Packaging Technology

Project #AH98

Title Clothing, Equipment, and Packaging

Category Exploratory Development

Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: This project is to increase human performance, environmental protection, and personal comfort; reduce the weight of soldier clothing and equipment; upgrade levels of protection against chemical agents, flame and fragmentation weapons; investigate countermeasure systems that provide camouflage against electro-optical devices; conduct investigations designed to develop improved personnel armor; and explore materials and designs to protect the eyes against nuclear flash, laser, and ballistic threats. Also included are studies to improve field service equipment, field life facilities, and the development of design criteria for field shelters. Packaging technology includes the improvement of packaging for ammunition, general supplies and other commodity items to increase protection and lighten the soldier's load.

RELATED ACTIVITIES: Related research is conducted by coordination with each of the other Services who develop their own Service-related clothing and equipment items. Coordination and liaison with industry is accomplished by U.S. Army Natick Research and Development Command personnel. The exploratory development efforts performed under this project move to advance development under P.E. 6.37.47.A, Soldier Support/Survivability and engineering development under P.E. 6.47.13.A, Combat Feeding, Clothing and Equipment.

WORK PERFORMED BY: In-house efforts are performed by the U.S. Army Natick Research and Development Command, Natick, MA; U.S. Army Armament Research and Development Command (ARRADCOM), Aberdeen, MD; and the U.S. Army Aero-Medical Laboratory, Fort Rucker, AL. Contracts include Battelle Columbus Laboratories, Columbus, OH; Moleculon, Cambridge, MA; Aerotherm, San Diego, CA; Georgia Tech, GA; Arthur D. Little, Cambridge, MA; IIT Research Institute, Chicago, IL; Lehigh, Allentown, PA; Gentex, Carbondale, PA; Sierra Engineering, Sierra Madre, CA; Southwest Research Institute, San Antonio, TX; and J.P. Stevens, New York, NY.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Clothing and equipment technology efforts include completion of exploratory development of the following items: nylon and ceramic armor vests; tropical combat uniforms; heated handwear; flame protective clothing; improved designs for personnel camouflage; and experimental helmet and personnel body armor prototypes. Packaging technology resulted in increased moisture protection and fire resistant treatment for ammunition packaging, and instrumentation to record environmental data during transportation and storage of packaged items. New clothing insulating concepts were developed which provide a significant increase in low temperature tolerance time. A power activated electro-optical protection device which provides nuclear flash protection was proven feasible. Wind tunnel tears of fabric and air-supported shelters were completed. A manufacturing method to directly mold expanded polyurethane outsoles onto combat boot uppers was developed under contract. Body measurement data representing 50,000 women were collected. Developed new methods of camouflage printing on uniforms and piece-dyeing of nomex. Established the theoretical basis and design of flexible materials for control of infra-red emittance. Successfully prepegged and laminated Kevlar fabric with a water-repellant treatment.

Budget Activity #1 - Technology Base

Program Element # 6.27.23.A Title Clothing, Equipment, and Packaging Technology

Project #AH98 Title Clothing, Equipment, and Packaging

2. FY 1977 Program: Continue exploratory development of: textile fibers and fabrics for chemical protection by studying activated carbon and other approaches; effects of fragment/yarn interactions upon ballistic performance of Kevlar unlaminated and laminated materials; effectiveness of various polymeric systems against a variety of thermal sources; most promising approaches to achieving novel porous sheets to replace woven and knitted fabrics; relationship of chemical structure of dyes to their effects on physical and chemical properties of various fabrous substrates; materials for reduction of thermal emittance and investigate pigments and formations used in camouflage of equipment; selection and evaluation of material to be used in eye protective devices; problems associated with present field tentage and space heaters; design studies of women's field uniforms; and alternate methods of shelter construction.

3. FY 1978 Planned Program: Continue exploratory development by using novel textile structures containing activated carbon or other sorbent material to improve chemical protected clothing; continue ballistic protective studies by determining actual danger due to transient deformation plus internal injuries; continue studies of the response to high energy sources; evaluate novel porous sheets in end items as replacements for woven fabrics; study fundamental photochemical process involved in fading of dyes; continue research on an integrated adaptive camouflage system; investigate photosensitive compounds for flashblindness protection; continue to develop a new generation of field tentage and improve field heaters and bath/laundry systems; utilize data from women survey to adequately size women's clothing and equipment. Initiate development of a combat vehicle crewman's (CVC) clothing system. Increase in funding due to expanded efforts to improve chemical protective clothing and to develop CVC clothing system.

4. FY 1979 Planned Program: Continue exploratory development of: chemical and ballistic protective materials which will provide increased levels of protection and be less bulky and lighter weight; fiber technology; clothing dyes and camouflage patterns which will aid in concealing the soldier from detection by surveillance devices; structural designs and materials for vulnerability protection in packaging/containers; studies in field service equipment; eye protection devices which provide protection against laser, ballistic and nuclear hazards; materials and designs for shelters; materials for protection against high energy sources; and combat vehicle crewman's clothing system. The funding increase is due to the increased level of research in passive countersurveillance, studies in field service equipment, and textile fiber utilization technology.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	2,372	467	2,041	3,140	3,534	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.27.24.A

Title Food Technology

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	8,880	2,080	9,725	8,062	6,723	Continuing	Not Applicable
AH99A	Analysis and Design of Military Feeding Systems	1,504	400	2,226	1,850	1,900	Continuing	Not Applicable
AH99B	Subsistence Technology	3,893	1,090	4,382	3,090	1,547	Continuing	Not Applicable
AH99C	Food Service Technology	518	200	651	100	100	Continuing	Not Applicable
AH99D	Radiation Preservation of Food	2,965	390	2,466	3,022	3,176	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Conduct exploratory development efforts in food service and subsistence technology to achieve significant improvements in military food service systems and operations within the Department of Defense. Determine techniques for maximizing the retention of essential nutrients and consumer acceptability of food during processing/preservation; develop methods to reduce the weight and volume of ration components, thereby reducing packaging and transportation costs.

BASIS FOR FY 1978 RDTE REQUEST: Complete Army/Marine Corps Field Feeding System Analysis and design efforts; continue efforts to find a substitute for Trichloromelamine (TCM); continue systems analysis of Army hospital food service operations; initiate efforts on a mechanized system for inventory control for Air Force; continue Navy afloat food service system analysis and continue irradiation support to wholesomeness feeding tests of irradiated foods.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Reduced funding in FY 1978 is accounted for primarily in the transfer of $1 million dollars from this program element to the 6.3 portion of the program (6.37.47.A-D610 - Food Advance Development).

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	213	0	213
(2) Contractor Employees	23	0	23
Total	236	0	236

Budget Activity #1 -Technology Base

Program Element # 6.27.24.A Title Food Technology

DETAILED BACKGROUND AND DESCRIPTION: This program element includes the exploratory development projects and requirements conducted by the Army, as executive agent for the Department of Defense (DOD) Food Research, Development, Testing and Engineering (RDT&Eng) program for all Services and the Defense Supply Agency, as prescribed in DOD Directive 1338.10 and Manual 1338.10. This work is designed to improve garrison and field food service by improving quality, acceptance, and shelf life of subsistence; reducing manpower requirements and total food service costs; improving facilities and equipment; eliminating rigid containers; reducing volume and weight of rations and reducing loss of subsistence because of microbial contamination and insect and rodent damage. Food irradiation services are also provided in this program element in support of wholesomeness tests conducted in 64713-DL47.

RELATED ACTIVITIES: Work conducted in this program element is part of the DOD Food RDT&Eng program, which also has projects in the following areas: 61102-AH52, Basic Research in Support Equipment for the Individual Soldier; 63747-D610, Food Advance Development; 64713-DL47, Wholesomeness Testing of Irradiated Foods; and 64713-D548, Military Subsistence Systems.

WORK PERFORMED BY: In-house effort is conducted by the U.S. Army Natick Research and Development Command, Natick, Massachusetts, with support from other government laboratories, such as the U.S. Department of Agriculture Regional Laboratories, universities, and industry contractors. Other participating government agencies include the Department of Commerce, Energy Research and Development Agency and National Research Council. Contractors include: Boston University, Boston, MA; National Research Council, Washington, DC; Oregon State University, Corvallis, OR; Innovative Foods, Incorporated, San Francisco, CA; Associated Food Equipment Company, Dallas, TX; University of Alabama, Huntsville, AL; and Oregon Freeze Dry Foods, Incorporated, Albany, OR.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Technology for preservation of meat items by irradiation was greatly improved and a contract was awarded for wholesomeness testing of irradiated beef. Development of reversible compression techniques for freeze- and air-dried fruits and vegetables has led to the introduction of several of these products into Armed Forces menus, permitting significant reductions in volume and weight of military rations. A seven-year cycle for rotating refrigerated combat rations, in lieu of three-year rotation of dry stored rations gave a significant savings in rotation costs. Completed the Uniform Ration Cost System Study for the DOD. Completed investigations of effects of prolonged freezer storage on quality of turkey, making expansion of production base and reduced procurement costs possible. Demonstrated that the Basic Allowance for Subsistence (BAS) is more costly, while the Ala Carte features of the system offered more effective operations with improved consumer acceptance in the Navy. Further advances were made in reversibly compressed products and new items were introduced into the supply system.

2. FY 1977 Program: Completion of evaluation of proposed ration cost system procedures; initiate analysis of Marine Corps Food Service System; and development and evaluation of alternative methods for application to current food service systems afloat. Methods are being expanded for application of natural anti-oxidants to extend shelf-life of ration items, and for development of a chemical dispersal system to replace both residual and space treatment in military warehouses. Continue efforts with food storage equipment directed towards maximum utilization of storage volume; and work to identify, test and apply techniques for improved ration dense foods for submarines.

Budget Activity #1 - Technology Base

Program Element # 6.27.24.A Title Food Technology

3. FY 1978 Planned Program: Conclude field feeding system analysis and design; develop a substitute for Trichloromelamine for use in disinfecting food; continue packaging reduction and subsistence compaction for use aboard submarines; and develop quality assurance techniques for polymeric food packages. Reduced funding in FY 1978 is result of transfer of $1 million dollars to the 6.3 level of efforts.

4. FY 1979 Planned Program: Implement Army Field Feeding System results; develop a new water tank heating system; investigate in-port feeding system for shipboard personnel; examine the feasibility of on-base commercial food service operations; and the feasibility of regional consolidation of military food preparation. Reduced funding reflects further transfers of money and service requirements to the 6.3 advanced development level of efforts.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.27.24.A

Title Food Technology

Project #AH99

Title Food Technology

Technical Area AH99B

Title Subsistence Technology

Category Exploratory Development

Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: This technical area includes food-related research, combined in 1972 from a number of different program elements and projects to clearly identify in one area the exploratory development efforts in subsistence technology, and further broadened in FY 1974 to incorporate efforts in human factors studies on military feeding systems and food packaging. The objectives of this technical area are to support the Department of Defense (DOD) Food Service Program, as set forth in DOD Directive 1338.10 and 1338-10-M, by: (a) establishing data and techniques towards overcoming the deterioration which process treatments and storage induce in quality and serviceability of military subsistence, and (b) establishing the food product, process, package, and human factors parameters which are essential to the subsistence requirements of the military services.

RELATED ACTIVITIES: This project is part of the DOD Food, Research, Development, Testing and Engineering Program (DOD Food RDT&Eng Program) and includes Army, Air Force, Navy, and Marine Corps requirements and supports the Defense Supply Agency (DSA). The Army is executive agent for the DOD Food RDT&Eng Program per DOD manual 1338.10. Service requirements are coordinated by Service representatives attached to the U.S. Army Natick Research and Development Command, Natick, Massachusetts. The overall DOD program is reviewed and assigned priorities by a Joint Formulation Board made up of representatives of the Services, The Surgeon General and the Defense Supply Agency (DSA). Coordination with industry and university programs is through the Research and Development Associates and the National Academy of Sciences advisory committees made up of leading food technologists, scientists and operational research personnel.

WORK PERFORMED BY: The U.S. Army Natick Research and Development Command performs in-house laboratory work, with support from other laboratories, universities and industry contractors. Participating Government agencies and contractors include the General Supply Agency; U.S. Department of Agriculture; Letterman Army Institute of Research; Construction Engineering Research Laboratory; and contractors include: Utah State University, Logan, Utah; National Academy of Science/National Research Council, Washington, D.C.; Shankman Laboratory, Los Angeles, California; Massachusetts Institute of Technology, Cambridge, Massachusetts; and Swift and Company, Oakbrook, Illinois.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Storage life of packaged combat rations and meal components was extended by reducing oxidation and other deteriorative processes. Improvement of freeze-drying techniques reduced shrinkage and loss of dehydration properties in freeze-dried fruits packed under vacuum. Investigation of factors affecting flavor, texture and keeping quality of flexibly packaged baked products resulted in better formulations and improved products. Compounds were identified that

Budget Activity #1 - Technology Base

Program Element # 6.27.24.A Title Food Technology

Project #AH99B Title Food Technology

Technical Area AH99B Title Subsistence Technology

are potential barriers to penetration of food packaging by insects and rodents. Improved measurement techniques were developed for sensory evaluation and food acceptance tests. A contract effort established an automated production line to form, fill, seal and heat-process flexible packages of foods to be used as components of a new operational ration. Investigations of prolonged freezer storage on the quality of turkey has made possible the expansion of the procurement base and a reduction of the procurement cost of frozen turkey rolls. Completed several food service preference studies from service installations in conjunction with such projects as the Uniform Ration Cost System, Air Force and Army contractor-operated food service facilities and Air Force installation food service system analysis. These data not only provided valuable input to the stated projects, but continue as a data base for similar projects, and serve as the basis for the development of service menus which reflect customer food and feeding frequency preferences. Several compacted foods were designed to help resolve the subsistence stowage problems aboard Navy submarines. Techniques were developed for the rapid detection of microbial contamination in certain precooked, frozen meat items, which reduced the time from the current standard of 24-48 hours to six hours. Compiled a data base for evaluating the sanitation and safety of feeding systems and developed techniques for monitoring the systems more efficiently. Published a report of the Armed Forces Food Preferences, the first overall analysis of the food preferences of all four Services, and the first comparison of how the Services differ in preferences. Developed an injection molded, high density, polyethyline container for the Meal, Ready-to-Eat, which is completely insect resistant. Made further advances in reversibly compressed products and new items into the supply system.

2. FY 1977 Program: Continue to examine food habits and appetite control in man; identify and assay animal and plant sterols and related compounds in dehydrated prepared foods; develop an improved in-flight food packet; develop a substitute for trichloromelamine; and develop quality assurance techniques for polymeric food packages and films. Continue exploratory development of ration dense foods for nuclear submarines.

3. FY 1978 Planned Program: Continue development of substitute for trichloromelamine for use in disinfecting food; packaging reduction and subsistence compaction for use aboard submarines; and quality assurance techniques for polymeric food packages. Develop a means of protecting subsistence packaging from microbial damage and determine the effects of insect and/or rodent secretions and eexcretions on the serviceability of military subsistence. Reduced funding in FY 78 reflects results of transfer of $1M to 6.37.47-D610, Food Advance Development.

4. FY 1979 Planned Program: Examine the food habits of females in relationship to military subsistence and feeding practices; develop shelf-stable salad ingredients by use of cryoprotective agents; evaluation of effect of climate on food habits and the relation of such food habits to job performance; develop an insect-resistant treatment polyethylene shroud (bag) for pallet size loads; and develop a non-polluting packaging/packing material for subsistence use and application. Reduced funding is result of transfer of $1.5M to 6.37.47-D610, Food Advance Development.

Budget Activity #1 - Technology Base

Program Element # 6.27.24.A Title Food Technology

Project #AH99B Title Food Technology

Technical Area AH99B Title Subsistence Technology

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	3,893	1,090	4,382	3,090	1,547	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.27.24.A

Title Food Technology

Project # AH99

Title Food Technology

Technical Area AH99D

Title Radiation Preservation of Food

Category Exploratory Development

Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: This technical area concerns the exploitation of the potentials of ionizing radiation for food preservation to make available a new source of ration components including fresh-like familiar foods, in cans and in flexible lightweight packaging. The ration items require no refrigeration or special preparation prior to serving and are suitable for global use. Major efforts are directed toward supporting on-going wholesomeness feeding tests to demonstrate the suitability of irradiated beef, pork, chicken and ham for unrestricted human consumption.

RELATED ACTIVITIES: This project is part of the Department of Defense (DOD) Food Research, Development, Testing and Engineering Program, for which the Department of the Army serves as the Executive Agent. Work conducted in this program element is directly related to wholesomeness feeding tests being conducted in project DL47 - Wholesomeness Testing of Irradiated Foods, of program element 6.47.13.A - Combat Feeding, Clothing and Equipment.

WORK PERFORMED BY: The US Army Natick Research and Development Command performs in-house laboratory work, with support from other laboratories, universities and industrial contractors. The Army Surgeon General, through his Medical Research and Development Command has primary interest in the efforts of this technical area, especially as it relates to wholesomeness feeding tests. Contractors include the University of Nebraska, Lincoln, Nebraska; and Boston University, Boston, Massachusetts.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976 and Prior Accomplishments: In-house gamma and electron sources have been designed, installed and improved for research on food irradiation for quantity radiation processing of meats for wholesomeness tests. Technology, dosimetry, microbiology and related parameters have been established for irradiated bacon, ham, other pork products, chicken, selected marine foods, beef, disinfected flour and sprout-inhibited potatoes. Recent efforts have shown that irradiation allows reduction of nitrite in ham. Irradiated food items (beef, ham, turkey and corned beef) were used by the US-USSR joint space flight. Irradiation services were performed on 16000 kilograms of beef. Overall qualities on red meats, poultry and seafoods were improved. Provided radiation services and food and food packaging technology, as well as microbiological, radiation chemical and related research support to wholesomeness tests of beef, pork, chicken and ham. Determined the effect of process conditions on reducing the minimal radiation dose of ration items.

Budget Activity #1 - Technology Base

Program Element # 6.27.24.A Title Food Technology

Project # AH99 Title Food Technology

Technical Area AH99D Title Radiation Preservation of Food

2. FY 1977 Program: Continue to provide irradiation service support to the wholesomeness tests of pork, chicken and ham, as well as microbiological and food chemistry support to these same products. Efforts will continue to define and solve problems related to the scale-up for commercial production of irradiation sterilized meats. Continue to prepare protocol for beef.

3. FY 1978 Planned Program: Continue efforts begun in earlier years and begin efforts in packaging of irradiated products to assure microbiological safety and product stability. Radiation services in support of the simultaneous wholesomeness feeding contracts of pork, chicken and ham will be very extensive during this fiscal year and is the major cause of the increased funding during this period.

4. FY 1979 Planned Program: Continue efforts begun in previous years and continue radiation services in support of the wholesomeness contracts for pork, ham and chicken. Funding increase is due to greater intense support requirements for animal feeding tests.

5. Program to Completion: This is a continuing program in support of wholesomeness testing of four meat items and in preparation for the technological transfer to industry of the food irradiation processes. Upon successful completion of the animal feeding tests in 1980, the successful petitioning of the Food and Drug Administration for product approval in 1981 and the eventual transfer of technology to industry in the early to mid 1980's, this technical area would be continued on a much reduced scale.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	2,965	390	2,466	3,022	3,176	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.25.A

Title Computer and Information Sciences

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	2920	855	2880	3559	3290	Continuing	Not Applicable
AT11	Engineering Software	205	70	200	200	250	Continuing	Not Applicable
DY10	R&D in Multicommand Data Systems	1770	600	1800	2168	2085	Continuing	Not Applicable
D051	Telecommunications Software	0	0	200	280	150	Continuing	Not Applicable
D730	Improved Data Effectiveness & Availability	805	145	580	711	630	Continuing	Not Applicable
A778	The Use of Behavioral Sciences in Computer Software R&D	140	40	100	200	175	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program element supports the exploratory development work of the Integrated Software Research and Development (ISRAD) Program, assigned to the US Army Computer Systems Command on 30 July 1974 and approved for implementation on 7 February 1975. The objectives are to integrate Army-wide software research and development into a single, cohesive program to produce improved techniques for software development extending throughout the entire life cycle of computer software and to provide a focal point of the development and coordination of Army computer software research and development. Each project within the element is associated with a particular Army agency or command which is involved in the research and development of generalized computer software techniques for Army-wide application.

BASIS FOR FY 1978 RDTE REQUEST: Research will be supported in new concepts and methods for the development of generalized tools, techniques, and procedures required to satisfy the needs of computer software developers for standard multicommand data processing systems, telecommunications systems, research in human factors aspects of computer software, and scientific and engineering applications. Engineering Software project (6.27.25.A/AT11): Research and develop new concepts, methods, and techniques in the major technological areas of interactive graphic software, program transportability and operating system software. Multicommand Data Systems project (6.27.25.A/DY10): Develop computer system simulation procedures and methodologies for performance prediction and optimization; implement performance evaluation and enhancement procedures; develop improved, standard programming languages; and provide advanced tools and techniques to improve ADP personnel productivity. Telecommunications Software project (6.27.25.A/D051): Research and develop computer languages and operational system software specifically designed for telecommunications

functions. Improved Data Effectiveness & Availability project (6.27.25.A/D730): Develop and disseminate generalized tools, techniques, and procedures to assist the Army ADP community in the development of applications programs/systems. The Use of Behavioral Science in Computer Software R&D project (6.27.25.A/A778): Research and develop concepts and techniques in the area of transferable software, transportable courseware, and human factors in software development.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The funding in FY 1978 is increased to accommodate the expansion of research areas to support the major new initiatives in the Defense Software Management Technology Base, the incorporation of advances in the technology base to continuing efforts, and increases in the costs of supporting research.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	41	0	41
(2) Contractor Employees	79	0	79
Total	120	0	120

DETAILED BACKGROUND AND DESCRIPTION: The Army's Integrated Software Research and Development (ISRAD) program was formulated in 1974. The ISRAD working group, consisting of technical representatives of the Army's ADP software developing agencies, was established the same year and submitted the first ISRAD program (FY 77-81) in January 1975. The program element presently includes the Engineering Software project (6.27.25.A/AT11) of the Office of the Chief of Engineers; the Multicommand Data Systems project (6.27.25.A/DY10) of the US Army Computer Systems Command; the Telecommunications Software project (6.27.25.A/D051) of the US Army Communications Command; the Improved Data Effectiveness and Availability project (6.27.25.A/D730) of the US Army Materiel Development and Readiness Command; and the Use of Behavioral Sciences in Computer Software R&D project (6.27.25.A/A778) of the US Army Research Institute for the Behavioral and Social Sciences.

RELATED ACTIVITIES: The ISRAD program receives support from Project 6.58.03.A/MY29 (Integrated Software). The Multicommand Data Systems and Improved Data Effectiveness projects were transferred to this program element from PE 6.58.03.A (Technical Information Activities) in FY 1976. Efforts in this program have application to developments in PE 6.37.22.A (Tactical Operations System), PE 2.37.26.A (Tactical Fire Direction System), and the Army's Management Information Systems. Participating developing agencies include the Office of the Chief of Engineers, US Army Research Institute for the Behavioral and Social Sciences, US Army Computer Systems Command, US Army Materiel Development and Readiness Command, US Army Communications Command, and the US Army Research

Budget Activity #1 - Technology Base

Program Element #6.27.25.A Title Computer and Information Sciences

Office. Efforts in this area affect and are affected by the Army's cooperative endeavor with the DOD Management Steering Committee for Embedded Computer Resources, and other DOD panels/committees. Continual liaison at the laboratory level and between the US Army's Integrated Software Research and Development Program Working Group and its Navy and Air Force counterparts preclude unnecessary duplication of effort.

WORK PERFORMED BY: Federal Computer Performance Evaluation and Simulation Center (FEDSIM), Washington, DC; Denelcor, Inc., Denver, Colorado; IBM Corporation, White Plains, New York; Kansas State University, Manhattan, Kansas; Planning Research Corporation, Los Angeles, California; and Stanford Research Institute, Menlo Park, California. Additional contractors total 30 in number with a dollar value of $700K. In-house developing agencies include: US Army Computer Systems Command, Fort Belvoir, Virginia; US Army Electronics Research and Development Command (ERADCOM), Fort Monmouth, New Jersey; Harry Diamond Laboratories, Adelphi, Maryland; US Army Communications Command, Fort Huachuca, Arizona; US Army Research Institute for the Behavioral and Social Sciences, Arlington, Virginia; and US Army Armament Research and Development Command (ARRADCOM), Dover, New Jersey.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Engineering Software project: developed requirements for automation of digital data field compilation process; developed requirements for Army system of computer science software dissemination. Multicommand Data Systems project: constructed simulation models of operations and maintenance phase of a typical computer system life-cycle to determine benefits obtainable from performance prediction; developed and demonstrated simulation models of various multi-command data systems; demonstrated generalized performance monitoring techniques to successfully reduce computer run time; initiated development of tools to permit software performance prediction and optimization; developed recommendations resulting in improved Army performance monitoring techniques; determined design requirements and developed specifications for recommended Army Management Information System structure based on interconnected computers, data bases, and terminals; developed plan for prototype multiprocessor installation system; develop an interactive programming capability; initiated implementation of structured programming in the production environment; published study of structured programming techniques; developed plan for interactive COBOL verification system. Improved Data Effectiveness and Availability project: developed and extended ALGRAPH compiler to support command query and design lanaguage; developed hybrid computer language for solution of differential equations; developed several transportable graphics routines; developed a directly executable langauge instruction set; analyzed hardware/architectural requirements for and designed a tactical executive system; analyzed sparse matrix processing procedures and designed associated algorithms; defined a transferrable FORTRAN language; developed requirements for machine independent development and test of microprocessor programs; developed data communication protocols and graphics techniques for associated processors. The Use of Behavioral Science in Computer Software R&D project: designed and validated approach for creating transferable language interpreter software; initiated human factors analysis of software development process and developed prototype job aids for planning, design, coding, validation, and modification of software.

Budget Activity #1 - Technology Base

Program Element #6.27.25.A Title Computer and Information Sciences

2. FY 1977 Program: Engineering Software project: conduct research into operation of large-scale computer system hardware and software and identify critical parameters of performance; investigate feasibility of implementing a graphic compatibility system in a minicomputer environment. Multicommand Data Systems project: design and evaluate new performance monitoring techniques; develop methodologies for use of hardware/software monitors; complete and evaluate back-end data base management system; implement and test distributed processing system; study requirements for standardization of Job Control Language and hardware language restrictions; develop an automatic test data generator; determine requirements for a standard high-order language; develop a prototype multiprocessor system. Telecommunications Software project (new start): develop system specifications for telecommunications language and architecture optimized to telecommunications functions; plan approach for development of telecommunications hardware/software trade-off analysis. Improved Data Effectiveness and Availability project: develop high-order language tactical executive system, performance evaluation tools, and automated security testing tools; develop automated tool to aid design/development of transportable FORTRAN programs; implement experimental real-time tactical language system in Army tactical environment; develop microprocessor programming system; develop sparse matrix processing programs. The Use of Behavioral Science in Computer Software R&D project: test transportability of language interpreter across tactical computers and minicomputers; prototype human factors job aids in the field.

3. FY 1978 Planned Program: Engineering Software project: develop machine protocol language and implement a translator on remote job entry processors to demonstrate protocol transportability; incorporate new technological capabilities into graphics compatibility system; develop guidelines for use of composite data field graphics tool. Multicommand Data Systems project: develop simulation model of minicomputer/Data Base Management System (DBMS); develop micro-monitor; extend performance monitoring techniques to determine optimal interactive programming tool configuration; evaluate capabilities of existing HOLs to meet requirements for standard high-order language; incorporate relational data base concept in back-end DBMS environment; complete implementation and evaluation of structured programming methodologies in the production environment; produce a modified HOL language specification. Additional funding over FY 1977 level is required to initiate prototype development of relational data base management system, implement and test prototype multi-processor system, and test data generator. Telecommunications Software project: develop computer software language and architecture optimized for telecommunications functions; develop techniques for telecommunications hardware/software trade-off analysis. Improved Data Effectiveness and Availability project: automatically reprogram FORTRAN programs to increase transportability; develop automated tools and data bank to support the transfer of computer technology; develop software to handle graphical input/output and protocols on associative processors; develop a device independent graphics system. Additional funding over FY 1977 level is required to evaluate performance of an experimental Army tactical real-time language system and recommend extensions and develop performance evaluation tools to measure tactical weapons software system effectiveness. The Use of Behavioral Science in Computer Software R&D project: increase in FY 1978 funding level over FY 1977 incurred by initiation of efforts to develop conceptual model of programming process for use in analyzing environmental factors.

4. FY 1979 Planned Program: Engineering Software project: develop and test generalized evaluation and validation program; incorporate parallel and pipeline processing techniques into graphics compatibility system. Multicommand Data Systems project: develop and implement tools and techniques in the areas of portability, interchangeability, security/privacy, verification/

validation, and programming languages; extend Data Base Management System to multicommand systems; implement fullscreen interactivity and other graphic capabilities utilizing minicomputers. Telecommunications Software project: implement new telecommunications language/architecture and trade-off analysis techniques. Improved Data Effectiveness and Availability project: test candidate minicomputer simulation languages and recommend adoption; implement device independent graphics system; implement graphics resources sharing system; implement minicomputer information transfer system; develop common controlling/processing language for micro-processors. The Use of Behavioral Science in Computer Software R&D project: develop methods for measurement of programmer performances in human factor terms.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.26.A Title Army Support of the Defense Advanced Research Project Agency (DARPA)

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	400	100	1000	2000	2000	Continuing	Not Applicable
DH59	Army Support of DARPA HOWLS	400	100	500	1500	1500	Continuing	Not Applicable
A557	Army Support of DARPA Netted Radar	0	0	500	500	500	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This project funds the Army's portion of a joint DARPA-Army effort to investigate long term solutions to the hostile weapons location problem, and techniques for integrating, remoting and netting moving target indicating surveillance radars. The most promising approaches are incorporated into experimental hardware for test and evaluation. Hardware successfully demonstrated will become candidates for follow-on advanced and engineering development.

BASIS FOR FY 1978 RDTE REQUEST: Army funding during FY 1978 will support the field evaluation of prototype sensors developed within the HOWLS program. These include the flight testing in piloted aircraft of a small radar intended for Remotely Piloted Vehicle (RPV) applications; a field test of an infrared countermortar system; and flight testing of a "two color" (two frequency) infrared guidance sensor. Radar processing and integration techniques will be evaluated and applied to two existing radars to demonstrate radar netting.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The increase in FY 1978 can be attributed to more extensive Army participation in the program. New prototype hardware will be developed, and existing prototype hardware will be evaluated.

PERSONNEL IMPACT

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ Employees	13	0	13
(2) Contractor Employees	76	0	76
TOTAL	89	0	89

Budget Activity #1 - Technology Base

Program Element #6.27.26.A Title Army Support of the Defense Advanced Research Project Agency (DARPA)

DETAILED BACKGROUND AND DESCRIPTION: In June 1973 the Defense Advanced Research Projects Agency (DARPA) was tasked by the Director of Defense Research and Engineering (DDRE) to conduct a research and development program in search of new and improved solutions for the location of hostile indirect fire weapons in both firing and non-firing modes. DARPA invited the Army to participate in a cooperative five year program under DARPA lead and share the program cost. A Memorandum of Understanding was signed in May 1974 which formalized the relationship between DARPA and the Army in the HOWLS program. This program is focusing on the use of small airborne radars; the application of a small, low cost infrared countermortar system; and fabrication of a dual frequency infrared sensor for homing on a hot weapon. Other areas undergoing varying degrees of investigation include: projectile tracking radars; electromagnetic emitters; airborne flash techniques; acoustic and seismic techniques; and other technology areas. DARPA is the primary source of funds for this program as the lead government agency. A Memorandum of Understanding was signed in September 1976 which formalized the Netted Radar program. This program will develop and demonstrate advanced radar technology for ground and air surveillance, to include advanced processing, antennas, and mobile terminals.

RELATED ACTIVITIES: The primary service activities which complement this program element are conducted by the Army in technology base efforts. These programs include: PE 6.27.03.A, Combat Surveillance, Target Acquisition and Identification; PE 6.27.09.A, Night Vision Investigations; and PE 6.27.32, Remotely Piloted Vehicle (RPV) Technology. There is a particularly close relationship with the weapons location activities in PE 6.27.03.A. A joint DARPA-Army steering group reviews all programs to insure there is no duplication and that the combined effort represents the best possible long term approach to weapons location. There is also a relationship between this program and Army work under: PE 6.37.04.A, Unattended Ground Sensors (UGS); PE 6.47.29.A, Countermortar Radar AN/TPQ-36; and PE 6.47.31, Counterbattery Radar AN/TPQ-37. These latter efforts will provide significant improvements in the near term, whereas HOWLS is searching for longer range solutions to complement the radars and UGS.

WORK PERFORMED BY: Lincoln Laboratory, Lexington, MA, is the primary technical agent for the HOWLS program. The US Army Electronics Research and Development Command is the lead service activity. The principle contractors are General Electric, Utica, NY; Martin Marietta, Orlando, FL; and Phillips Broadcasting Company, Mahwah, NJ.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1976 and FY 197T and Prior Accomplishments: Developed a small airborne radar for mounting on a Remotely Piloted Vehicle (RPV); developed an Infra-Red (IR) Countermortar System; initiated a Multispectral Measurements Program on Tactical Targets; initiated a program to analyze trajectory data obtained from the AN/TPQ-37 Radar.

2. FY 1977 Program: Continue testing of the Small Airborne Radar for RPVs; continue testing of the IR Countermortar System and analyze the data; continue Multispectral Measurements on Tactical Targets; analyze trajectory data obtained from the AN/TPQ-36 Radar. Develop real time computer programs for incorporation of extended track algorithms into AN/TPQ-37 Counterbattery Radar. Initiate development of components to reduce cost and weight. Initiate development of experimental short baseline acoustic array for mortar location. Initiate investigations of radar integration and netting techniques. Two existing radars will be modified to incorporate advanced signal processing techniques. Begin design and fabrication of components of prototype radar and antenna incorporating advanced integration techniques.

Budget Activity #1 - Technology Base

Program Element #6.27.26.A

Title Army Support of the Defense Advanced Research Project Agency (DARPA)

3. FY 1978 Planned Program: Integrate a CO_2 Laser into the IR Countermortar System; utilize the Airborne Radar in a standoff mode of operation and investigate its utility in the Stand-Off Target Acquisition System (SOTAS); investigate other techniques and their applicability to hostile weapons location. Existing surveillance radars will be netted to a central display unit to demonstrate radar integration techniques. Complete design and fabrication of prototype radar incorporating advanced signal processing and antenna techniques. Increase in FY 1978 is due to increased emphasis on this program. New hardware will be developed, and existing hardware will be evaluated.

4. FY 1979 Planned Program: Conduct field tests of prototype hardware previously developed, to include netting of ground surveillance radars with the SOTAS display; begin work on integration and netting of air surveillance radars. FY 1979 funding will continue prototype development, test, and evaluation of promising systems providing long term solutions to locating hostile weapons and integration and netting of surveillance radars.

5. Program to Completion: The HOWLS program will be completed in FY 1980. Applications studies will be accomplished to assist in establishing the proper role for tactical radar nets within the Army. Promising techniques will be transferred to the Army for further development, if supported by appropriate requirements.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.27.A

Title Non-Systems Training Devices Technology (NSTD)

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	0	2,500	2,300	4,250	Continuing	Not Applicable
A230-01	Laser Simulation Technology	0	0	705	350	1,000	Continuing	Not Applicable
A230-02	Visual Display Technology	0	0	420	465	600	Continuing	Not Applicable
A230-03	Electronic Simulation Technology	0	0	475	400	800	Continuing	Not Applicable
A230-04	Maintenance Simulation Technology	0	0	165	285	700	Continuing	Not Applicable
A230-05	Electro-Mechanical Simulation Technology	0	0	735	400	1,150	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Program effort to conduct exploratory research and feasibility studies on alternative technical approaches to assist in the selection of the most cost and operationally effective training devices and simulators in support of the unit environment, and to improve the analytical effort and risk assurance which allow progression into Advanced Development. Development effort is applied to the following primary technical areas: Laser Simulation, Visual Display, Electronic Simulation, Maintenance Simulation and Electro-Mechanical Simulation.

BASIS FOR FY 1978 RDTE REQUEST: Program provides for the development effort to determine feasible technological concepts for the development of realistic, cost and operationally effective training devices and simulators to support combat unit training in the areas of weapons engagement simulation, tank crew training, indirect area fire simulation, high fidelity-high resolution visual simulation, tactical environment simulation, Nuclear-Biological-Chemical environment simulation, and more effective maintenance training devices.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Funding for FY 1978 remains essentially at the same level as FY 1977 in order to direct and establish a sound foundation for this program. Major effort is directed at more economical devices and wider use in unit training and in areas of higher training cost.

Budget Activity #1 - Technology Base

Program Element #6.27.27.A Title Non-Systems Training Devices Technology (NSTD)

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	9	0	9
(2) Contractor Employees	32	0	32
Total	41	0	41

DETAILED BACKGROUND AND DESCRIPTION: The Army's Non-Systems Training Device development programs have traditionally been financed exclusively with Category 6.4 funds (Engineering Development). Such a system was sufficient to support a training philosophy which embraced the use of simulation in institutions and the use of operational equipment as the unit's training support mechanism by using state-of-the-art technology. Escalating resource costs and diminishing training budgets compel the Army to introduce simulation and simulative devices into the unit environment. The Exploratory Development program determines how to develop devices which are cost and operationally effective in support of the unit environment, and improves the "front-end" analytical effort which will allow progression into Advanced Development. New technologies and applications for training devices will be explored.

RELATED ACTIVITIES: The program of development is closely coordinated with the Navy and Air Force (currently conducting cooperative research in visual simulation), joint use of resources at the Naval Training Equipment Center, and worldwide staffing of training equipment requirements. Related program elements are P.E. 6.37.38.A, Non Systems Training Devices Development; 6.47.15.A, Non-Systems Training Devices Engineering; 6.27.22.A, Army Training Technology; 6.22.05.F, Training and Simulation Technology; 6.27.57.H, Training and Human Engineering Technology.

WORK PERFORMED BY: Primary contractors: American Airlines, Fort Worth, TX; Sperry Rand Corporation, Madison County, AL; Unified Industries, Alexandria, VA. Additional potential or anticipated bidders include: General Electric Co., Pittsfield, MA; Battelle Laboratories, Columbus, OH; Computer Science Corporation, Huntsville, AL; AAI Corporation, Baltimore, MD; International Laser Systems Incorporated, Orlando, FL; Farrand Company, Valhallo, NY; Decilog, Melville, NY; EG&G Corporation, Alburquerque, NM; Arthur D. Little Company, Cambridge, MA; and ITT Corporation, Nutley, NY. The above list does not represent a complete list of contractors that may bid competitively for approximately $1.5M. In-house development is performed by the U.S. Naval Training Equipment Center, Orlando, FL, and by U.S. Army Development and Readiness Command Subordinate agencies as tasked by the Project Manager for Training Devices (PM TRADE).

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Not Applicable

Budget Activity #1 - Technology Base

Program Element #6.27.27.A Title Non-Systems Training Devices Technology (NSTD)

2. FY 1977 Program: Program provides initial development effort to determine feasible technological concepts, cost effectiveness and potential development risks associated with each conceptual approach to the solution of the various problems and training challenges confronting the Army. Major effort is being applied towards the development of armor unit training systems, tank gunnery training devices and simulators, improved high fidelity-high resolution visual systems, Command Group Training System, and more effective maintenance training devices and simulators.

3. FY 1978 Planned Program: Complete development on the major program thrusts initiated during FY 1977. Continue development of eye-safe laser training devices capable of realistically simulating the tactical characteristics of laser designated weapons engagement, and techniques to improve indirect area fire simulation which will enhance training of the total tactical engagement system. Initiate development of Electronic Warfare (EW) and Nuclear-Biological-Chemical (NBC) simulation devices which will provide realistic, objective, and realtime means of assessing the effects of EW and NBC on mission accomplishments. Initiate development of Weapons Effects Signature Simulators (WESS) for both U.S. and enemy weapon systems to assist units/crews in target acquisition training.

4. FY 1979 Planned Program: Continue and complete development of the major programs initiated during FY 1977/FY 1978. The significant funding increase is projected to be applied towards breadboard prototypes of EW, NBC, and WESS training devices and simulators initiated during FY 1978. Additionally, a major follow-on effort is planned to develop realistic, cost and training effective maintenance training devices and simulators for use at the individual and unit levels.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.30.A

Title: Design Construction and Operations Technology for Cold Regions

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	2530	727	2730	3186	3203	Continuing	Not Applicable
AT42-01	Ice and Snow Technology	333	88	304	355	405	Continuing	Not Applicable
AT42-02	Soils and Foundations Technology	707	159	512	635	715	Continuing	Not Applicable
AT42-03	Facilities Technology	640	195	734	1005	950	Continuing	Not Applicable
AT42-04	Environmental Constraints on Material Development	850	285	1180	1191	1133	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The objectives of this project are: (1) To insure that the Army combat engineering capability is maintained in both a winter temperate zone or in an extreme cold environment; (2) to develop cost effective and environmentally compatible techniques and engineering criteria for the construction, maintenance and operation of permanent Army facilities in areas where cold weather presents a problem; and (3) to develop methods for identifying and evaluating how terrain, climate and other environmental aspects constrain design and performance of Army material.

BASIS FOR FY 1978 RDTE REQUEST: The FY 1978 request is based on three requirements: The first two support Corps of Engineers requirements and the third supports the Army Material Development, Acquisition and Readiness Command (DARCOM). The first is to provide a marked reduction in the costs to operate and maintain military facilities in cold regions (northern United States, Alaska, Europe and Korea). Operation and maintenance costs at these facilities currently averages $84 million in excess of comparable costs at temperate zone facilities; much of this "add-on" cost can be avoided by research. The second requirement is to provide a combat engineering capability which will insure that US forces are at least on an equal basis with the expert winter combat capability of Eastern European countries. The third requirement supports DARCOM concerning the design of weapons and equipment employed in winter warfare and other adverse conditions; currently the top priority item in this area is solution to the problem of icing on the rotor blades of combat helicopters.

BASIS FOR INCREASE IN FY 1978 OVER FY 1977: The total increase in FY 1978 over FY 1977 is $456,000. Of this a $319,000 increase is required to support planned field verification studies in such areas as winter camouflage, snow roads, foundations in permafrost and explosive effects. The field evaluations are a necessary step to supplement previous laboratory studies prior to technology transfer to the user. The remaining increase of $137,000 is due to cost growth.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	110	0	110
(2) Contractor Employees	9	0	9

Budget Activity 01 - Technology Base

Program Element 6.27.30.A Title Design Construction and Operations Technology for Cold Regions

DETAILED BACKGROUND AND DESCRIPTION: During FY 1977, the US Army Cold Regions Research and Engineering Laboratory (CRREL) provided centralized management for this project with the US Army Engineer Topographic Laboratories (ETL) and the US Army Engineer Waterways Experiment Station (WES) performing, along with CRREL, the research in support of the US Army Material Development and Readiness Command (DARCOM). The inclusion of this work in Project AT42 streamlines the management, performance and reporting of this research which formerly was included as parts of separate programs which have since been consolidated.

RELATED ACTIVITIES: CRREL conducts research for as many as 25 different federal and state organizations and a small number of private organizations. As the single national cold regions research facility, this enables CRREL to prevent duplication and stay abreast of the state-of-the-art in cold regions construction. Some of the related programs are the Civil Works Research and Investigation programs on ice engineering and wastewater management, Program Element 6.27.31.A, Project AT41, Fixed Facilities Energy Studies for Army Facilities and Program Element 6.27.20.A, Project A896, Environmental Quality for Military Facilities, and numerous reimbursable orders.

WORK PERFORMED BY: Approximately 60 percent of the work is performed in-house by CRREL. CRREL serves as the managing laboratory for this project, and is the primary performing activity. Other laboratories performing portions of the work include the ETL at Fort Belvoir, VA and WES at Vicksburg, MS. Other participants in this effort are US Army Facilities Engineering Support Agency (FESA), Fort Belvoir, VA; US Army Engineer District, Alaska; University of Alaska; Barringer Research Corporation, University of Michigan; and University of California.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976 and Prior Accomplishments: Engineering reports were published on such topics as ballistic attenuation of ordinary snow, snow drift control problems, frequency and duration of various forms of freezing precipitation in relation to synoptic weather conditions, cutting and evaluting frozen ground, ice bridging technology, and ice reinforcement. Laboratory tests and field trials were conducted on such topics as foundations, quick curing low temperature concrete, and utility distribution systems and pavement. An extensive amount of research was translated into construction criteria with the issuance of Technical Manual 5-852-4, "Arctic and Subarctic Construction, Foundations for Structures". A laboratory ballistic testing program in which Fragment Simulating Projectiles were fired into frozen soil furnished data on the influence of target temperature and moisture content on projectile penetration. A series of preliminary maps were prepared which show the probable dates of the earliest and latest occurrance of snow, and length of the snow season in East and West Germany. Field tests were conducted to evaluate the effectiveness of various types of 7.62 millimeter rounds against snow fortifications. Soil and permafrost investigations were conducted along trans-Alaska pipeline road to obtain data on initial conditions of foundations, slopes, roads and airfields. Initial observations were taken along pipeline route for long term performance surveys of thaw-consolidation and settlement or frost heaving of piling. Resistivity surveys were made in Alaska to demonstrate application in locating permafrost, soil type and bedrock, with particular emphasis on grounding and cathodic protection potential. Explosives were detonated to determine stress wave attenuation and damping characteristics of permanently frozen ground for applications in earthquake engineering, seismic surveys, effects of explosives and use of explosives for excavating. Tests of thermal performance of protective membrane roofs were initiated. Advice and assistance on

cold regions rehabilitation problems was continued and the outline prepared for a comprehensive report. A report on utility distribution systems in northern Europe was completed and the draft of a contractual report on cold regions habitability was prepared. A coupled moisture and heat flow computer program was developed. Performance monitoring of camps and facilities on the Alaska pipeline was started. A joint program was developed with the State of New Hampshire to field test regulated-set (REGSET) cement. Field studies were initiated to study raw water quality at existing remote facilities. A report "Design Data for Construction in Alaska" was drafted cooperatively with the US Army Engineer District, Alaska and reports prepared on methods for monitoring energy consumption and on feasibility of using large structural envelopes in cold regions.

2. FY 1977 Program: During FY 1977, both laboratory and field trails are being conducted to improve combat engineer capability in winter. These studies include evaluation of frozen soil used as an expedient protective structure; improved camouflage techniques using snow; capability to use ice covers for cross-country mobility and for parked loads. A major monitoring effort continues with regard to all engineering aspects of the construction of the Alaska pipeline with techniques, equipment and material performance documented. Other research is continuing on many of the major aspects of design, operation and maintenance of permanent Army facilities located in cold regions. Research in support of US Army Materiel Development and Readiness Command (DARCOM) objectives was initiated with focus on identifying and evaluating constraints on Army materiel imposed by terrain and climate which often result in materiel failure.

3. FY 1978 Planned Program: During FY 1978, research in support of DARCOM requirements will be continued under this project. US Army Cold Regions Research and Engineering Laboratory (CRREL) will evaluate new techniques to control ice adhesion problems, particularly concerning helicopter rotor blades; explore the feasibility of air-cushion vehicles for Army use in cold regions, develop a prototype air transportable shelter in coordination with US Army Natick Laboratories; evaluate the action of fuzed ammunition in snow and weapon emplacement in snow. US Army Engineer Topographic Laboratories (ETL) will continue work to establish an improved data base for environmental effects on materiel and closely coordinate the requirements of product managers in the various commodity commands as well as the testing requirements of the US Army Test and Evaluation Command (TECOM). The US Army Engineer Waterways Experiment Station (WES) will continue work on acoustic sensors, electromagnetic target characteristics, surveillance systems and conduct a terrain analysis study for helicopter operations. During FY 1978 CRREL will also continue research to meet Corps of Engineers requirements concerning combat engineering and the design, operation and maintenance of Army and Air Force fixed facilities in cold regions.

4. FY 1979 Planned Program: By the end of FY 1979 a number of efforts now underway will be completed with input prepared for the appropriate user. A tri-service manual on techniques to locate moisture contaminated roof insulation will be prepared; a report concerning snow signature as a camouflage material will be written; the helicopter vulnerability study will be completed and input to revise seven field manuals and twelve technical manuals concerned with reducing the cost of operating and maintaining Army facilities, improving the initial design of such facilities, and advancing the Army capability to conduct winter warfare.

5. Program to Completion. This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.31.A

Title Design, Construction, and Operations and Maintenance Technology for Military Facilities

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	4625	1135	5032	6254	6463	Continuing	Not Applicable
AT41-01	Development of Automated Procedures for Military Construction	1100	260	1095	2100	2220	Continuing	Not Applicable
AT41-02	Development of Industrialized Construction for Military Facilities	250	85	280	285	285	Continuing	Not Applicable
AT41-03	Architectural Research and Development in Support of Military Facilities	290	40	300	300	300	Continuing	Not Applicable
AT41-04	Military Construction Technology	310	59	312	373	373	Continuing	Not Applicable
AT41-05	Military Construction Management	365	180	390	390	390	Continuing	Not Applicable
AT41-06	Energy Systems	1300	275	1400	1511	1600	Continuing	Not Applicable
AT41-07	Military Construction Materials	170	55	290	290	290	Continuing	Not Applicable
AT41-08	Research for Base Development in the Theater of Operations	260	66	315	315	315	Continuing	Not Applicable
AT41-09	Facilities Operations and Maintenance	580	115	650	690	690	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program addresses three high cost areas in facility construction and operation where substantial cost avoidance can be realized: (1) Analysis design and construction of the annual $1.5 billion Army military construction program; (2) Maintenance and Operation of facilities costing $1.5 billion annually with a growing deferred maintenance backlog; and (3) the high cost and growing shortage of energy resources.

BASIS FOR FY 1978 RDTE REQUEST: The funds requested for FY 1978 will support substantial initiatives in the development of computer aided systems for facility planning, design and construction to provide least cost facility configurations and designs based on a thorough analysis of alternatives for the maintenance and operations functions of the facility engineer to maximize the effective use of resources and for the evaluation, analysis and design of facilities to conserve energy and utilize alternative sources of energy.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Project costs increased by $1222K in FY 1978 over FY 1977. $697K of the increase represents increased effort in the energy and facilities engineering research and development program transferred in FY 1978 from Program Element 6.37.34.A, Military Construction and Field Engineering, to retain work in the technology base that does not result in development work for hardware procurement. $273K was added to provide for the development of computer-aided engineering and architectural design systems. Cost growth accounted for $252K.

Budget Activity #1 - Technology Base

Program Element #6.27.31.A Title Design, Construction, and Operations and Maintenance Technology for Military Facilities

PERSONNEL IMPACT:

The average number of employees supported with the requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
	(#)	(#)	(#)
(1) Federal Civilian Employees	0	0	0
(2) Contractor Employees	33	0	33
TOTAL	93		93

DETAILED BACKGROUND AND DESCRIPTION: This exploratory development research is structured to the solution of problems in the planning, design, construction, operation and maintenance of military facilities. The objectives are to develop procedures, management systems, and materials which will reduce construction time and cost, improve operation efficiency, insure the quality of an all-volunteer Army, and minimize the impact on Army operations because of energy shortages.

RELATED ACTIVITIES: This project was identified under Program Element 6.27.20.A in FY 1976. The project is supported by Project AT23, "Basic Research in Military Construction", and it complements (but does not duplicate) research under Program Element 6.27.20.A on "Mobility, Soils and Weapons Effect" assigned to the US Army Engineer Waterways Experiment Station and research under Program Element 6.27.19.A on "Construction and Operations in Cold Regions" at the Cold Regions Research and Engineering Laboratory. Joint Services laboratory coordination meetings are held tri-annually to coordinate effort.

WORK PERFORMED BY: Approximately 50 percent of the work is in-house. The US Army Facilities Engineering Support Agency, Fort Belvoir, VA, and the US Army Cold Regions Research and Engineering Laboratory, Hanover, NH, perform research on energy systems under this program element. Principal contractors are the Board of Trustees, University of Illinois, Urbana, IL; Hittman Associates, Inc., Columbia, MD; Florida Institute of Technology, Milborn, FL; Massachusetts Institute of Technology, Cambridge, MS; Reynolds, Smith and Hittle, Jacksonville, FL.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976 and Prior Accomplishments: A prototype system for the computerized cost estimating system and portion of the computer-based specifications system were demonstrated. Three interactive computer programs were prepared to evaluate water, sewage, and electrical systems for adequacy in terms of future development and base mobilization. In construction systems technology, procedures were formulated for determining the seismic resistance of existing military structures to quantify the extent of required seismic strengthening. In energy systems, a manual was prepared on the selection and application of automated control systems for heating and cooling of buildings. The construction materials research included identification of tolerable limits of weld current voltage and travel speed for welding certain carbon and low alloy heat treatable steels. Accomplishments in the base development studies included techniques for rapidly producing hardened dome shelters using polyurethane foam and steel fiber shotcrete. For facility operation and maintenance, a hospital equipment maintenance system prototype was field tested at Fort Gordon and the system evaluated for Army-wide implementation.

Budget Activity #1 - Technology Base

Program Element #6.27.31.A

Title Design, Construction, and Operations and Maintenance Technology for Military Facilities

2. FY 1977 Program: The planned accomplishments in the automated procedures technical area include the development of an operating system for computer-based estimates. The industrialized building systems will include the development of preliminary cost estimating procedures for performance specifications. Architectural research will include the development of recommendations for seismic analysis methods and structural design criteria for military buildings. In construction management, prototype tools and procedures for improving communications will be formulated and cost-effective applications of micro processors to military construction functions will be identified. The accomplishments in energy systems will include a conceptual design of a nuclear total utility system; the development of guidance for energy control systems application and installation; and the validation of computer design procedures for solar heating and cooling demonstration projects. Materials for military construction will include design criteria for tropical facilities, corrosion control and a users manual and guide specification revisions on the field jointing of plastic pipe. The base development research accomplishments will include completing model studies of expedient foam forms for inflation forming of concrete and ferro-cement; and a field demonstration on the use of computer programs for construction scheduling of Army facility component systems (AFCS) activities. The facility operation and maintenance accomplishments include preliminary scheduling procedures for facilities engineering shop scheduling and the allocation of resources.

3. FY 1978 Planned Program: Planned accomplishments in the automated procedures for military construction include field testing the computer-aided cost estimating system and the computer-based specification system. For industrialized building systems, planned accomplishments include computerized procedures for determining cost by performance specification. The architectural research accomplishments include computer final procedures for deriving functional requirements for facilities. Military Construction technology accomplishments will include performance, design, and procurement specifications for essential utility and lifeline systems equipment. Military construction management planned accomplishments include field testing of tools and procedures for improving communications and field testing micro processor prototypes for military application. For energy systems, an evaluation of economics and feasibility of radioisotope power systems will be completed and preliminary guidance will be developed for total energy/total utility concepts on an installation. The planned materials research accomplishments will include draft guide specifications for galvanized reinforcing steel and a draft guide specification on the durability of field joints in plastic pipe. The base development accomplishments will include constructing hardened shelters using glass and synthetic fibers in the shotcrete process and the technology transfer of the computer-aided procedures on construction scheduling of facilities. The facilities operations and maintenance planned accomplishments include a revised technical manual for improvements/modernization of facilities engineer maintenance shops; and a draft regulation on a table of distribution and allowances for facilities engineering equipment needs based on installation size, mission, location, personnel strength, and capabilities.

4. FY 1979 Planned Program: In automated procedures the stand alone subsystems will be integrated into the computer-aided engineering and architectural design systems. The architectural research activities will include procedures for review of design to assure compliance with habitability criteria. Military construction technology will include design guides for strengthening existing buildings against seismic shock. In construction management validated prototype micro processors for military application will be transferred to the user in the field. The energy systems will include validation of the energy prediction model with the data obtained in the fixed facility energy consumption investigation. In materiels new concepts for flat roof systems will be laboratory tested. For base development procedures will be completed for the repair of damaged structures using foam materials.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.32.A

Title Remotely Piloted Vehicles (RPV)

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	0	1500	1500	3000	Continuing	Not Applicable
AF34	Remotely Piloted Vehicle (RPV) Supporting Technology	0	0	1500	1500	3000	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The objective of this element is to develop technological capabilities in those areas which are not adequately addressed by Lab Single Program Element Funding programs, and which currently limit the operational potential of mini-RPVs for Army missions of reconnaissance, surveillance, target acquisition, target designation, and artillery adjustment. Emphasis is being given to four key technological areas: aeronautics, jam resistance, radar, and electro-optics. Examples of these activities include development of small propulsion systems, launch and recovery techniques, survivability and vulnerability testing, day/night/all weather sensors and jam resistant techniques. RDTE efforts are being directed toward establishing and expanding the capabilities of mini-RPVs, to improve overall system reliability, and to reduce life cycle costs wherever possible.

BASIS FOR FY 78 REQUEST: The AQUILA Remotely Piloted Vehicle (RPV) program has experienced a host of technological problems which need immediate solutions. This project is directed toward the eradication of these barriers to successful deployment of mini-RPVs. In so doing, it is mandatory to complete the mini-RPV propulsion system developments, establish viable recovery techniques, increase survivability, develop economical fabrication techniques and address the cost of jam resistant command and data links. In addition to these immediate problems, attention must be given to longer term problems, notably, night and all weather sensors, data links for beyond line of sight, and improved lasers for mini-RPVs. Mini-RPV engine development program started in FY 77 will be completed in FY 78 and engines will be delivered for testing. Recovery techniques will be integrated into optimized automatic recovery systems. Fabrication techniques/materials deemed best suited for a mini-RPV, as determined through prior year Army studies and the Air Force Harassment Program, will be used in the fabrication of several RPVs. These vehicles will be evaluated for survivability and vulnerability. The Night Vision Laboratory, Electronics Command, is developing infrared sensors that offer potential for lower cost, reduced size, and reduced cooling requirements compared to conventional night vision devices. Adaptation of these infrared imagers to an RPV configuration will commence in FY 78. Systems and antenna analysis for development of a 35 pound prototype millimeter radar for RPVs will be initiated. The trade off between ground station cost and anti-jam margin will continue to be defined more precisely. Flight tests of anti-jam systems against multiple jammers will be conducted under program element 6.37.25.A, Remotely Piloted Vehicles.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Not applicable.

Budget Activity #1 - Technology Base

Program Element #6.27.12.A Title Remotely Piloted Vehicles (RPV)

PERSONNEL IMPACT

The average number of employees to be supported with FY 78 funds is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	8	0	8
(2) Contractor Employees	20	0	20
TOTAL	28	0	28

DETAILED BACKGROUND AND DESCRIPTION: The objective of this element is to develop and evaluate technological capabilities in all areas relating to the RPV system. Initial efforts will concentrate on those areas which currently limit the operational potential of RPVs for various Army missions. The areas include survivability, propulsion, recovery, manufacturing technology, human engineering, aircraft configuration, radar, electro-optics, and command and control. The chief technical concern is to militarize the complete RPV system which includes the RPV, sensors, ground control station, and launch and recovery systems. All of these actions are interrelated. The small RPV engines have had poor performance, frequent failure, and excessive vibration. The current engines were developed for ground use and before they could be integrated into the RPV, considerable costly modifications were required. More suitable propulsion systems are required and will be developed under this element. Previous experience has shown a high loss rate during recovery and high turn around time. Investigation will be made to provide for simple/low cost/highly reliable means of retrieving the RPVs and relaunching them in forward tactical areas. The cost drivers in the mini-RPV system are the sensor packages and the control stations. Except for daylight TV, the RPV sensors, including radar or infrared, are too large or costly. Investigations into RPV compatible pyroelectric vidicons and near infrared imagers will be pursued to reduce cooling requirements, size, and cost. Key components which restrict the use of millimeter wave radar for mini-RPVs will be developed. The tradeoff between cost and anti-jam capability for the ground station will be determined.

RELATED ACTIVITIES: In prior years the Department of Defense Advanced Research Projects Agency (DARPA) conducted RPV exploratory developments which gave initial impetus to the technologies specific to RPVs. In keeping with its mission, DARPA has phased out its efforts and the services must now conduct the supporting technology. The results of this element will be integrated into the Advanced Development RPV under PE 6.37.25.A. The US Air Force has exploratory technological efforts supporting the RPV mission area included in the following program elements: 6.27.02.F. Ground Electronics, 6.22.01.F. Aerospace Flight Dynamics, 6.22.03.F. Aerospace Propulsion and 6.22.04.F Aerospace Avionics. The US Navy also has some RPV related activities included in PE 6.22.41.N. Aircraft Technology and PE 6.27.12.N. Surface/Aerospace Target Surveillance. All of the RPV related efforts are being monitored in order to utilize applicable technology and preclude duplicative efforts. The formal mechanism to ensure coordination is the Joint Technical Coordinating Group on RPVs, which meets quarterly. Examples of this coordination include the Army being designated as lead service in conducting a joint service propulsion program in which Navy requirements have been included in the contractual planning, and Army cooperation with a Navy recovery program using steerable fabric wings.

Budget Activity #1 - Technology Base

Program Element #6.27.32.A Title Remotely Piloted Vehicles (RPV)

WORK PERFORMED BY: The Air Mobility Research and Development Laboratory's - Ames Research Center, Mountain View, and Ft. Eustis Directorate, Ft. Eustis, VA; US Army Electronics Research and Development Command, Ft. Monmouth, NJ; and it's Night Vision Laboratory, Ft. Belvoir, VA; US Army Missile Research and Development Command, Huntsville, AL, and the US Army Human Engineering Laboratory, Aberdeen Proving Ground, MD. Contractors expected to participate are: Harris Corporation, Melborne, FL; General Electric Uttica, NY; Texas Instruments, Dallas, TX; Perkin-Elmer, Norwalk, CT; Hughes Aircraft, Culver City, CA; and International Laser Systems, Orlando, FL.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1976, FY 197T and Prior Accomplishments: Not applicable.

2. Planned FY 1977 Program: This is a new element beginning in FY 77. The areas to be investigated encompass the following. Propulsion: The purpose of this program is to develop a multi-cylinder engine with nominal 20 horsepower and growth potential to 25 horsepower from existing two cycle components. Survivability: An investigation will be conducted to determine the best methods for reducing the visual signatures of RPVs. Launch and Recovery: A contractual effort will be initiated to fabricate and test one or two simplified launchers based on simplified design; emphasis will center on increased relability and maintainability. Fabrication and Structures: An in-house evaluation of several manufacturing techniques/structural concepts will be conducted; applicable Air Force techniques will be considered. A contractual effort to fabricate several RPVs will be initiated. Low Light Level Solid State Imager: Development of a form, fit, and function replacement for the RPV day camera will be completed. Reduced Cost/Weight Sensor: This program will achieve cost and weight reductions for the stabilized TV RPV system. Command and Control: Work will start to convert an anti-jam data link from test frequencies to deployable frequencies.

3. Planned FY 1978 Program: The FY 1978 program will continue the efforts initiated during FY 1977. Propulsion: Prototype engines will be delivered to the Army for testing. Survivability: The radar cross section of the vehicles being built under the fabrication and structures effort will be established and the ballistic tolerance will be tested. Launch and Recovery: Recovery techniques will be integrated into optimized automatic approach systems. Fabrication and Structures: The contractual effort to build several RPVs will be completed and structural testing of the specimens will commence. Pyroelectric Vidicon: A pyroelectric vidicon (a potentially low cost imager) will be built and tested. Three to Five Micron Thermal Imager: A contract will be initiated to build a thermo-electrically cooled thermal imager featuring low cost less complexity. Command and Control: Work on an anti-jam data link will continue. Radar: Systems and antenna analysis of a 35 pound prototype millimeter radar will be initiated.

4. Planned FY 1979 Program: Those efforts on-going in FY 1978 will be continued. Increased effort will be expended on potentially low cost imagers. New technological, problems identified under PF 6.37.25.A which require long term solutions will be added.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.33.A

Title Mobility Equipment Technology

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	8813	1907	8914	9926	12002	Continuing	Not Applicable
AH20-01	Fuels and Lubricants	1963	514	2069	2225	2527	Continuing	Not Applicable
AH20-02	Countermine and Barrier Techniques	3781	590	3825	3596	4652	Continuing	Not Applicable
AH20-03	Combat Support Technology	3069	803	3020	4105	4623	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This element covers exploratory research in areas of fuels, lubricants, power transmission fluids and corrosion preventative coatings, mine detection and neutralization, advanced tactical barriers and related concepts, camouflage, power generation, bridging, water and wastewater management, fuels handling, environmental control, marine equipment, containerization, construction equipment, expedient surfacing and soil stabilization. These programs are designed to improve and support the increased mobility of friendly forces while decreasing losses of friendly personnel and material and inhibiting enemy mobility.

BASIS FOR FY 1978 RDTE REQUEST: Investigate effects of high-sulfur foreign fuels on military engines. Evaluate micelle polymer modified diesel fuels and multi-viscosity oils for Army combat vehicles. Establish tolerances for re-refined oils. Prepare specifications for reduced maintenance silicone brake fluid and hydraulic fluid for military vehicles. Field test anti-freeze extender additive. Continue efforts on short range detection of buried mines and standoff detection of surface laid minefields, explosive detection, close-in mine neutralization devices and techniques, reduction of vehicle signatures by demagnetization, advanced barrier systems to include engine interference, slippery substances and visual degradation. Develop concept for long-range camouflage screening concepts. Identify materials and techniques for camouflage of fixed installations. Initiate research towards developing active decoy devices and synthetic snow camouflage material. Continue investigation of design concepts and experimental modular radar reflectors. Demonstrate feasibility of foam obscurants. Study camouflage techniques through understanding of human perception. Complete evaluation of electric generator cooling and insulation techniques. Continue tactical power distribution effort, power conditioners, and indirect and direct hydrocarbon/air fuel cells. Evaluate assault, dry and wet gap support bridge interfaces, and application of various materials, and expedient techniques for rapid access and egress at bridge sites. Continue development of multi-purpose reverse osmosis membranes to achieve versatility and reduce water pre-treatment requirements. Continue research on fuel tank materials, cross-country baselines, and marine terminal systems. Continue research on rapid excavation equipment.

Budget Activity #1 - Technology Base

Program Element #6.27.33.A Title Mobility Equipment Technology

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The increase in funding will be used to place increased emphasis in areas of camouflage, bridging, power generation and evaluation of extended-life, reduced-maintenance lubricants and fluids for Army combat vehicles.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	102	0	102
(2) Contractor Employees	67	0	67
Total	169	0	169

DETAILED BACKGROUND AND DESCRIPTION: This element covers those efforts directed towards overcoming all conceivable obstacles to mobility, whether the obstacles are enemy created, naturally created, or are a result of our own logistic shortcomings. Concurrently, this element explores systems for the physical security of our forces and support activities by the use of new and advanced camouflage techniques, new barriers and intruder detection devices. It covers exploratory development efforts to detect and neutralize minefields; it covers new and improved marine and bridging capabilities to by-pass minefields and/or to cross water and land gap obstacles. New and improved mobile electric power sources and distribution means are explored. It covers efforts to determine whether or not Army diesel engines can operate satisfactorily on non-specification fuels, e.g., those with a high sulfur content which are common in many parts of the world and may be commandeered for our use. At the same time, new formulations are tested to decrease the fire hazard of fuels, lubricants and hydraulic fluids used in our combat and tactical vehicles. Finally, it covers water purification systems, containerized/bulk cargo and fuel handling equipment, logistics watercraft, environmental control, and rapid construction materials and means, to provide the support needed to sustain Army mobility and logistics in a hostile environment.

RELATED ACTIVITIES: In the fuels and lubricants technical area, active liaison and coordination maintained with other Services, the Environmental Protection Agency, Federal Aviation Administration and Energy Research and Development Administration. The Countermine and Barrier Technical Area provided direct support for advanced and engineering development program elements 6.36.06.A, Landmine Warfare; 6.36.19.A, Countermine and Barriers; 6.46.19.A, Landmine Warfare; and 6.46.12.A, Countermine and Barriers. Combat Support Technology area interfaces with other Services and agencies through the Interagency Advanced Power Group, Logistics Systems Policy Committee, Joint Container Steering Group and Program Manager for Army Container-Oriented Distribution System.

WORK PERFORMED BY: In-house work by U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, VA; U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS; Yuma Proving Grounds, Yuma, AR; US Army Armament Research and Development

Budget Activity #1 - Technology Base

Program Element #6.27.33.A Title Mobility Equipment Technology

Command (ARRADCOM), Aberdeen, MD; and Harry Diamond Laboratories, Washington, D.C. Contractual support over $25,000 is provided by Southwest Research Institute, San Antonio, TX; SKF Industries, Philadelphia, PA; Yucca International, Incorporated, Scottsdale, AR; Energy Research Corporation, Dansbury, CT; Chrysler Corporation, Detroit, MI; Goodyear Aerospace, Akron, OH; and Beckman Industries, Carlsbad, CA. Additional contracts are planned amounting to $3,200,000.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Accomplishments in the area of fuels include: compatibility of military standard engines with unleaded gasoline was determined; NATO F-54 diesel fuel and F-46 gasoline were standardized for United States Forces; crude oils were characterized as emergency fuels for diesel engines; fuel tolerance of L-141 power plant to blends of JP-4, DF-2, and JET-A in gasoline was determined. In the area of lubricants: specification MIL-L-2104C was prepared for use by the Army tactical fleet; a specification for Arctic engine oil with improved performance and wider operating temperatures was prepared; feasibility of emerging air-oil mist lubrication for helicopter engine/transmissions under oil loss conditions was established; and basic performance characteristics of commercial long-life lubricants were determined. The following concepts feasibility was demonstrated: thermal (infrared) imaging devices, metal reradiation devices (METRRA), high resolution short pulse radar, and microwave devices for mine detection. Bridging anti-personnel minefields with quick hardening foam was demonstrated. The use of nuclear magnetic resonance to detect explosives was investigated. Plasma chromotography was evaluated as an explosive trace gas detector. Magnetic signatures of U.S. and foreign vehicles were studied for use in signature duplicators. Effectiveness of the Soviet mine roller was evaluated. The effectiveness of fuel air explosives against pressure fused mines was evaluated. Developed laboratory test and simulation devices to establish camouflage baseline data and measure effectiveness of new materials and methods. Established criteria, performed design analysis, and began composite materials studies to support trilateral US/UK/FRG program for bridging in the 1980's. Developed and tested dry reverse osmosis membrane, ultrafiltration, and new techniques for treating salt, brackish and contaminated waters. Demonstrated feasibility of new air-cycle air conditioning concept.

2. FY 1977 Program: Conduct laboratory screening tests of micella polymer modified heat-sink safety fuel. Conduct simulated service tests on spent anti-freeze extender in preparation for full-scale testing. Complete the limited field test of silicone brake fluid in vehicles with air-assisted brake systems. Complete stroking tests with silicone brake fluids in the Hydrovac system. Complete extended drain interval field test of synthetic and conventional engine oils in spark-ignition engines. Characterize re-refined base stock and prepare fully compounded engine oils for qualification testing. Evaluate selected multi-viscosity engine oils in diesel engines. Evaluate an airborne metal reradiation prototype for long range detection of scatterable minefields. Examine a variety of techniques for standoff buried minefield detection. Continue evaluation of an off-route buried minefield detector, a manportable metal reradiation detector, and explosive detectors. Conduct effectiveness studies of hybrid mine clearing roller. Demonstrate the use of manportable liquid explosives (MANFLEX) and a vehicle mounted system (SPRAYFAE) for mine neutralization. Continue efforts on engine interference, tractive entanglements, and optical coatings for use as barriers. Initiate efforts on slippery substances. Examine available and advanced demolition items and devices for incorporation into a family of explosive demolitions. Complete cost reduction study for camouflage paints, design of color image software, and initial analysis of global backgrounds. Conduct work on color coatings, foams, radar decoys, snow screens, and thermal signature reduction.

Budget Activity #1 - Technology Base

Program Element #6.27.33.A Title Mobility Equipment Technology

Investigate new power processor concepts, modularization for power conditioning, insulation for tactical power distribution, and cooling for generators. Continue work on advanced fuel cells. Test optimized hybrid power system. Continue composite materials study for bridge components and modeling analysis of dry gap span.

3. FY 1978 Planned Program: Conduct full-scale tests on multi-viscosity engine oils for diesel engines. Select most promising oils and establish tentative requirements for military specifications. Complete turbine combustor tests on FM-9 modified turbine fuel. Complete laboratory engine tests on most promising micelle polymer modified safety fuels. Conduct field tests on fire-resistant hydraulic fluids. Perform full-scale tests using anti-freeze extender and prepare a specification for this material. Continue efforts on selected minefield sensors such as multispectral photography and electromagnetic techniques. Continue efforts on short pulse radar and manportable metal reradiation detectors. Continue efforts on sprayed fuel-air explosives (SPRAYFAE) and vehicle demagnetization. Continue efforts on engine interference, slippery substances, and visual degradation for barriers. Examine concepts for future camouflage screens, and evaluate multi-spectral coatings. Analyze cues for dynamic targets. Continue research on global backgrounds, snow screens, radar reflectors, foam obscurants, computer-generated imagery, and thermal suppression. Complete evaluation of electric generator cooling. Continue efforts on tactical power distribution, high frequency power conditioners, solid state controls, improved fuel cells,and hybrid propulsion. Investigate interface between various advanced bridge types, and conduct optimization analysis. Test improved dry membranes for sea water treatment. Continue tests of soil stabilizers with emphasis on application to bridge access/egress and logistics-over-the-beach problems. Increased funding will be used to adequately support vital areas of bridging, camouflage, power generation and lubricants and fluids for combat vehicles.

4. FY 1979 Planned Program: Conduct full-scale engine tests using re-refined engine oils in tactical equipment. Conduct limited field tests with high-sulfur fuel and selected fuel/engine oil additives. Specifications will be prepared for hydraulic fluids for Army-wide use, and fire-resistant hydraulic fluids. Laboratory scale engine and fuel system compatibility tests will be performed on high energy fuels. Continue longer-range FY 1978 tasks. Continue efforts on standoff buried minefield detection and manportable metal reradiation detection. Increase level of effort on vehicle component hardening and demagnetization. Continue efforts on slippery substances and visual degradation barriers. Investigations will continue on new and improved camouflage and counter-surveillance methods and hardware concepts; support for bridging in the 1980's; seeking solutions to electrical, mechanical and technical problems associated with power generation, with emphasis on improving efficiency, reliability, fuel reduction and components to support energy needs. Verify feasibility of concepts for Army watercraft for logistics resupply and coastal, harbor, inland-waterways missionss and develop equipment concepts toward an integrated containerized supply distribution system. Increased funding will be used to continue new thrusts on camouflage, power generation, advanced bridging and lubricants and fluids for combat vehicles.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.33.A Title Mobility Equipment Technology

Project #AH20 Title Mobility Equipment Technology

Technical Area 02 Title Countermine and Barrier Techniques

Category Exploratory Development Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: This project contains two major areas of interest: countermine and advanced barrier techniques. In the countermine area, applied research and exploratory development is conducted to detect mines and booby traps from local and stand-off positions. Capabilities and limitations of specific technical approaches as a function of mine and environment are evaluated. Technical solutions are provided for allowing safe passage for vehicles and personnel through mined enemy territory. The objective of the barrier program is to define field fortification and obstacle concepts that will reinforce measures to economize force. The approach is to generate and evaluate concepts for means to rapidly construct tactical fortifications fighting emplacements, obstacles, and controllable barriers.

RELATED ACTIVITIES: Army mine/countermine advanced and engineering development program elements, 6.36.06.A, Landmine Warfare, and 6.46.12.A, Countermine and Barriers, respectively, are directly supported by technology emerging from this project. Techniques for neutralizing buried land mines or damaging mine components are similar to techniques of interest in explosive ordnance disposal (EOD). Techniques for detecting mines or mine components are similar to techniques employed for detecting narcotics, drugs, chemicals and metals. Therefore, federal agencies such as the State Department, Bureau of Standards, Federal Bureau of Investigation (FBI), and the Federal Aviation Agency (FAA), maintain strong interest and closely follow the Army's work. Liaison with the United Kingdom and Federal Republic of Germany is maintained. Formal coordination occurs through the Quadripartite and North Atlantic Treaty Organizations.

WORK PERFORMED BY: In-house efforts are conducted at the Mobility Equipment Research and Development Command, Fort Belvoir, VA; Yuma Proving Grounds, Yuma, AZ; US Army Armament Research and Development Command (ARRADCOM), Aberdeen, MD; and the Harry Diamond Laboratories, Washington, DC. Contractual support is provided by: Neurocommunications, Danbury, CN; Cubic Corporation, La Jolla, CA; Georgia Institute of Technology, Atlanta, GA; Beckman Instruments, Carlsbad, CA; Southwest Research Institute, San Antonio, TX; Goodyear Aerospace, Akron, OH; Illinois Institute of Technology Research, Chicago, IL; Teledyne McCormick Selph, Hollister, CA; and Chrysler Corporation, Detroit, MI.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: During this period, feasibility of the following concepts was demonstrated: thermal (infrared) imaging devices, metal reradiation devices (METRRA), high resolution short pulse radar and microwave devices for mine detection. German shepard dogs were trained to detect mines. Bridging anti-personnel minefields with quick hardening foam was demonstrated. The use of nuclear magnetic resonance to detect explosives was investigated. High energy laser mine

neutralization was determined not to be feasible. Sixteen volume encyclopedia of land mine and countermine warfare was published. Plasma chromatography was evaluated as an explosive trace gas detector. Magnetic signatures of US and foreign vehicles were studied for use in signature duplicators. Effectiveness of the Soviet mine roller was evaluated. The effectiveness of fuel-air explosives against pressure fuzed mines was evaluated. An electronic time fuze to provide field resettable capability for the fuel-air explosive rounds was designed and fabricated.

2. FY 1977 Program: Evaluate an airborne metal reradiation prototype for long range detection of scatterable mine fields. Examine a variety of techniques for standoff buried minefield detection. Continue evaluation of an off-route buried minefield detector, a manportable metal reradiation detector, and explosive detectors. Conduct effectiveness studies of hybrid mine clearing roller. Demonstrate the use of manportable liquid explosives (MANFLEX) and a vehicle mounted system (SPRAYFAE) for mine neutralization. Continue efforts on engine interference, tractive entanglements, and optical coatings for use as barriers. Initiate efforts on slippery substances. Examine available and advanced demolition items and devices for incorporation into a family of explosive demolitions.

3. FY 1978 Planned Program: Continue efforts on selected minefield sensors such as multispectral photography and electromagnetic techniques. Continue efforts on short pulse radar and manportable metal reradiation detectors. Continue efforts on sprayed fuel-air explosives (SPRAYFAE) and vehicle demagnetization. Continue efforts on engine interference, slippery substances, and visual degradation for barriers.

4. FY 1979 Planned Program: Continue efforts on standoff buried minefields detection and manportable metal reradiation detection. Increase level of effort on vehicle component hardening and demagnetization. Continue efforts on slippery substances and visual degradation barriers. Increased funding requirements reflects greater level of effort on buried minefield detection.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	3781	590	3825	3596	4852	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.33.A — Title Mobility Equipment Technology

Project #AH20 — Title Mobility Equipment Technology

Technical Area 03 — Title Combat Support Technology

Category Exploratory Development — Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: This technical area supports efforts to provide the technology base leading to item development for general purpose forces mobility, combat engineering, and logistics support. Specific activities covered include camouflage, power generation, bridging, water/wastewater management, fuels handling, environmental control, Army logistics watercraft, cargo containerization, construction equipment, and expedient soil surfacing and stabilization.

RELATED ACTIVITIES: Coordination and interface with other agencies/services activities is accomplished by the Joint Service Civil Engineering Research and Development Group; Bridging in the 1980's Cooperative Research and Development Program; Interagency Advanced Power Group; Logistics System Policy Committee; Joint Container Steering Group; and Project Manager for Army Container-Oriented Distribution System. Related basic research is conducted in Program Element (PE) 6.11.02.A, Project AH47, Electronic Devices Research, and Project AH51, Combat Support Research. This technical area supports component and hardware items developed under P.E.'s 6.37.02.A, Electric Power Sources; 6.37.26.A, Combat Support Equipment; 6.47.14.A, Tactical Electric Power Sources; and 6.47.17.A, General Combat Support.

WORK PERFORMED BY: In-house work is performed by the U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, VA, and the U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS. Contractors include Ferro Corporation, Cleveland, OH; Brunswick Corporation, Deland, FL; National Foam, Lionsville, PA; Universal Oil Products, Incorporated, Des Plaines, IL; Yucca International, Incorporated, Scottsdale, AZ; Energy Research Corporation, Danbury, CT; General Dynamics Corporation, San Diego, CA; ROVAC, Incorporated, Maitland, FL; Rensselaer Polytechnic Institute, Troy, NY; University of Texas, San Antonio, TX; and 20 additional ongoing or planned contracts in an amount of $983,000.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Completed designs for camouflage paint patterns. Confirmed feasibility of a thermal camouflage canopy. Developed a radar diagnostic facility, a computer measurement and classification model, and other laboratory test and simulation devices to establish baseline data and measure effectiveness of new camouflage materials and methods. Designed new woven fabric radar attenuating material. Developed improved foams, paint formulations, and decoy concepts. Completed efforts on aerosols for radar protection. Developed improved components for advanced and high-speed rotating electric machinery, fuel cell materials to improve performance and reduce costs, solid state power conditioning, and hybrid power concepts for electric propulsion. Identified problems in tactical electric power distribution. Developed design and test criteria for trilateral US/UK/FRG cooperative program for bridging in the 1980's. Developed improved dry reverse osmosis membranes for water

Budget Activity #1 - Technology Base

Program Element #6.27.33.A Title Mobility Equipment Technology

Project #AH20 Title Mobility Equipment Technology

Technical Area 03 Title Combat Support Technology

purification. Confirmed capability of a new material for rapid road and airfield construction, and established feasibility of a new concept for stabilizing dry sand. Developed new concepts for fuel decontamination. Identified longer-life collapsible fuel tank materials, and developed new materials for low temperature fueling. Designed a seamless fabric fuel storage tank and developed method for field-fabricating rigid plastic tanks. Completed studies of various candidate Army watercraft for logistics-over-the-shore. Completed a joint Army/Navy test of a containership discharge concept. Completed research of modular containers, ammunition restraints, and an electronic container control and identification system. Demonstrated feasibility of new air-cycle concept for air conditioning. Verified feasibility of high-speed excavation of soil and rock, explosive drilling, an explosive earth ripper, and rapid combat trenching.

2. FY 1977 Program: Complete cost reduction study for camouflage paint. Design software for producing color target and background imagery. Analyze satellite data for global backgrounds. Investigate coatings for canvas, foam-obscurants, concepts for reducing turbine-engine signatures, a synthetic snow camouflage material, battlefield-created radar decoys, radar reflectors, and tactical target signatures. Study high frequency power processors, and modularization of power conditioners and electric devices. Investigate insulation for power distribution, and cooling and insulation of generators. Continue work on new fuel cell components. Test optimized hybrid power system in an electric forklift. Continue study of lightweight composite materials for bridge components, and complete modeling analysis of dry gap bridge structure. Develop chlorine-resistant dry membranes for water purification, an air-assist filter cleaning method, and evaluate ozone and halogen water disinfection concepts. Continue evaluations of potential expedient soil surfacing, soil stabilization, and general purpose construction materials. Conduct tests of new fabric fuel tank materials, a seamless fabric tank, and a rigid plastic tank. Investigate 6 inch fuel hoseline and marine terminal system concepts. Analyze air spill problem for air cushion vehicles, and explore air cushion technology for cargo barges. Investigate exhaust-powered, absorption cycle air conditioning concept. Conduct feasibility analysis of a forklift stability safety device. Continue high-speed earth excavation studies.

3. FY 1978 Planned Program: Develop concepts for future camouflage screens. Evaluate candidates for multispectral coatings. Analyze detection cues for selected weapon systems in a firing/moving mode. Examine camouflage of fixed installations. Continue research on global backgrounds, synthetic materials for snow camouflage, modular radar reflectors, long-acting foam obscurants, infrared suppression of heat-generating targets, and computer-generated target imagery. Begin research on active decoys. Complete evaluation of electric generator cooling and insulation techniques. Continue efforts on tactical power distribution, high-frequency, power conditioning, microprocessor controls, new solid state devices, improved components for fuel cells, and hybrid electric propulsion system. Study interface between assault, dry, and wet gap bridge concepts, and initiate bridge system optimization analysis using various materials and configurations. Continue development of multi-purpose water purification membranes with longer life and reduced water pretreatment needs. Investigate new water disinfection and clarification techniques. Continue

Budget Activity #1 - Technology Base

Program Element #6.27.33.A Title Mobility Equipment Technology

Project #AH20 Title Mobility Equipment Technology

Technical Area 03 Title Combat Support Technology

evaluation studies of general purpose construction materials, soil surfacing and stabilizers with emphasis on solving bridge access/egress and logistics-over-the-shore problems. Continue research on fuel tank materials, cross-country hoselines, and marine fuel terminal concepts. Develop anti-venting device for air cushion vehicles, define characteristics for air cushion barge, and begin effort to improve wear of air cushion skirts. Fabricate concept model of exhaust-powered absorption-type air conditioner. Fabricate and begin test of forklift stability safety device. Continue research on mobile, high-speed earth excavation, drilling and trenching concepts. Increase in funding for FY 1978 over FY 1977 is required to adequately support vital areas of camouflage, bridging, power generation, and water purification.

4. FY 1979 Planned Program: Studies and investigations will continue in combat support technologies concerned with: new and improved camouflage/countersurveillance methods and hardware concepts, with emphasis on advanced multi-spectral capabilities; analytical system characterization, and development of lightweight composite-type materials for bridging for the 1980's; developing more fuel-efficient, mobile, and reliable tactical power generation equipment; improving water purification methods and materials, with emphasis on capabilities to purify all types of water encountered in any environment; achieving new materials and techniques for rapid soil surfacing where existing soil and conditions are detrimental to mobility; improved fuels handling, storage, distribution, and dispensing fuels to sustain tactical operations; more efficient air conditioning/heating for all environments; pursue concepts for Army watercraft for logistics resupply and coastal, harbor, inland-waterways missions; develop equipment concepts leading to an integrated containerized supply distribution system; and exploit innovative methodology for rapid construction operations involving soil or rock, earth drilling, tunneling, and transporting. Increase in FY 1979 funds essential to allow pursuit of increasing technologies focusing on camouflage, power generation, advanced bridging, and water purification.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	3,069	803	3,020	4,105	4,623	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.34.A Title Medical Technology for Defense Against Chemical Agents

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES/PROJECT LISTING: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	5,489	1,635	6,042	6,541	7,074	Continuing	Not Applicable
AH26	Medical Defense Against Chemical Agents	5,489	1,635	6,042	6,541	7,074	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Program Element is designed to develop medical prophylaxis and therapy for known lethal and incapacitating agents, and to study long term effects of riot control agents on user and occupationally exposed personnel. Program develops definitive measuring techniques for measurement of agents in man as well as behavioral techniques to measure performance decrement in man after agent use.

BASIS FOR FY 1978 RDTE REQUEST: Death and disability emanating from the use of chemical agents against unprotected personnel have not been modified, and at this time, adequate warning of chemical attack and adequate protective clothing and equipment are not available to obviate these effects. Therefore, medication taken routinely to prevent chemical agent intoxication or medication taken post intoxication to negate the effects serve to maintain unit strength.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The funding increase is required to accelerate the program to meet the immediate need of field medication. The totality of medical defense against chemical agents must be sparked with a demanding reappraisal and innovative approach to the long standing requirements.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	132	0	132
(2) Contractor Employees	10	0	10
Total	142	0	142

Budget Activity #1 - Technology Base

Program Element #6.27.34.A Title Medical Technology for Defense Against Chemical Agents

DETAILED BACKGROUND AND DESCRIPTION: Research in this program element is to design or develop drugs, equipment, and methods required to furnish prophylaxis and therapy for poisoning by all chemical agents. This program investigates and evaluates equipment and procedures for self-administered treatment. The program searches for drugs and other means to achieve prophylaxis against or treatment for poisoning by lethal chemical agents and to devise the most effective ways of applying them.

RELATED ACTIVITIES: Investigations under this program provide essential exploratory efforts in medical defense to support program elements 6.37.21.A Chemical Defense Material Concept and 6.47.25.A, Chemical Defense Material. The Army is responsible for its own medical defense program and those of joint requirements for the Army and other Services. Coordination and cooperation is maintained with the United Kingdom, Canada, Australia and with the North Atlantic Treaty Organization.

WORK PERFORMED BY: In house work is performed at the US Army Biomedical Laboratory, US Army Armament Research and Development Command (ARRADCOM), Edgewood, MD.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, 1976 and Prior Accomplishments: Progress was made in the formulation and development of an improved decontaminant for skin which led to the development of the M258 kit. Many hundreds of drugs have been prepared and tested for a therapy for lethal agents. All standard chemical protective equipment such as protective masks and clothing has been evaluated for body stress. Research was conducted in physiology, biochemistry and clinical studies to improve self-treatment and resuscitation equipment. Prototype protective masks were evaluated in field tests along with protective clothing. The effects of drugs when the body is stressed from wearing protective equipment was studied. Various nerve agent vaccines were prepared and tested. A convenient enzymatic slide test was developed for estimation of antibodies. A system for measuring changes in the eye caused by exposure to incapacitating agents has been refined. A new skin decontaminant was developed and underwent extensive evaluation.

2. FY 1977 Program: New protocols for investigating performance effects of mask dead space and the dynamics of resistance and flow patterns will be started. Continued testing of resuscitating devices and the peripheral leakage of prototype masks during physical activity are planned. Studies are planned into first and second generation therapy and prophylaxis of lethal agents. Minor exploration into third generation therapy will continue. Stability studies of the finalized therapeutic and prophylactic formulations as well as all constituents will be performed. Behavioral aspects of all final formulations and their separate components will be evaluated. Drug metabolism studies will be started and toxicological studies, both acute and subacute, will be performed in a variety of species. The properties of enzymes in skin responsible for repairing mustard chemical agent induced DNA damage will be investigated. Attempts will be made to enhance their activities in order to minimize or reverse the vesicant effects of this agent. Initial studies will be designed to measure the differences between alkaline solution I and acidic solution II in the M258 kit for decontaminating skin. Animal studies on projected therapies for phosgene and cyanide will be initiated. Toxicology of riot control agents will continue.

Budget Activity #1 - Technology Base

Program Element #6.27.34.A Title: Medical Technology for Defense Against Chemical Agents

3. FY 1978 Planned Program: Therapy and prophylaxis studies against lethal agents will continue. Behavioral work will be expanded because of the increased emphasis for behavioral data by the user as well as the Food and Drug Administration. Clinical trials will be performed for the prophylaxis formulations.

4. FY 1979 Planned Program: Studies on the decontamination of blister agents and the prophylaxis and therapy of mustard agent-induced vesication will be continued. Approximately 60% of animal studies necessary for evaluating treatments for new phosgene and cyanide poisoning will be accomplished. The increased funding is required in order to meet additional standards imposed by the Food and Drug Administration and to meet the increased costs of performing this research.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.45.A Title Tactical Electronic Warfare Techniques

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT						Continuing	Not Applicable
A904	Tactical Electronic Warfare Tech						Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The objectives of this project are to develop

BASIS FOR FY 1978 RDTE REQUEST: Work on a universal modulator will be completed and the task will proceed to advanced development. Studies and investigations will begin on

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Increase in funds in FY 78 is to accelerate work in communications collection techniques.

Budget Activity #1 - Technology Base

Program Element #6.27.45.A Title Tactical Electronic Warfare Techniques

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	8	0	8
(2) Contractor Employees	16	0	16
Total	24	0	24

DETAILED BACKGROUND AND DESCRIPTION: The objectives of this project are to

RELATED ACTIVITIES: Related electronic warfare developments are conducted by the Air Force and Navy. Coordination is effected between the services to maximize the interchange of technical data and minimize duplication of effort. Coordination is effected by the exchange of technical reports, attendance at scientific meetings and conferences, joint participation on subgroups and working panels of the Technical Cooperation Program, and by the Joint Tri-Service Electronic Warfare Panel. In addition, formal requirement documents of each service are exchanged, reviewed, and commented upon by the other services. Coordination is also accomplished as part of the program reviews conducted by the Office of the Secretary of Defense (Director of Defense Research and Engineering). This program supports programs/projects 6.37.45.A/D905 (Division Tactical EW Systems), 6.37.45.A/D925 (Corps Tactical EW Systems), 6.47.45.A/D906 (Division Tactical EW Systems), and 6.47.45.A/D926 (Corps Tactical EW Systems).

WORK PERFORMED BY: US Army Security Agency, Arlington Hall Station, Arlington, Virginia; US Army Electronic Research and Development Command, Fort Monmouth, New Jersey. The major contractors are Georgia Institute of Technology; Cincinnati Electronics, Cincinnati, Ohio; Vero, Inc., Garland, Texas; ITEK Corporation, Lexington, Massachusetts; Quest Research Corporation, McLean, Virginia.

Budget Activity #1 - Technology Base

Program Element #6.27.45.A Title Tactical Electronic Warfare Techniques

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: In the tactical antenna area,

2. FY 1977 Program: Studies will be completed on the feasibility design of a universal modulator. An analysis/techniques investigation will be accomplished, in-house, as part of the effort. A experimental prototype model of a device will be conducted. In-house study and investigation will continue on a high-power, solid state amplifier. Work effort on tactical signals. FY 76

Budget Activity #1 - Technology Base

Program Element #6.27.45.A

Title Tactical Electronic Warfare Techniques

results in

will be evaluated and fabrication of a experimental prototype model

initiated.

studies will be completed. Work will be initiated on a

receiver.

3. FY 1978 Planned Program: Work on a universal modulator will be completed and the task will proceed to advanced development. Studies and investigations will begin on

The increase in funds is required to accelerate work in communications collection techniques.

4. FY 1979 Planned Program:

5. Program to Completion: This is a continuing program. Developments under this program element will normally transfer to program element 6.37.45.A, Tactical Electronic Warfare Equipment.

6. Major Milestones: This is a technology base effort not readily reducable to milestones.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.70.A Title Military Infectious Diseases Technology

Category Exploratory Development Budget Activity #1 Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	12,887	3,242	14,093	15,530	16,154	Continuing	Not Applicable
A802	Military Preventive Medicine and Tropical Diseases	6,097	1,534	6,577	7,348	7,820	Continuing	Not Applicable
A803	Malaria Prophylaxis and Treatment	6,790	1,708	7,516	8,182	8,334	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Objectives of the program are to conduct studies of bacterial, viral, parasitic and rickettsial diseases of military importance. Research includes investigations in epidemiology, control, prevention, treatment, and evaluation of their impact on military operations. Methods for laboratory investigations are explored, developed and standardized.

BASIS FOR FY 1978 RDTE REQUEST: Research will be concentrated on specific diseases of military importance such as malaria, schistosomiasis, trypanosomiasis, and adeno- and arbovirus infections. Work will include providing data on the diseases, their reservoirs, arthropod vectors, and development of improved drugs for treatment and vaccines for prevention of infection. New techniques for laboratory test and evaluation and for control of vectors of pathogenic organisms will be developed.

BASIS FOR CHANGE IN 1978 OVER FY 1977: A modest increase will be required to fully develop the capability for human testing of drugs and vaccines under investigation, and to establish advanced development and field evaluation of a new insect repellent.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement) is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	82	0	82
(2) Contractor Employees	228	0	228
Total	310	0	310

Budget Activity #1 - Technology Base

Program Element #6.27.70.A Title Military Infectious Diseases Technology

DETAILED BACKGROUND AND DESCRIPTION: This program includes studies required to develop preventive measures and improved diagnostic and treatment methods for infectious diseases of military importance, to include parasitic, viral, bacterial and rickettsial diseases. Epidemiology data will be gathered providing information on the transmission, ecology, control, vectors and reservoirs of malaria, adeno- and arboviruses, leishmaniasis, trypanosomiasis, and tick borne rickettsial diseases. A major portion is devoted to development of improved methods for preventing, curing, and eradicating malaria as a menace to military forces.

RELATED ACTIVITIES: Army studies related to this program element are performed under program elements/DA projects 6.11.02.A/BS01, Basic Research on Military Injury and Diseases; 6.11.02.A/BS03, Medical Defense Against Biological Agents; and 6.27.76.A/A841, Medical Defense Against Biological Agents. Complementary research is performed by the National Institutes of Health, Department of Agriculture, and Navy. However, the unique aspects of Army field operations dictate an Army program which focuses on optimal support of military operations and learning to recognize, prevent and treat infectious diseases which cause more lost duty time than combat wounds. Army representation on Department of Defense coordinating committees, intergovernmental agency coordination councils and committees insures coordination at the working and administrative levels in order to prevent unnecessary duplication of effort. Army scientists serve as consultants with the World Health Organization and have access to this organization's studies, reports and publications. Other coordination is accomplished by site visits by project officers, organization of symposia on selected topics, routine exchange of reports among staff and laboratory organizations, open publication of results in scientific journals, and distribution of research and technology resumes.

WORK PERFORMED BY: Approximately 45% of the research is performed by in-house laboratories at Walter Reed Army Institute of Research and field units in Thailand, Malaysia, Brazil and Kenya. The remaining work is conducted by extramural contractors of which the following are representative: Midwest Research Institute, Kansas City, MO; Bio-Med Inc., Silver Spring, MD; University Hospital, Boston, MA; Johns Hopkins University School of Medicine, Baltimore, MD; Stanford Research Institute, Menlo Park, CA; Harvard University, Cambridge, MA; University of Miami, Miami, FL; Southern Research Institute, Birmingham, AL; Parke Davis & Company, Ann Arbor, MI; and Starks Associates Inc., Buffalo, NY. Eighty-nine other contracts are supported by this program.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Vaccines were developed which resulted in dramatic decreases in the incidence of adenovirus infections and meningococcal meningitis in troops in recruit centers. Vectors of malaria and filariasis were identified in Southeast Asia and the vector of leishmaniasis was studied in Brazil. Malaria vector control by the use of sterile males was proven to be a feasible technique, and techniques for isolation and purification of malarial ookinetes from mosquitos were developed. Properties of E. coli and Salmonella bacteria which cause diarrhea were identified. An improved radioimmunoassay technique for identification of hepatitis B was developed. An adenovirus was identified as a pathogen of potential importance. Animals were successfully immunized with an irradiated trypanosome vaccine and with vaccines prepared from irradiated forms of malaria parasites. A coordinated program for the development of new antimalarial drugs was established and resulted in the screening of more than 225,000 drugs of which more than 25 were tested in man. Recent emphasis was placed on synthesis and testing of new 8-aminoquinolines, several of which had greater activity against malaria than drugs previously used.

Budget Activity #1 - Technology Base

Program Element #6.27.70.A Title Military Infectious Diseases Technology

2. FY 1977 Program: Occurrence, spread and consequences of swine influenza infections in military personnel will be investigated. Isolations of the virus will be characterized and diagnostic biologics will be prepared for use in Army laboratories. Occurrence of adenovirus type 21 in recruits with respiratory disease will be determined. Sustained release antischistosomal drugs will be evaluated and new drugs will be synthesized. The mechanism of malaria transmission in the absence of known vectors will be investigated and new arthropod repellents will be developed. Development of dengue vaccine and data accumulation for development of antimalarial, antidiarrheal and antihepatitis vaccines will continue. Chemical compounds with antimalarial activity will continue to be tested in the drug development program. New methods to determine blood and tissue levels of selected candidate antimalarial drugs will be developed as will the human testing capability.

3. FY 1978 Planned Program: Studies will be directed toward accumulation of data on infectious diseases of military importance with the goal of making improvements in prevention, control, diagnosis and treatment. The appropriate employment of a live adenovirus type 21 vaccine will be determined and developmental requirements evaluated. Research on vaccines against malaria, enteritis and hepatitis will continue as will development of a dengue 2 vaccine. Protection against arthropod vectors and improved insect control measures will be investigated. Advanced field studies for evaluation of insect repellents will be conducted. New drugs will be tested in a systematic fashion in order to identify and develop more effective antimalarial compounds. Malaria research will continue in an effort to obtain a better understanding of the mechanisms of multi-drug resistance by the parasite and innate and acquired resistance to infection by the host. Small increments for advanced field studies and anticipated increases in human testing capability for new drugs and vaccines account for the increased funding requirement.

4. FY 1979 Planned Program: Studies will be directed toward development of data which will establish host-parasite-vector relationships of diseases in tropical and temperate regions of the world where U.S. troops must be prepared to operate. New and improved products for prevention, control, and treatment of selected diseases will be emphasized. New antimalarial drugs and a dengue 2 vaccine will be developed as will improved arthropod repellents and control techniques. Increased costs result from additional requirements for drug synthesis and vaccine production, test and evaluation.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.70.A Title Military Infectious Diseases Technology

Project #A802 Title Military Preventive Medicine and Tropical Diseases

Category Exploratory Development Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: Infectious diseases have been the main cause of manpower loss in all wars in and outside the combat zone. In Vietnam, two thirds of all casualties were due to infectious diseases; in 1968, two million man days were lost in Continental United States (CONUS) and in non combat areas overseas due to infections. Every element of the military force is affected. The strategic mobility of US Forces to support national interests is enhanced by an ability to cope with diseases peculiar to other parts of the world. Tropical areas are a source (and sometimes the only source to the Free World) of many key resources required by the US, but these same areas also represent significant infectious disease hazards, e.g. the recent occurrence in African hemorrhagic fever in the Sudan and Zaire. Research efforts must begin well before troops are deployed since years are required to develop acceptable preventative and therapeutic procedures for any disease. The research supports a broad and continuing military field and laboratory oriented program essential to the recognition, prevention, treatment, and control of infectious diseases of military significance and crucial to fostering the national interests. This is a balanced program between in-house (which also serves to retain and maintain a quick response Department of Defense (DOD) strike force of tropical disease experts) and extramural efforts that are complementary to the in-house program.

RELATED ACTIVITIES: Related effort is performed under program elements/DA projects 6.11.02.A/BS01, Basic Research on Military Injury and Diseases, BS02, Basic Mechanisms of Recovery From Injury; and 6.27.70.A/803, Malaria Prophylaxis and Treatment. Small complementary programs exist in the Navy, Department of Agriculture and Public Health Service. Army presentation on Department of Defense committees and other intergovernmental agencies (for example, Armed Forces Pest Control Board and Federal Working Group on Pest Management) insure coordination at the working and administrative levels to prevent unnecessary duplication of effort. Army scientists serve as consultants with the World Health Organization and have access to this organization's studies, reports, topics, routine exchange of reports among staff and laboratory organizations, open publication of results in scientific journals, and distribution of research and technology resumes.

WORK PERFORMED BY: The Walter Reed Army Institute of Research performs most of the in-house work in this Project. Overseas efforts are conducted by field units of the Walter Reed Army Institute of Research in Thailand, Malaysia, Brazil, and Kenya. Approximately 60% of the effort is supported by in-house research and 40% by extramural contracts. Some of the largest contracts are with University Hospital, Boston, MA; Johns Hopkins University School of Medicine, Baltimore, MD; Smithsonian Institution, Washington, DC; Stanford Research Institute, Menlo Park, CA; Baylor College of Medicine, Houston, TX; Harvard University, Cambridge, MA; and University of Georgia, Athens, GA. Forty-three other contracts are supported by this program.

Budget Activity #1 - Technology Base

Program Element #6.27.70.A Title Military Infectious Diseases Technology

Project #A802 Title Military Preventive Medicine and Tropical Diseases

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: The adenovirus vaccine against types 4 and 7 adenovirus diseases markedly reduced the incidence and morbidity of adenovirus infections in recruit centers, leading to significant training cost savings. Vaccines against groups A and C meningococcal meningitis were developed, which provided protection from those diseases and resulted in a dramatic drop in the number of cases and deaths of recruits due to meningitis. Arthropod-borne diseases were studied in tropical and subtropical areas. From those studies data were established on the vectors of malaria and filariasis in Southeast Asia. Several epidemiologic studies were conducted of infectious diseases transmitted among populations along the Trans-Amazon Highway. Taxonomic and ecological studies of the sand fly vectors of leishmaniasis were conducted providing considerable new information on these man-biting flies. Additional information was accumulated on the use of lumbar injections of hyperbaric glucose-amphotericin in the treatment of coccidioidal meningitis. Simplified models of the dynamics of mosquito-vector populations were developed and related to control technology. The feasibility of malaria vector control by the sterile-male mosquito control technique was proven. Demographic and epidemiological bases for epidemic dengue infection in the Caribbean area were identified. Techniques were developed for the isolation and purification of malarial ookinetes from mosquitoes. Factors were discovered that induce diapause in eggs of floodwater mosquito species, Aedes canadensis and Psorophora ferox, which are potential arbovirus vectors. Identified diarrhea causing properties of E. coli and Salmonella bacteria. A new radioimmunoassay for hepatitis B identification in serum has retained the necessary sensitivity and increased the specificity for detection of this virus. Adenovirus type 21 was identified as a possible emerging strain of adenovirus. Animals were successfully immunized with irradiated trypanosome vaccines.

2. FY 1977 Program: The occurrence, spread and consequences of swine influenza infection in military personnel will be studied at Fort Dix, NJ, and wherever this infection occurs. Diagnostic antigens and antisera will be prepared for this newly emergent type of influenza for use by Army laboratories. Strains of swine influenza will be characterized. The occurrence of adenovirus type 21 respiratory disease in recruits will be documented. Determine mechanism of malaria transmission in tropical forest areas where the known mosquito vectors are absent. Evaluate sustained release formulations of antischistosomal compounds. Develop arthropod repellent treated clothing that provide increased protection time to troops. Develop in vitro cultivation of malaria parasites beginning with ookinete form. Provide data that will lead to the development of vaccines against diarrhea and hepatitis. Continue studies toward development of dengue vaccine. Synthesize new antischistosomal drugs based on leads developed from drug screening program. Test suitability of vaccine antigens as group B meningococcal vaccine.

3. FY 1978 Planned Program: Continued studies will be directed to development and evaluation of data which will elucidate host-parasite-vector relationships in tropical and temperate regions. Emphasis will be placed on diseases of military medical significance, especially parasite, viral, bacterial and rickettsial diseases. Additional research reflecting increase over FY 77

Budget Activity #1 - Technology Base

Program Element #6.27.70.A Title Military Infectious Diseases Technology

Project #A802 Title Military Preventive Medicine and Tropical Diseases

funding will be directed to advanced development of prophylaxis, diagnosis and treatment of tropical diseases of military importance. Genetic and biological control systems of insect vectors will be studied in addition to chemical control methods. Biosystematics and behavioral studies of arthropod vectors of parasitic, viral, bacterial and rickettsial diseases of importance or potential importance to the military forces will continue. Additional emphasis will be directed toward advanced development and field evaluation of an insect repellent having improved qualities for protection of US troops against disease bearing insects. The most appropriate method for use of live attenuated adenovirus type 21 vaccine will be established. The efficacy of the adenovirus 21 vaccine to prevent disease will be evaluated.

4. FY 1979 Planned Program: Investigations will continue on development of new and improved biological products for military use. Investigations will continue on the development of a dengue virus type 2 vaccine.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	6,097	1,534	6,577	7,348	7,820	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.70.A Title Military Infectious Diseases Technology

Project #A803 Title Malaria Prophylaxis and Treatment

Category Exploratory Development Budget Activity #1 Technology Base

DETAILED BACKGROUND AND DESCRIPTION: Malaria is a worldwide problem and has been pivotal in every major war involving US military (90,000 casualties in Vietnam alone). Because of the massive drain on force strength, malaria is one of the world's most important infectious diseases to combat soldiers in temperate, subtropical and tropical regions. Even though new antimalarial drugs and insecticides have been developed, malaria is becoming increasingly prevalent in many regions of the world. The disease-causing parasites and mosquito vectors are constantly changing, developing resistance to drugs or insecticides. As a result, malaria has reappeared in a number of areas (e.g. India, Pakistan, parts of Africa and Central and South America) from which it had been eliminated. Disruption in a country resulting from combat operations foster the increase of malaria and other infectious diseases. In order for the Army to operate effectively in areas in which malaria is endemic, new and effective means of preventing and treating malaria are needed. Experience of Vietnam has clearly indicated that present knowledge, techniques, drugs and insecticides are not adequate to assure that the Army can cope effectively in malarious regions. Since malaria does not occur in the United States, the military has a unique requirement for research and development efforts to solve the problem of this devasting disease. To remedy the problem, a well balanced program of laboratory, clinical and field research is directed at developing new or improved methods for preventing and curing the disease. The present research effort is divided into two general areas: (1) drug development and (2) vaccine development. A major effort is directed at development of drugs against resistant forms of malarial organisms.

RELATED ACTIVITIES: Related work is performed under Program Elements/DA Projects 6.11.02.A/8801, Basic Research on Military Injury and Diseases, and 6.27.70.A/A802, Military Preventive Medicine and Tropical Diseases. Some complementary research is conducted by the Department of the Navy and National Institute of Allergy and Infectious Diseases. The Army program is the only significant program of systematic search for drugs to prevent and cure the different types of human malaria. Coordination of the program is achieved by project officer visits to in-house and extramural contractor laboratories, and conferences and symposia with participants from all over the world.

WORK PERFORMED BY: About 30% of the work is performed in-house at the Walter Reed Army Institute of Research, Washington, DC and its affiliated field unit in Thailand. Approximately 70% of the work is done under contract with universities, research institutes and industry. Among the top contracts are those with the Midwest Research Institute, Kansas City, MO; Bio-med Inc., Silver Spring, MD; University of Miami, Miami, FL; Warner and Company, Washington, DC; Southern Research Institute, Birmingham, AL; Parke Davis & Company, Ann Arbor, MI; Interx Research Corporation, Lawrence, KS; Starks Associates, Buffalo, NY; and Ash Stevens Inc., Detroit, MI. Thirty other contracts are also funded.

Budget Activity #1 Technology Base

Program Element #6.27.70.A Title Military Infectious Diseases Technology

Project #A803 Title Malaria Prophylaxis and Treatment

PROGRAM AND ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: A program for development of new antimalarial drugs was established and subsequently refined by inclusion of several new test systems. An automated information storage and retrieval system was developed to index screened chemicals and to correlate results from various test systems. To date, over 225,000 different chemical compounds have been screened for antimalarial activity. Most were provided by industry but more than 6,000 were synthesized specifically for this program. Recent emphasis was placed on synthesis and testing of new 8-aminoquinolines, which appear to have more preventive and curative potential than primaquine. More than 200 compounds were tested in subhuman primates and over 25 were tested in man. The current annual rate of compound synthesis is 450; primary screening, 8,250 (8,000 curative, 250 prophylactic); advanced screening 250; toxicity and pharmacology, 3; Phase I and II clinical testing, 5; and field testing, 2. Mefloquine, a recently developed drug, proved effective against multi-drug resistant strains of falciparum malaria. For other investigations designed to gain a better understanding of drug mechanisms, methods for determining human blood levels of four different antimalarial drugs were developed. Highly purified immunoglobulin G, as well as other serum components obtained from immune animals was shown to be active against murine malaria. Gamma irradiated sporozoites of murine malaria or red cells from rodents infected with murine malaria were used to immunize non-infected rodents. The latter were protected against subsequent challenge by the same parasite.

2. FY 1977 Program: The antimalaria drug development program will be continued with special emphasis on preparation and testing of compounds structurally related to drugs with known antimalarial activity - specifically the 8-aminoquinolines. Projected goals are to complete field tests of two new drugs or combinations and initiate tests of a third. New methods to determine blood and tissue levels of selected candidate antimalarials will be developed. Toxicity levels of those 8-aminoquinolines shown to be effective against drug resistant falciparum malaria will be determined. Human testing capabilities will be developed. The immunogenic properties of irradiated sporozoites and trophozoites and their potential value as vaccines will be studied further. The viability of cryopreserved malaria parasites and their usefulness for extended in vitro culture as a means of testing promising antimalarial drugs will be evaluated.

3. FY 1978 Planned Program: Integrated search for improved drug prophylaxis and therapy will continue. Clinical tests and field trials of nine different antimalarials are expected to be in progress. Increased funds over FY 77 levels will be used in the development of new test systems (human, in vitro) for analytic and physiologic determinations. Antimalaria vaccine development will be explored more fully.

4. FY 1979 Planned Program: The development of new and improved anitmalaria drugs will continue as will drug action studies. Immunologic and physiologic studies of the host-parasite relationships will be pursued with vaccine development as an objective. Investigations of the pathogenesis of malaria will continue and will be directed at understanding natural resistance, acquired immunity, and proper treatment of human infections.

Budget Activity #1 Technology Base

Program Element #6.27.70.A Title Military Infectious Diseases Technology

Project #A803 Title Malaria Prophylaxis and Treatment

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	6,790	1,708	7,516	8,182	8,334	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.71.A

Title Military Psychiatry and Microwave Injury

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	2,459	547	3,040	3,120	2,417	Continuing	Not Applicable
A804	Military Psychiatry	1,710	359	2,221	2,220	1,877	Continuing	Not Applicable
A805	Microwave Injury	749	188	819	900	540	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Program seeks to identify and minimize the effects of those factors in the military environment such as combat stress and microwave irradiation which can adversely affect the mental and biological health and subsequently the performance of the soldier.

BASIS FOR FY 1978 RDTE REQUEST: The Army has a requirement for research to minimize the unfavorable effects of continuous military operations on personnel health and combat effectiveness. This requirement is based partially on increased emphasis being given to night operations with extended technological support such as night vision boosting devices. Microwave research provides the basis upon which the Army Surgeon General makes recommendations which protect the health of military personnel exposed to radar and related electro-magnetic energy fields.

BASIS FOR INCREASE IN FY 1978 OVER FY 1977: The slight funding increase over cost growth is required to determined if pulsed microwaves present special hazards not seen with continuous wave microwaves. This research is in direct support of the Tri-Service Electromagnetic Radiation Plan.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1979 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	58	0	58
(2) Contractor Employees	6	0	6
Total	64	0	64

Budget Activity #1 - Technology Base

Program Element #6.27.71.A Title Military Psychiatry and Microwave Injury

DETAILED BACKGROUND AND DESCRIPTION: The research is directed toward maintaining a rate of breakdown that is consistent with readiness requirements, manpower availability and health care delivery resources. Recently, Israeli forces underwent rapid deployment and experienced sustained intense combat. It is reported that Israeli forces suffered a serious number of casualties in both their infantry and armored forces due to "combat exhaustion." It has been documented that the combat psychiatric casualty is suffering from a syndrome unlike any other acute psychiatric illness. An understanding is required of the conditions necessary to produce this array of disorders leading to a determination of the most expeditious means of restoring casualties to duty and to the development of preventive measures. The program is tailored to the battlefield of the future to be characterized by rapid deployment, mobility of units and around-the-clock combat. The Department of Defense (DOD) is the nation's largest user of nonionizing electromagnetic radiation (EMR) devices including a wide variety of reconnaissance, surveillance and communications systems. The systems range in frequency from 45Hz to 100 GHz with the majority having service or system specific parameters, i.e., frequency, power, pulse rate and mode of operation. These variables all contribute to the biological injury problems; therefore, human hazard assessments require multiple parameter studies. Early DOD effects data were the basis for establishing Federal safety criteria at 10 mW/cm^2 and were based on single frequency studies using many different animal models. Dosimetry was limited and biological effects were extrapolated across frequencies and animal species. Subsequent research has clearly indicated that bioeffects are frequency and/or power dependent. There is general agreement that the data on discrete frequency ranges across the total spectrum are incomplete and that knowledge of energy deposition mechanisms is inadequate. The extensive use of new systems with different frequencies and modes of operation requires more complete knowledge of the biological and psychological effects of EMR.

RELATED ACTIVITIES: While there is a broad interest in and support of research dealing with psychiatric illness, stress induced performance decrements and microwave injury, the problems dealt with under the program element are militarily unique. An extensive network of formal and informal relationships with other governmental agencies and Army medical laboratories is maintained. US Army Medical Research and Development Command scientists participate in international study groups such as NATO's Advisory Group for Aerospace Research and Development (AGARD) and the Technical Coordination Program (TCP). Liaison observers sit on relevant study sections conducted by the Department of Health, Education and Welfare. The United States Army, Navy, and Air Force have established a Tri-Service Electromagnetic Radiation Research Plan (EMR) to insure proper allocation of limited resources to the highest priority tasks identified by all three services. Other government agencies supporting related activities include the Bureau of Radiological Health, Environmental Protection Agency and the Department of Transportation. Program coordination and review is accomplished by the Electromagnetic Radiation Management Advisory Council (EMRMAC) and the Interdepartment Radio Advisory Committee (IRAC), both of the Office of Telecommunications Policy (OTP).

WORK PERFORMED BY: The in-house program is conducted at the Walter Reed Army Institute of Research, Washington, DC. Seven extramural contracts are funded at the University of Utah, Salt Lake City, UT; Virginia Commonwealth University, Richmond, VA; University of Maryland, College Park, MD; Contributers to the Pennsylvania Hospital, Philadelphia, PA; University of Georgia, Athens, GA; University of South Florida, Tampa, FL; and University of Texas at Austin, TX. Total contract funding is $391,000.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

Budget Activity #1 - Technology Base

Program Element #6.27.71.A Title Military Psychiatry and Microwave Injury

1. FY 197T, FY 1976, and Prior Accomplishments: The Biomedical Factors in Drug Abuse program was terminated effective 30 June 1976. Major Accomplishments include: (1) documented effect of marijuana use on time perception (critical to pilots, etc.), (2) defined effects of marijuana and alcohol and their combined use on visual function (critical to all night operations), (3) developed a urine analysis system now used world-wide, (4) via epidemiological studies of drug abuse, defined target/high risk populations for focussed command attention and resource allocation for prevention and treatment, and (5) prepared (in draft form) a Senior NCO and Commander's Drug Abuse Handbook. A major accomplishment of the Military Psychiatry program is the development and deployment of a computer support system for psychiatric treatment (producing a savings of manpower and funds). Major accomplishments of the microwave program: Prototype electrodes and thermistor probes for use in microwave fields were developed and evaluation of these devices was started. Effects of microwave radiation have been demonstrated in the central nervous system, the eye and on the behavior of animals; this program has been directed toward determining the optimal frequency of concern. Lethality studies have been completed and the results clearly indicate that microwave effects are most pronounced when the long body axis is parallel to the E vector of the field. Using both free field and parallel plate exposures, data collected tends to indicate a "half-wave" relationship between body size of the exposed animal and lethality from microwave exposure.

2. FY 1977 Program: The scope of the military psychiatry program will increase consonnant with combat doctrine. Stress induced psychiatric disorders are the third leading cause of combat ineffectiveness. Advanced methods for minimizing the effects of stress created by continuous military operations, night combat, and rapid translocation must be developed. These factors are especially critical in the D-day to D+15 phase of military operations. Also in FY 77, a Secretary of the Army directed medical and epidemiological follow-up examination and study will be initiated. Microwave research will continue in the study of relationships of body size and orientation utilizing other species to facilitate application of animal results to man. Further preliminary research on central nervous system and behavioral effects must by conducted prior to initiation of an essential long-term ocular study. Final development of the RF-decoupled tissue electrodes should be initiated.

3. FY 1978 Planned Program: FY 77 efforts to develop a viable field applicable performance model will lead to studies in FY 78 to determine the effects of rapid translocation and sleep deprivation on troop performance. Microwave research is planned in studies related to dosimetry and measurement techniques, energy absorption and deposition, effects of short duration high intensity pulses, and will continue in the long range ocular effects on primates.

4. FY 1979 Planned Program: Results of epidemiology studies will be applied to ongoing laboratory and field projects to determine the appropriate direction and emphasis for psychiatric research. It is anticipated that microwave studies will continue in the long range ocular effects on primates, effects of short duration high intensity pulses and the possibility that pulsed microwaves may present special hazards not seen with continuous wave microwaves.

5. Program to completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.72.A Title Recovery From Injury

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	6,993	1,759	7,305	8,428	8,097	Continuing	Not Applicable
A810	Military Skin Disease	1,213	305	1,288	1,462	1,595	Continuing	Not Applicable
A811	Military Nutrition and Food Hygiene	1,310	330	1,338	1,578	922	Continuing	Not Applicable
A812	Military Research Animal Resources	498	125	448	601	655	Continuing	Not Applicable
A813	Health Effects of Military Lasers	915	230	1,077	1,102	1,203	Continuing	Not Applicable
A814	Military Trauma and Resuscitation	2,596	653	2,801	3,129	3,115	Continuing	Not Applicable
A815	Combat Surgery	461	116	353	556	607	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This is a multifaceted program designed to prevent loss of combat troops and rapidly return injured troops to duty. New types of warfare and weapons have increased the combat injury problem by an order of magnitude which demands maximum research effort to maintain combat strength. Research programs are designed to determine, prevent and treat biological effects of laser radiation; develop prophylaxis and treatment of skin disorders occurring in the combat environment; to improve repellents; to establish combat nutritional requirements, to establish colonies of essential research animals, and to develop diagnostic means and treatment modalities to care for the combat wounded and rapidly return them to their units.

BASIS FOR FY 1978 RDTE REQUEST: To continue ongoing extramural and in-house studies to solve the problem of shortage of replacements early in a war by making possible the rapid return to duty of injured trained troops.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Increase in funding due to cost growth and initiation of new studies (see paragraph 3, FY 1978 Planned Program).

Budget Activity #1 - Technology Base

Program Element #6.27.72.A Title Recovery From Injury

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	194	0	194
(2) Contractor Employees	70	0	70
Total	264	0	264

DETAILED BACKGROUND AND DESCRIPTION: This is a multiple program designed to solve a range of problems that confront combat troops. Programs are closely monitored to introduce advances for implementation, bring promising programs to rapid conclusion, close out non-productive programs, and initiate new innovative programs. The intimate and potential associations of combat troops with many worldwide environments provide the setting for a multitude of rarely encountered skin disorders. The nutritional maintenance of combat health as well as the special nutritional requirements of the wounded is vitally needed information to assure troop fitness. Laser technology, a relatively new phenomena, is progressing faster than bioeffects can establish safety criteria. Absorption of laser radiation by living tissue can cause burns, loss of vision, and other deleterious effects. Current standards are based on limited data from early research and acute effects only. The introduction and use of many new military laser applications, both friendly and hostile, demand establishment of realistic standards that will not impose needless constraints. Research into continuous development of increasingly improved diagnostic capabilities, surgical procedures and ancillary medical techniques to save severely wounded soldiers, will insure that experienced troops can be rapidly returned to combat units--a vital requirement early in the war when other practical replacements will not be available. Primate colonies must be established to support research in animals, prior to human clinical testing, since many required species are endangered and impossible to import.

RELATED ACTIVITIES: Related nonduplicative research is conducted by other government agencies, institutes, universities, and other federal services. Continual coordination and review of related research by technological summaries, periodic program reviews, joint medical research conferences, literature review, etc., insures that there is no duplication at the work bench level.

WORK PERFORMED BY: Work is performed in the in-house laboratory of Letterman Army Institute of Research, San Francisco, CA. Major extramural contracts are with the Harvard University School of Public Health, Boston, MA; Yale University, New Haven, CT; New York University, New York, NY; Ohio Wesleyan University, Delaware, OH; University of Louisville, Louisville, KY; Virginia Commonwealth University, Richmond, VA; Duke University, Durham, NC; Technology Incorporated, San Antonio, TX; University of Wisconsin, Madison, WI; and University of California, San Francisco, CA. A total of 41 contracts are supported with $2,376,000.

Budget Activity #1 - Technology Base

Program Element #6.27.72.A Title Recovery From Injury

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Animal models were developed for investigation of fungal and leishmaniasis infections and topically applied antifungal agents and insect repellents were evaluated. Initial breeding stocks of owl and rhesus monkeys were obtained. A resuscitative solution of stroma-free hemoglobin has been shown to be effective in transporting oxygen and maintaining life. Blood shelf-life has been prolonged. An antiserum has been shown to be effective in preventing gram-negative sepsis in animals. Orthopedic implants shown to be feasible in animal hard and soft tissue injuries. Electroanesthesia double-blind studies were initiated.

2. FY 1977 Program: Development of an *in vitro* model to study skin flora. Insect repellents will continue to be evaluated. A *Leishmania* tissue culture will be refined. Investigations of idiopathic chronic diarrhea will continue. Domestic production of primates to be optimized. Clinical trials of an antiserum against gram-negative sepsis will be undertaken. Electroanesthesia studies to move in-house. Licensure of new blood preservatives will be sought. The use of pharmacologic agents to reverse acute renal failure will be investigated. New methods for evaluating food products will be developed.

3. FY 1978 Planned Program: Develop vaccines etc., against fungal infections. *Leishmanial* antisera for animal testing against amastigote antigens will be prepared. An increase in funds is required to continue ongoing programs and initiate new studies to prevent or reverse shock lung syndrome, to further develop clinical use of stroma-free hemoglobin, to elucidate conditions for intraoperative autotransfusion, and clinical use of collagen tube xenografts for small vascular replacement, to initiate studies relating to brain trauma and continuation of peripheral nerve damage studies. Repellents, nutritional, gastrointestinal, primate breeding program and orthopedic implant studies continue.

4. FY 1979 Planned Program: All ongoing programs will continue. Potential patents or licensing of stroma-free hemoglobin solution, anti-shock measures, vascular implants, and blood preservative solutions will be sought.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.72.A Title Recovery From Injury

Project #814 Title Military Trauma and Resuscitation

Category Exploratory Development Budget Activity #1 - Technology Base

DETAILED BACKGROUND AND DESCRIPTION: Conservative estimates indicate new types of sophisticated armored warfare and revolutionary weapon modalities will increase combat injuries by an order of magnitude. This fact, coupled with the current policy of no draft, mandates that replacements early in a war must come from the rapid return to duty of injured combat troops. A priority research effort must continue to reduce treatment time and maximize professional productivity to rapidly return injured troops to duty and maintain combat strength. This research addresses those problems that contribute significantly to mortality, and disfigurement of the combat wounded soldier. Solution of these problems involves research of trauma, shock, blood replacement, blood preservation, blood substitutes, anesthesia, tissue oxygenation, circulation, vascular and skeletal replacements for avulsion type soft and hard tissue wounds, sepsis, wound healing and nutrition.

RELATED ACTIVITIES: Related nonduplicative research is conducted by other government agencies, institutes, universities, and other federal services. Continual coordination and review of related research by technological summaries, periodic program reviews, joint medical research conferences, literature review, etc., insures that there is no duplication at the work bench level. Many in-house personnel are prominent scientists who serve on study sections of the National Institutes of Health, are sought after as lecturers and consultants, and as such remain continually abreast of all meaningful research and insure that no duplication exists, and that all militarily supported research is directed to the solution of problems of the combat soldier.

WORK PERFORMED BY: Work is performed in-house at the Letterman Army Institute of Research, San Francisco, CA. Major extramural contracts are with the University of Pennsylvania, PA: The Johns Hopkins School of Medicine, Baltimore, MD; Harvard University School of Public Health, Boston, MA; Loyola University Medical Center, Maywood, IL; Yale University, New Haven, CT; and New York University, New York, NY. A total of 27 contracts are supported with $1,511,000.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: A resuscitative solution of stroma-free hemoglobin can now be prepared more efficiently by a crystallization technique and has been shown to be effective in transporting oxygen and maintaining life in experimental animals. New blood preservatives and improved methods of storage now allow prolonged shelf-life and increased availability of blood. Better preservation methods for platelets will allow decreased complications due to post-traumatic bleeding problems. An antiserum has been shown to be effective in preventing gram-negative sepsis in animals. Identification of various living tissues by non-invasive ultrasound methods has been accomplished. Orthopedic implants have been shown to be feasible in hard and soft tissue injuries in animals. Electroanesthesia double-blind studies have been initiated.

Budget Activity #1 - Technology Base

Program Element #6.27.72.A Title Recovery From Injury

Project #A814 Title Military Trauma and Resuscitation

2. FY 1977 Program: Clinical trials of an antiserum against gram-negative sepsis will be undertaken. Electroanesthesia studies will be moved to in-house facilities for further evaluation. Compilation of an atlas of ultrasonic images of living tissue will standardize diagnostic capabilities of this non-invasive technique. Licensure of new blood preservatives will be sought for through the Food and Drug Administration. Human toxicity studies of stroma-free hemoglobin solution will be initiated. The use of pharmacologic agents to reverse acute renal failure will be investigated. An animal model of shock lung will be further developed.

3. FY 1978 Planned Program: All ongoing programs will continue. An increase in funds is required to support new studies to prevent or reverse shock lung syndrome and techniques to improve metabolic status immediately following surgery of the combat wounded, clinical use of stroma-free hemoglobin which will be further developed, elucidation of conditions for intraoperative autotransfusion, and clinical use of collagen tube xenografts for small vascular prostheses, studies relating to brain trauma and continuation of peripheral nerve damage studies.

4. FY 1979 Planned Program: Statistical evaluation of the clinical use of various devices and techniques will begin. Potential patents or licensing of stroma-free hemoglobin solution, anti-shock measures, vascular implants, and blood preservative solutions will be sought.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	2596	653	2801	3129	3115	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element 62.27.73.A Title Helicopter, Combat Crew and Airborne Medicine

Category Exploratory Development Budget Activity 02 Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	1,681	423	1,838	2,026	2,211	Continuing	Not Applicable
A819	Helicopter, Combat Crew and Airborne Medicine	1,681	423	1,838	2,026	2,211	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program studies the biomedical aspects of current and anticipated problems of Army aviation and airborne operations, the aeromedical evacuation program, and the vision and acoustic requirements of the field soldier. Goals are to determine the causes and means for preventing disability and performance decrement, and to determine means of enhancing performance in aviation, airborne and combat crew field operations. Investigations range from problems associated with the cockpit environment and airmobility to long term fundamental studies of hearing loss, color vision and night vision, and other factors that affect the safety, well-being and efficiency of the soldier.

BASIS FOR FY 1978 REQUEST: This program is vital to the Army's combat success in airmobility operations and sustained around-the-clock helicopter operations. Provides research to insure safe crashworthy protective equipment, protects the hearing and vision of the soldier and increases aircrew and combat crew effectiveness. Studies biomedical parameters as they relate to design, development, testing and application of major systems and related life support equipment.

BASIS FOR INCREASE IN FY 1978 OVER FY 1977: Ongoing research must complement the Army's current requirement to increase survivability of helicopter operations in a mid-to-high intensity conflict/battlefield and provide the ground commander with increased aviation effectiveness in sustained around-the-clock operations in adverse weather and at night. There is increased need to provide medical information about those variables found in helicopter operations which influence the health of aircrews, affect pilot performance particularly at night and at very low levels including nap-of-the-earth (NOE), and environmental hazards inherent to the helicopter and other enclosed combat vehicles. Additionally, this research has direct impact on the success of major systems development and testing programs to assess hazards to crewmembers.

Budget Activity #1 - Technology Base

Program Element #6.27.73.A Title Helicopter, Combat Crew and Airborne Medicine

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement) is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	50	0	50
(2) Contractor Employees	0	0	0
Total	50	0	50

DETAILED BACKGROUND AND DESCRIPTION: The requirement for medical research in helicopters, combat crews and airborne operations focuses on the Army's operational combat readiness needs related to helicopter airmobility, medical evacuation, and the basic need to ensure the safety and effectiveness of the soldier. These objectives are met through a comprehensive study of all biomedical factors related to accident prevention, crash injury protection, and performance enhancement. The study of factors such as perception, disorientation, fatigue, judgment, and performance under stress are relevant to improved crew health and efficiency. In-flight studies and laboratory analysis provide a validation data base for assessing protective equipment requirements secondary to visual, hearing, psychological, and biomedical design hazards induced by new equipment and operator techniques. Noise analysis is taking place to identify hearing hazards, protect against or eliminate those hazards, and reduce hearing disability. Research in vision is being conducted to assess and solve problems associated with optical viewing and tracking devices, problems associated with night vision goggles, and visual stresses such as glare and lighting. Psychophysiological studies are assessing psychomotor performance during stressful flight profiles including Nap-of-the-Earth. Life support equipment failure analysis and medical impact of engineering design criteria for helmets, aircraft and related equipment will reduce crash injury and improve flight safety. Assessment of aviation related disease and injury will improve aviator retention on the job and provide insight to aviator selection criteria.

RELATED ACTIVITIES: Technology and expertise evolving from aeromedical research is sought by other Army agencies in aviation and non-aviation related fields and other military services. Consultation is provided and research studies are conducted to support requestors. Specific relationships exist through memorandums of understanding, letters of agreement, and regulations to provide medical assessment of non-medical equipment for the Army Aviation Research and Development Command (AVRADCOM), medical assessment of hazards inherent in developmental equipment for US Army Materiel Development and Readiness Command and Natick Army Research and Development Command, and medical input to training and doctrine for the US Army Training and Doctrine Command. Through tri-service agreement specific responsibilities have been developed for coordination of research effort to avoid duplication and to share results. Army efforts directly support Air Force and Navy requirements for research in helicopter crashworthiness and physiology of low level flying. Work is performed in-house under Program Element/DA Project 6.11.02.A/BS07, Helicopter, Combat Crew and Airborne Medicine, to conduct basic research to develop methodology and enlarge the technology base for exploratory development in vision and hearing.

WORK PERFORMED BY: All work is performed in-house at the US Army Aeromedical Research Laboratory, Fort Rucker, Alabama.

Budget Activity #1 - Technology Base

Program Element #6.27.73.A Title Helicopter, Combat Crew and Airborne Medicine

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: FY 1976 and prior accomplishments include development of SPH-4 Helmet with improved noise attenuation and bump protection, noise cancelling microphone technology, developmental medical evaluation of military anti-shock trousers demonstrating lifesaving value in 36 of 53 cases, prototype methodology for measuring attenuation of sound by helmets and ear protection devices, biomedical design criteria applicable to crashworthiness and the first helicopter crashworthy troop seat, methodology for enhancement of helicopter cockpit visual environment, study of visual/vestibular effect of stabilized viewing devices, biomedical evaluation of a high speed hoist for helicopters, and improved helmet design criteria for hearing and bump protection. Progress was made in dark adaption studies associated with the use of night vision goggles, dynamic visual acuity in fatigued helicopter pilots and experimental methodology to evaluate in-flight effects of stabilized optical viewing devices on visual acuity and target acquisition/detection/tracking. FY 1977 accomplishments include completion of biomedical evaluation of the XM-128 Helmet Mounted Sight System, development of methodology for research on the effect of increased and unbalanced helmet weight on neck muscles, continued life support equipment failure analysis and design evaluation, and assessed capability and adequacy for protection of selected hearing protectors.

2. FY 1977 Program: Research will continue in all major areas. Anticipated accomplishments: a new standard helmet test methodology for protective performance, computer analysis of electrocardiographic data of US Army aircrewmembers, continue new life support equipment failure analysis and design improvement, biomedical evaluation of aviator performance at night and at low flight levels, study and simulation of effect of vibration on body systems, medical input to problems associated with major weapons systems including XM-198 howitzer, XM-1 tank, Mechnaised Infantry Combat Vehicle, Utility Tactical Transport Aircraft System, Advanced Attack Helicopter, XM-29 protective mask. New starts are planned to assess effect of impulse noise and blast overpressures secondary to medium and heavy artillery and new aircraft systems.

3. FY 1978 Planned Program: Research will continue to increase in all major areas. Results are expected to provide significant and operationally relevant input to providing a more effective, more reliable, and better protected human environment in the man machine complex. Methods will be sought to eliminate, reduce and/or protect against those hazards which cause loss of life or decrement to performance. This includes continued psychophysiological studies of crewmember performance in the hazardous environments, medical analysis of human factors related to engineering design, study of the physiology of these hazards to identify the true nature of their effects on the body, and study of performance under conditions of minor acute and chronic diseases. This program will insure fielding of new weapons systems that are safe for crewmember operation and improved crew efficiency on existing weapons systems secondary to reducing effects of hazards. The increase in funds partially offsets large research and development inflationary trends and is considered a minimum to sustain current research and allows greater participation of information transfer.

4. FY 1979 Planned Program: Medical assessment will be continued in the areas of airmobility, aeromedical evacuation, airborne visual requirements, crewmember related accoustical hazards, effects of helicopter vibration on the musculoskeletal physiology, fatigue and stress induced by helicopter and airborne crew performance, and effectiveness of task performance.

5. Program Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.74.A Title Military Burn Technology

Category Exploratory Development Title #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	545	137	747	657	717	Continuing	Not Applicable
A820	Military Burn Technology	545	137	747	657	717	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Not only does the shortage of replacements early in a war make rapid return to duty of those injured trained/experienced troops a matter of ultimate importance but also intensity of conflict due to new types of armored warfare and weapon developments has increased the combat burned injury problem by an order of magnitude requiring maximum research effort to maintain combat strength. These combat injuries result in multiple problems such as shock, nervous system injury, pulmonary complications, blood replacement, sepsis, wound healing and nutrition.

BASIS FOR FY 1978 RDTE REQUEST: To continue short and long range extramural and in-house studies of the multiple interrelated wound treatment problems of the combat burned soldier.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Research progression to clinical utility results in net decrease to RDTE funds in FY 78.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	13	0	13
(2) Contractor Employees	8	0	8
Total	21	0	21

DETAILED BACKGROUND AND DESCRIPTION: This research is targeted toward time/treatment goals to reduce duty time loss and return injured troops rapidly to duty. To this end, research is conducted into the understanding and development of procedures to treat the multiple interrelated problems of the combat wounded soldier whose injuries include major burns. Research techniques are

developed in the laboratory and then moved to treatment of the wounded. The research approach involves fundamental studies in areas such as shock, burns, nervous system injury, pulmonary complications, blood replacement, sepsis, wound healing and nutrition as they apply to the massive trauma and complicated treatment requirements of the severely wounded soldier. Also required are continued evaluation of current methods of treatment in light of experimental study results, and research on the pathologic effects of injury upon the whole organism. It is imperative to continue research into this highly complex problem in order to save more lives, prevent disability and disfigurement and rapidly return the wounded to duty. Most disease can be cured, but the loss of a soldier due to thermal and other injury is often permanent - a price that the Army can ill afford to pay.

RELATED ACTIVITIES: Army studies related to this program element are performed under Program Element/DA Project 6.11.02.A/BS05, Military Burn Research. Related nonduplicative research is conducted by burn centers in the United States and various institutes and universities as well as the US Navy and Air Force. Continual coordination and review of related research by technology summaries, periodic program reviews, monthly joint medical research conferences, literature review, etc., insures that there is no duplication at the work bench level. The personnel of the in-house laboratories are regarded as prominent scientists in research today and are sought after as lecturers and consultants and remain continually abreast of all meaningful research.

WORK PERFORMED BY: Approximately 44 percent of the available funds support the Army in-house research program conducted at the US Army Institute of Surgical Research, Fort Sam Houston, TX. Major extramural contracts are with Newark Beth Israel Medical Center, Newark, NJ; University of Virginia Medical Center, Charlottesville, VA; University of Rochester, Rochester, NY; and Baylor College of Medicine, Houston, TX. A total of 10 contracts are supported with $196,000.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Rapid identification techniques of microbes and antibiotic sensitivity testing has been accomplished. Clinical studies to identify patients at risk of developing stress ulcers has been started. The relationship of sepsis to the complications of burn trauma continues to be studied, especially with respect to pulmonary and immunological defects. Synthetic dressings are still an object of intense research.

2. FY 1977 Program: Continued monitoring of bacterial epidemiology among burn patients. Clinical trials in antisera against endotoxin will continue, as will studies concerning hemorrhagic gastritis. The completion of ultrasonography in diagnosing the extent of burns will be completed. Pulmonary and immunological studies will continue. Research into nutritional defects will also continue.

3. FY 1978 Planned Program: All ongoing research to continue. Methods to improve the patient's ability to immunologically respond will be developed. Research will branch out to include additional organ systems and their role in short and long term recovery. Research progression to clinical utility results in net decrease to RDTE funds in FY 78.

Budget Activity #1 - Technology Base

Program Element #6.27.74.A Title Military Burn Technology

4. FY 1979 Planned Program: All studies will continue with added emphasis on clinical research and improved methodology.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.75.A

Title Combat Oral and Maxillofacial Injury and Disease

Category Exploratory Development

Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	958	241	1,048	1,155	1,260	Continuing	Not Applicable
A825	Combat Maxillofacial Injury	958	241	1,048	1,155	1,260	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The extremely high intensity of conflict due to revolutionary weapons' development causing a dramatic increase in maxillofacial injuries and the shortage of adequately trained immediate replacements early in a war requires maximum research effort to rapidly return troops to duty to maintain combat strength. It is also essential to vigorously pursue research efforts in prevention of dental disease to assure that the soldier of this high intensity combat area is not lost to his unit due to conditions which could have been prevented through proper oral health care management. These research efforts for improved professional care must be pursued and intensified to develop better materials, methods, and techniques for early and definitive management of combat injuries.

BASIS FOR FY 1978 RDTE REQUEST: To continue both short and long term in-house and extramural studies which are acquiring information necessary to solve problems in providing improved care of maxillofacial combat injuries.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Projected cost growth as well as requirement for progress for animal models to human clinical studies in essential development of biodegradable and nonbiodegradable materials for tissue replacement/wound healing enhancement.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	18	0	18
(2) Contractor Employees	10	0	10
Total	28	0	28

Budget Activity #1 - Technology Base

Program Element #6.27.75.A Title Combat Oral and Maxillofacial Injury and Disease

DETAILED BACKGROUND AND DESCRIPTION: The high incidence of combat maxillofacial injury, the increase in traumatic injury and oral disease with their associated trend of higher treatment costs dictate research targeted toward time/treatment goals to reduce duty time lost and to return injured troops to duty rapidly. Areas of investigation include materials for immediate and delayed restoration of combat maxillofacial wounds, improved means of administering analgesia to the dental complex in a combat area, and development of materials for prevention of dental emergencies in the combat area. The information gained from these research efforts is used to save limited military dollars by increasing productivity of dental professionals, improved immediate treatment in combat areas, decrease soldiers morbidity, increase quality of care and decrease the clinical treatment and hospitalization time.

RELATED ACTIVITIES: Army studies related to this program element are performed under Program Element/DA Project 6.11.02.A/BS06, Combat Dental Materials and Techniques. Related, but nonduplicative research is conducted by the US Navy, Air Force, and the National Institute of Dental Research. Coordination of research is achieved by consultations between participants, project officer visits, review of research and technology summaries, periodic program reviews, and reviews of scientific publications both military and civilian. In addition, liaison memberships are held on the National Advisory Dental Research Council and the Dental Study Section, National Institute of Dental Research.

WORK PERFORMED BY: Approximately 52 percent of the available funds support the only Army in-house research effort, the US Army Institute of Dental Research, Washington, DC. The remaining funds are used for extramural contracts. Contractors receiving funds over $25,000 are: University of Oregon, Portland, OR; University of Illinois, Chicago, IL; Battelle Memorial Institute, Columbus, OH; and Polymer Research Corporation, Brooklyn, NY. Five contracts are supported/planned for total extramural program of approximately $486,000.

PROGRAM ACCOMPLISHMENTS AND FUTURE PORGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Prototype presurgical handwasher clinical testing completed in major Army hospital with outstanding success; more effective surgical scrub accomplished by surgeons in 85 percent less time. Animal studies confirmed a new rapid and simple electroless metal plating process with potential to have dramatic impact on reduction of dental emergencies in the field. Electrical circuitry in prototype vitalometer reworked to provide capability on all animal models; new technique will provide definitive information via a nonpainful diagnostic route. High impact human studies using biodegradable ceramic material completed with overwhelming success. Studies addressing biodegradable copolymers and their degradation rates, tissue compatability and animal technique phase for various surgical procedures completed and awaiting the Food and Drug Administration approval for continuation in other models.

2. FY 1977 Program: Completion of present optical recording vitalometer conversion to sound activated identifying form. Completion of supplemental presurgical handwasher studies with recommendations. Continuation of animal studies with electroless metal plating in new applications and extended simplification of techniques. Continuation of investigations seeking less expensive

replacements for militarily unique dental restorative materials. Continuation of human biodegradable ceramic investigations to obtain additional and statistically significant data. Initiate major human study using biodegradable copolymer materials to address diversified animal proven applications in maxillofacial fracture fixation, avulsive wounds, nerve regeneration, vascular surgery, and tendon repair.

3. FY 1978 Planned Program: Increase in funds will be necessary to initiate major human studies using electroless metal plating to confirm animal applications in reducing dental emergencies in areas of deployment or combat. Complete prosthetic insertion phase and the continuation of human studies using metallic tooth implants both as a fracture fixation device and single tooth replacement. Continuation of animal studies using biodegradable copolymers to show the potential of this material for long term drug administration. Continuation of past studies addressing the surgical management of combat wounds using biocompatible ceramic tooth implants to achieve both comprehensive animal data and definitive evaluation of a newly designed infrastructure. Initiation of project in 3-dimensional imagery for rapid identification of combat fatalities, and transmission of avulsive wound size/type information for more prompt surgical treatment and replacements to reduce post surgical hospitalization time and soldier morbidity.

4. FY 1979 Planned Program: Continuation of human studies with metallic implants both as a fracture fixation device and single tooth replacement. Continuation of studies in 3-dimensional imagery for identification of combat fatalities and transmission of data for more rapid surgical treatment of evulsive wounds. Animal and human studies with electroless metal plating will address new applications and even easier techniques for preventive and restorative utilization in the combat soldier. Extensive material characterization both biodegradable and nondegradable, will form basis for future study. The anticipated increase in required financial support is based on the number of human projects being supported and the number of animal projects which will enter the human testing phase.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element 6.27.76.A Title Medical Defense Against Biological Agents

Category Exploratory Development Budget Activity 1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	6,359	1,600	6,657	7,663	7,564	Continuing	Not Applicable
A841	Medical Defense Against Biological Agents	6,359	1,600	6,657	7,663	7,564	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Objective of this program is to develop an effective integrated medical defense against biological weapons utilizing data from basic studies on the pathogenesis of infection and rapid diagnosis techniques to formulate a total medical approach for the prevention and treatment of BW casualties, laboratory identification of BW agents and vaccine development, production and stockpiling of vaccines to be used for worldwide deployment of troops.

BASIS FOR FY 1978 RDTE REQUEST: Concentrated research efforts are necessary to further advances in prevention of biological casualties and to develop new methods of diagnosis and early detection of virus infections. Expansion of vaccine production and test programs are required to meet predeployment immunication-capability requirement against most likely biological warfare (BW) agents and to test a new inactivated Venezuelan equine encephalomyelitis (VEE) vaccine in man. Initial trials for these two vaccines in at-risk personnel are very promising. Initiation of efficacy tests in man are required for dengue-2 vaccine. A highly important element is the continuing capability for the mass production of vaccines developed at US Army Medical Research Institute of Infectious Diseases imperative for a rapid response to a BW threat or infectious diseases endemic in an area of operations.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Initiation of studies to determine chemoprophylactic efficacy of 2 promising drugs against diseases with potential BW importance, and further development of inactivated VEE vaccine require a modest increase in funding.

Budget Activity #1 Technology Base

Program Element #6.27.76.A Title Medical Defense Against Biological Agents

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	152	0	152
(2) Contractor Employees	38	0	38
Total	190	0	190

DETAILED BACKGROUND AND DESCRIPTION: This project represents the applied complementary portion of the total Army program for Medical Defense Against Biological Warfare (BW) Agents. Utilizing information gained in the basic research (BS03) element of the program, improved development of procedures are applied to production of vaccines against known, potential BW agents. The only national resource for vaccine development of any magnitude for the Armed Services (Merrill National Laboratories) is utilized for mass production of the candidate vaccines. More efficient methods devised for prevention and treatment, aerosol immunization, and drug therapy of BW agents and other militarily important diseases are tested for effectiveness in the special containment facilities located at Fort Detrick, MD, and designed especially for investigations involving highly infectious organisms.

RELATED ACTIVITIES: Related Army studies are performed under Program Elements/DA Projects 6.11.02.A/BS01, Basic Research on Military Injury and Diseases; 6.11.02.A/BS03, Medical Defense Against Biological Agents, and 6.27.70.A/A802, Military Preventive Medicine and Tropical Diseases. This program element provides the major input to the national program for medical defense against biological agents. General infectious disease research conducted by the Navy and National Institutes of Health is pertinent to this program element. Coordination is accomplished by personal contacts at the operating level, technical symposia, and regular exchange of documents for review, which avoids unnecessary duplication of efforts.

WORK PERFORMED BY: Approximately 75 percent of the work is performed by the US Army Medical Research Institute of Infectious Diseases, Fort Detrick, MD, and 25 percent by extramural contractors including Merrill-National Laboratories, Cincinnati, OH; Wyeth Laboratories, Inc., Philadelphia, PA; and Washington State University, Pullman, WA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Vaccines were developed against Rift Valley fever (RVF), Q fever, tularemia chikungunya virus, plague, Eastern (EEE), Western (WEE) and Venezuelan (VEE) equine encephalomyelitis and evaluated in volunteers. Mode of action of staphylococcus enterotoxin was studied and an experimental toxoid using fragments from the molecule prepared. Utilizing currently available methods of improving VEE and EEE vaccines, significant progress was made in developing other arbovirus vaccines. A new rapid identification procedure was developed for VEE, WEE, and EEE viruses that eliminates the cost of

utilizing laboratory animals and significantly reduces the time for virus identification. Quantitative doses of immune serum and gamma globulin were determined for prevention and early treatment of Bolivian hemorrhagic fever in monkeys. An improved Rocky Mountain spotted fever (RMSF) vaccine was developed and underwent preliminary evaluation in laboratory volunteers. Laboratory development of an inactivated Venezuelan equine encephalomyelitis (VEE) vaccine was completed. New antiviral drugs (poly I.C., rimantidine and ribavirin) have proven highly effective in prevention and treatment of influenza. Laboratory disease animal models have been developed in order to study the disease, develop therapy procedures, and preventive measures. These include swine influenza, RMSF, and Bolivian hemorrhagic fever. A new diagnostic assay designed to measure lymphocyte subpopulations has been highly effective in evaluating the immune response to viral infections and particularly in evaluating cellular responses to vaccines.

2. FY 1977 Program: Adjuvant studies and evaluation will be expanded to utilize basic information obtained in the BS03 program. Newly developed polynucleotides will be tested for their effect in enhancing protection against a variety of viral agents, and a broad base of adjuvants for vaccine application will be initiated. Inactivated VEE vaccine will be tested in man. Vaccine production for Western equine encephalomyelitis isolate 17B-1344 has been completed. Potency tests in animals and limited volunteer studies are planned. Immunological assay tests to identify subpopulations of lymphocytes will be utilized to evaluate reactions to various infectious diseases and responses to vaccines of military importance. In collaboration with National Institutes of Health the possible toxicity of immunizing levels of polynucleotides will be determined. This is a vital step in the utilization of polynucleotides as adjuvants.

3. FY 1978 Planned Program: Increase in FY 77 funds reflects increased emphasis on applied studies in animals of several very promising antiviral chemotherapeutic compounds. These compounds, due to their rapid preventive as well as therapeutic nature, are prime candidates for usage in early phases in military operations. In addition, there will be an expanded program for developing new vaccines and toxoids for diseases envisioned as critical in strategic planning of military operations. The effectiveness of new rapid diagnostic techniques previously developed for various infections of military importance will be evaluated.

4. FY 1979 Planned Program: Capabilities for defining the true effectiveness of experimental vaccines, that is cellular as well as humoral responses, are now being developed and refined. These capabilities will be used to better evaluate vaccines for potential Biological Warfare agents. The feasibility of using non-toxic fractions of staphylococcal enterotoxin as immunizing agents will be tested. The use of polynucleotides for prevention of disease will be continued and expanded as feasibility dictates.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.77.A Title Environmental Stress, Physical Fitness and Medical Factors in Military Performance

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	2,092	526	2,287	2,521	2,752	Continuing	Not Applicable
AB45	Environmental Stress, Physical Fitness and Medical Factors in Military Performance	2,092	526	2,287	2,521	2,752	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: To conduct applied research to determine how heat, cold, high terrestrial altitude, work and physical fitness affect the soldier's life processes, his performance and his health. To develop improved methods for prevention, diagnosis, and treatment of diseases produced by the extremes of climate to which the soldier may be exposed.

BASIS FOR FY 78 RDTE REQUEST: This program provides basic sciences, medical, and technological transfer information on the physiological and psychological responses of men to the environmental stresses of heat, cold, high terrestrial altitude, physical fitness and high workload upon which may be based improved procedures for enhancement of troop performance and protection and treatment of related injuries that occur in harsh environments. This program must continue to explore the physiological and psychological factors which may compromise military operations and affect the soldier's performance and health. Research on cold injury and medical problems of military operations in the Arctic is required to improve current equipment, operational doctrine and the soldier's performance in the cold as this area of the country assumes a greater strategic value. With the integration of women in combat forces an increased technological base is required in order to obtain the goals of military physical training and the impact of physical training on health, morale and job efficiency. The continued emphasis on support of NATO forces, information on the recent Israeli-Arabic conflict, and turbulence in the Middle East emphasize the requirement for ready technological competence in hot climate and high terrestrial operations and increased micro-environments for chemical, biological and radiological protection. Additionally, a wide variety of environmental stresses adversely affect the soldier's physiology, reducing mental and physical capabilities and possibly seriously endangering the health of the soldier. The combat effectiveness of the soldier demands maximum physical effort and high level mental processes in the use of complex weapons and equipment, especially in the doctrine of continuous operations. These requirements create the need for greater knowledge about the soldier's resistance and his ability to adjust to environmental extremes and improved techniques and equipment for protection from the environment.

Budget Activity #1 - Technology Base

Program Element #6.27.77.A Title Environmental Stress, Physical Fitness and Medical Factors in Military Performance

BASIS FOR INCREASE IN FY 1978 OVER 1977: The increase is considered a minimum to sustain the current required program and to allow needed greater participation of investigators in field exercises.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement) is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	44	0	44
(2) Contractor Employees	1	0	1
Total	45	0	45

DETAILED BACKGROUND AND DESCRIPTION: The objective is to perform studies in environmental medicine to conserve military manpower, prevent and treat injuries, and to maintain the effectiveness of the soldier in any type of environment and to transfer this information to the Field Forces. This includes developing improved methods for prevention, diagnosis, and treatment of diseases produced by the extremes of climate to which the soldier may be exposed; continuing research into the complex effects of climatic stresses on the human body and the body's defenses; developing psychological and physiological techniques which can be employed in extreme environments to facilitate muscular endurance performance; increased performance during continuous operations; prediction of biological limits of military performance as a function of the environment, clothing and equipment; design of military clothing and equipment including selection of crew compartment; and improved information transfer of results to the Field Forces.

RELATED ACTIVITIES: Army studies related to this program element are performed under Program Element/DA Project 6.11.02.A/8S08, Environmental Stress, Physical Fitness and Medical Factors in Military Performance. Basic complementary work is conducted by contract with nonprofit and civilian educational institutions. Army membership on Department of Defense Committees, intra-government agency coordinating committees and councils insures coordination at the working and administrative levels.

WORK PERFORMED BY: Approximately 99 percent of the work is conducted by the US Army Research Institute of Environmental Medicine, Natick, MA; and the remainder through contract with nonprofit and educational institutions. Planned contracts, with yet unnamed contractors, will total approximately $60,000.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Animal heatstroke models (dog) demonstrated similar morbidity patterns as those seen in endotoxic shock; increased endotoxin activity was demonstrated in animal models; exercise of human volunteers demonstrated

plasma creative phosphokinase to be a sensitive indicator of fatigue; in rat heatstroke models it was determined that groups of both heat sensitive and heat resistant animals could be identified while work related factors contributed to an increased rate of heatstroke mortality at low thermal loads. Women entering the Army were found to be 25 percent less fit (aerobic) with a muscle strength 30-50 percent lower than comparable males; the determination of anerobic threshold was found to be a sensitive and feasible measure of aerobic fitness. A study performed on the initial treatment and evacuation of casualties under cold weather conditions resulted in recommendations to modify doctrine, forcestructure, equipment and training. Fire Direction Center tasks were found to deteriorate faster when team members were exposed to altitude and a wet environment as opposed to sea level. The combination of fasciotomy, vasodilators, and whirlpool treatment were found to increase tissue survivability in animal models of frostbite. A scenario-script design methodology was developed to regulate simulated mission demand and facilitate performance assessment over time. New therapeutic and preventive measures for acute mountain sickness (AMS), cold and heat injury and work performance for the soldier have been developed. Some significant examples are: the combination of staging and carbonic anhydrase inhibitors reduced the symptoms and incidents of acute mountain sickness; animal models have been developed for use in harsh environments in order to evaluate methods for prevention and treatment of injury incident to heat and cold; by using the AGA therma-vision camera, divitalized tissue secondary to cold injury was identified; performance tests which sensitively measure small group performance of highly specialized Army teams subjected to environmental stress have been developed; the pro-life program of the 2nd Infantry Division (Korea) was found to be effective in terms of raising physical stamina of all age groups and in reducing excess body weight; mathematical models were developed to determine energy cost of the soldier marching and performing duties in difficult types of terrain.

2. FY 1977 Program: Predisposing factors leading to heat disorders in man with correlation between potassium depleted animals and myocarditis; prevention of the effects of heat illness by prehydration; define the extent to which the release of endogenous agents produced during heatstroke and the resulting fatal heatstroke cascade. Assess the efforts of rapid deployment across time zones, psychological stress, high environmental temperatures on the combat troop. Sex differences in fitness levels and response to fitness training will be related to major differences in perception of effort and expectation of work capacity between women and men. A coordinated Army study will evaluate a medical company in support of an infantry brigade during cold weather operations. Studies will be carried out to explore the interaction of hypoxia and cold on symptomatology, work performance and selected physiological responses. The effects of vasodilation on the development and severity of AMS will be assessed. Investigation on the biomedical impact of military clothing and equipment design including the selection of new compartment environments will continue. A joint study utilizing the 82nd Airborne Division Fire Direction Center teams will determine the operational cost factors of sustained command/control and communications functions under heavy vision demand, noise, and sleep deprivation.

3. FY 1978 Planned Program: The FY 78 programs will reflect increased emphasis on those areas of FY 77 which have proved to be of greatest importance to operational requirements. Studies in the major research areas of military performance; human adaptations to climate and related stresses; the biophysics of clothing and the pathophysiology of environmental induced diseases, e.g., cold injury, acute mountain sickness and heat injury will continue. Systematic analysis of the physiology of physical training will continue.

4. FY 1979 Planned Program: The FY 79 programs will reflect increased emphasis on those areas of FY 78 which have proved to be of greatest importance to operational requirements.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.78.A Title Combat Medical Materiel

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	1,163	293	1,272	1,402	1,531	Continuing	Not Applicable
A838	Combat Medical Materiel	1,163	293	1,272	1,402	1,531	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: A reliable and efficient casualty treatment system during wartime is vital to maintaining the combat strength. The need for tactical flexibility in modern warfare and new weapon developments has increased the problems and complexity of diagnosing and treating large numbers of devastating combat injuries. This requires an agressive research effort to develop new and improved medical field equipment in areas such as clinical laboratory determinations, dental operating sets, sterilization of medical supplies, whole body x-ray, purified water production, eye examination, insect detection and control, field sanitation, and patient handling.

BASIS FOR FY 1978 RDTE REQUEST: To conduct short and long range development of field medical equipment to meet approved DA materiel requirements needed to support improved medical treatment of the combat wounded soldier.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The requested increase promotes necessary growth in the level of effort to insure accomplishment of project objectives, namely, advancing and improving field medical treatment and considers inflationary trends. It will permit activating tasks in support of Letter of Agreement prepared by the Academy of Health Sciences, US Army and concurred in by The Surgeon General.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	19	0	19
(2) Contractor Employees	25	0	25
Total	44	0	44

Budget Activity #1 - Technology Base

Program Element #6.27.78.A Title Combat Medical Materiel

DETAILED BACKGROUND AND DESCRIPTION: This research is aimed at optimizing combat treatment capabilities and the rapid return to duty of injured troops. Research is conducted to improve and expand health care delivery resources through exploratory development to approach problems of providing better field medical, dental, and veterinary material for the purpose of enabling a smaller number of medical personnel to deliver quality health care to the soldier in the field at lowest reasonable cost. The approach is through feasibility studies and development of experimental prototypes coupled with evaluation in both clinical and field environments. These efforts provide the basis for determining technical feasibility and cost of required advanced development and/or engineering development. The other services as well as foreign state-of-the-art, trends and potential threats to present and future materiel shortages are being considered throughout the research and development cycle. Project areas being emphasized are as follows: Field dental equipment, field sterilization equipment and techniques, field optometric/ophthalmological equipment, field pharmaceutical equipment, field medical human body diagnostic examination and recording system, field veterinary equipment, and other medical supplies and equipment for field medical facilities.

RELATED ACTIVITIES: Related studies are performed under Program Elements/DA Projects 6.37.32/A836, Combat Medical Materiel, and 6.47.17A/D832 Combat Medical Materiel. All three Program Elements are under the immediate supervision of the same responsible individual to avoid any duplication of effort. The Navy is supporting this element in the amount of $35,000. Continual coordination and review of related research by technological summaries, periodic program reviews, joint medical research conference and literature review, avoids duplication of research with the other military services.

WORK PERFORMED BY: Castle Company, Rochester, NY; University of California, Berkeley, CA; High-Voltages Engr, Inc., Burlington, MA; Optical Sciences Group, San Rafael, CA; USDA Insects-Affecting Man Research Laboratory, Gainesville, FL; USDA Stored-Product Insects Research and Development Laboratory, Savannah, GA; US Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: A prototype Automated Ophthalmic Refraction system was installed and tested at Letterman Army Medical Center. Tests demonstrated feasibility of providing optical prescriptions for 90-96% of the military populations. A prototype for objective and automated measurement of visual acuity was successfully tested at Letterman Army Medical Center. A contract was formalized on the Army Life Support Power System for Environmental Control of Casualty Holding and Evacuation Bags to continue development of a heat source. Development actions for a Field Dental Compressor-Dehydrator Dental Operating and Treatment Unit, and Light/Tray/Stool Unit were completed and progressed into engineering development. Fabrication of a prototype self-contained, electrically powered field dental operating unit was initiated. Operational Testing was conducted on a prototype of the Pulsed Water Pressure Device for Arm and Hand Washing. Fabrication of processing equipment was completed and delivered under exploratory development of the Field Sterilization Study.

Budget Activity #1 - Technology Base

Program Element #6.27.78.A Title Combat Medical Materiel

2. FY 1977 Program: Development of modular cabinetry for a "family" of field dental sets will move into advanced/engineering development. Experimental prototypes of self-contained, electrically-powered field operating units and field dental chairs will be fabricated. Reconfiguration/testing of the field container for a new dental x-ray will be completed. Progress in the Field Medical Human Body Diagnostic Examination and Recording System will include clinical evaluation. Prototype fabrication will be initiated on a laminar flow hood, and a drug packaging/dispensing unit for the Field Pharmacy System. Feasibility of using trailer or motorhome vehicles in lieu of the present bus ambulance will continue to be investigated for relative suitability for patient handling, loading, and transport, flexibility of operational use, and cost effectiveness. Clinical testing and evaluation of the Automated Ophthalmic Refraction System will be continued. Modifications will be incorporated to achieve a 96% level of effectiveness. Test results on the Instrument for Objective and Automated Measurement of Visual Acuity will be evaluated and used for design of a field prototype. Development has been initiated to design and fabricate an experimental prototype instrument for the military to detect hidden insect infestation of foods using a CO_2 analysis system. Efforts will be made to develop data and equipment for tailoring the use of insecticides to control selected insect populations, thus minimizing cost and environmental insult.

3. FY 1978 Planned Program: Prototypes of the field sterilization equipment fabricated under existing contract will be evaluated for guidance in engineering development. Field evaluation in the combat support hospital prototype pharmacy equipment will be initiated. Testing of a field operating unit and field dental chair will be completed. These tasks will be moved into advanced/engineering development. Testing of ultralow-volume nozzles for delivery of insecticides for the control of selected insect populations will be completed. Prototypes of the Military CO_2 Analysis System for the detection of hidden insect infestation of foods will be fabricated and tested. Evaluation of new medical field shelters will be conducted. The program increase is requested to partially offset inflation which has outpaced program increases in the past.

4. FY 1979 Planned Program: The Field Pharmacy Study will move into advanced development based on the equipment evaluations of Phase II. Technical, operational, and practicability evaluations of the Field Sterilization Study will be executed. Results of evaluations will provide input for preparation of Required Operational Capability documents for progression into advanced/engineering development. Feasibility studies and fabrication of experimental prototypes of proposed, new and better medical, dental, laboratory and veterinary materiel will be initiated in accordance with mission objectives and fund availability. Increases in funding for this program are due to cost growth plus anticipated expansion of development efforts.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.27.79.A Title Test Measurement and Diagnostic Equipment (TDME) Technology

Category Exploratory Development Budget Activity #1 - Technology Base

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	352	112	450	505	435	Continuing	Not Applicable
AH-62	TMDE Technology	352	112	450	505	435	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The Test, Measurement and Diagnostic Equipment (TMDE) Technology program develops new testing and diagnostic techniques and methodologies in order to reduce the number of different test equipments and skills required at all levels of maintenance. Minimization of application - peculiar, dedicated test equipment is a basic objective.

BASIS FOR FY 1978 RDTE REQUEST: Provide internal support for the contractual efforts for the Microminiaturized Test Equipment System (MITES) and Built-In Test Equipment (BITE). Continue to evaluate advanced prototype test equipment designs, correlating the internally and externally generated test results to define a sound technological design base for an Advanced Development Program for Contact Test and Repair Equipment (CARTE). Fund FY 1978 contracts to develop design techniques and information for stimuli sources for CARTE and to develop BITE stimuli/measurement hardware.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The increase in FY 1978 funding level over that of FY 1977 is due to an expansion in the investigations into new BITE technologies.

PERSONNEL IMPACT:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	4	0	4
(2) Contractor Employees	4	0	4
Total	8	0	8

Budget Activity #1 - Technology Base

Program Element #6.27.79.A Title Test Measurement and Diagnostic Equipment (TMDE) Technology

DETAILED BACKGROUND AND DESCRIPTION: The objective of the Test Measurement and Diagnostic Equipment (TDME) Technology Program is to develop new testing techniques and equipments which will reduce the number of different test equipments and skills required at all levels of maintenance. Major effort will be directed toward the elimination of the need for most application-peculiar dedicated test equipment. New TMDE will provide the Army with the capability to diagnose faults and pinpoint defects without tear-down. The TMDE being developed will afford more efficient means of detecting equipment defects with greater accuracy thereby offsetting the shortage of skilled manpower. The ultimate benefits to be derived from this program will be manifested in time-to-maintain and cost savings.

RELATED ACTIVITIES: Program Elements 6.37.48.A, Automatic Test Equipment Advanced Development and 6.47.46.A, Engineering Development - Automatic Test Equipment accomplish the advanced and engineering development work, respectively for work started in this element.

WORK PERFORMED BY: The in-house and contract monitoring work is performed by the US Army Communications Research and Development Command, Fort Monmouth, New Jersey. Contractors participating in the program include: Teledyne Electronics, Newbury Park, California; E-Systems, Falls Church, Virginia; Booz-Allen, New Shrewsbury, New Jersey; and Geartner Research Inc., Saddle Hill, Connecticut.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976 and Prior Accomplishments: Established detailed design plan for a modularized, microprocessor-based test system (MITES) to satisfy field contact team test and repair requirements. A high-speed programmable sampled-data measurement capability was built with a basic operating frequency range through 20 Mega Hertz (MHz). Also an arbitrary waveform generator covering the frequency range from Direct Current (DC) to 3 MHz was designed which generates complex waveshapes in response to programmable digital information supplied by the test system's 16-bit microprocessor. A metrology contractual effort was initiated to forecast the impact of future technology and design trends on TMDE requirements for the Field Army 1985 to 2000 time frame. An analysis was undertaken of Army communications-electronic systems and sub-systems currently in the exploratory and feasibility stages of development. Prior to FY 1977, funds contained in Program Element 6.27.05.A, Electronics Technology and Devices.

2. FY 1977 Program: Initiate an effort to extend the frequency coverage of the MITES measurement module capability to 500 MHz. Develop design technology for application to the development of miniature stimuli modules for the MITES system. Provide internal support for the MITES and Metrology. The investigations of charging vented nickel-cadmium batteries will be completed while the optimum charging and charge control parameters of the charger-analyzer for the determination of the state of discharged mercury-zinc cells will be extended to other systems.

3. FY 1978 Program: Initiate the first phase of a two phase program to determine the feasibility of partitioning general Built-in Test (BIT) characteristics into standard functional cells and implementing these standard cells with the newer technologies.

Budget Activity #1 - Technology Base

Program Element #6.27.79.A Title Test Measurement and Diagnostic Equipment (TMDE) Technology

The first phase will be devoted to defining the classes and types of Built-in Test (BIT) measurement/stimuli/electrical interface capabilities required for various classes of end item equipments. End item-BIT interface as well as BIT inter-module interfaces will be defined to ensure compatibility when interconnecting several standard BIT modules to obtain selected BIT testing capabilities. Initiate the stimuli module development effort for the Microprocessor-Based Test System (MITES). Design details of an explora exploratory development model of a charger/analyzer for charging vented nickel-cadmium batteries will be completed. An advanced model will be procured for evaluation purposes. Based upon the new testing concepts developed during the previous years, a new test equipment for Charge Prediction for Primary Batteries will be designed and breadboarded. The increase in FY 1978 funding over that of FY 1977 is due to an expansion in the investigation into new Built-in Test Equipment (BITE) technologies.

4. FY 1979 Program: Implement the second phase of the BIT effort which pertains to the development of a capability whereby many types of BIT-applicable stimuli (analog as well as digital) can be generated from digital information provided from a microprocessor and its associated memories and logic. The second task is to develop processing techniques and algorithms. Initiate development of transducers/sensors to permit on-line signal injection, acquisition and processing, utilizing the BIT capabilities previously developed.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.31.02.A

Title Materials Scale-Up/Structures Demonstration

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	950	500	1235	2382	4502	Continuing	Not Applicable
D071	Materials Scale-Up/ Structures Demonstration	950	500	1235	2382	4502	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Scale-up and evaluation of geometric shapes related to Army weapon systems structures in which advanced materials will be used. Characterize scaled-up materials to the extent necessary to permit confident use by Army weapon systems design engineers. Demonstrate cost effectiveness, reliability, maintainability of scaled-up advanced materials prior to use in weapon systems development.

BASIS FOR FY 1978 RDTE REQUEST: Materials scale-up/evaluation for two major systems: (1) high density penetrators for 726, 735 and 774 type projectiles and (2) vibration/wear reduction in CH47C and UTAAS type helicopter drive system.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Existing penetrator munitions materials are lacking in good reproducibility and are costly. Materials compositions and processing methods for lower-cost penetrator materials will be determined and fully evaluated in the scaled-up state. Accelerated wear of components of Army helicopter drive system is the major factor in high maintenance cost and reduced life time. Scaled-up metal-matrix, composites will be fabricated and fully evaluated to provide 42% life time cost reduction.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ Employees	44	0	44
(2) Contractor Employees	35	0	35
Total	79	0	79

Budget Activity #2 - Advanced Technology Development

Program Element # 6.31.02.A Title Materials Scale-Up/Structures Demonstration

DETAILED BACKGROUND AND DESCRIPTION: Knowledge is being continually produced through exploratory development on new materials, new materials specifications and characterization of new materials in specimen configurations. A critical gap exists between the knowledge of these new materials in specimen configurations and the knowledge required for use of advanced new material in engineering development of Army weapon systems. This program to fill that gap, was initiated late in FY 1976 to fully characterize advanced materials in geometric shapes used in Army systems to avoid cost overruns in engineering development; prove superiority of advanced materials by competitive evaluation to avoid poor materials choices in weapon system development; fabricate scaled prototypes from advanced materials to minimize scale-up surprises; and to demonstrate cost effectiveness of advanced materials hardware to minimize cost overruns.

RELATED ACTIVITIES: The Air Force, Navy, other Government agencies and allied nations have analogous programs. Although similar in approach, these programs differ greatly in emphasis placed on materials advanced development for specific hardware applications. Coordination within the Department of Defense is achieved through biennial update of the Materials Technology Coordinating Paper and meetings of the Office of the Director of Defense Research and Engineering's ad hoc Service Materials Laboratories Council. Coordination with the non-military federal agencies is effected through participation in activities of the National Materials Advisory Board of the National Academy of Sciences -- National Academy of Engineering, and the Federal Council on Science and Technology - Committee on Materials. International coordination is effected through participation in The Technical Cooperation Program with Australia, Canada and the United Kingdom and the Structures and Materials Panel of the Advisory Group for Aerospace Research and Development of the North Atlantic Treaty Organization.

WORK PERFORMED BY: Approximately 65% of this work will be accomplished in-house in FY 1977 at the Army Materials and Mechanics Research Center, Watertown, Massachusetts; US Army Armament Research and Development Command (ARRADCOM), Watervliet, New York; Mobility Equipment Research and Development Command, Fort Belvoir, Virginia; Natick Research and Development Command, Natick, Massachusetts; and ARRADCOM, Dover, New Jersey. In FY 1978, it is planned to accomplish approximately 55% of the work in-house at the Army Materials and Mechanics Research Center, the Army Missile Research and Development Command, Redstone Arsenal, Alabama and ARRADCOM, Watervliet, New York. Typical contractors are Honeywell, Pratt and Whitney Aircraft, Boeing Aircraft, DWA Associates, Fiber Materials, Inc., and Bolt, Beranek and Newman.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: This program was initiated in FY 1976. Structural foams, that are lightweight, stress free and less costly than metals, provide insulative and damping qualities and exhibit high stiffness and strength-to-weight ratios, were developed for use as ammunition pallets, track shoe components and for the Pointing and Stabilization Element of the mini-Remotely Piloted Vehicle. Commercial ammunition pallets and prototype track shoes were developed and evaluated. As a result of the development of polyphosphazene fluoroelastomers under the Materials Project, 1T162105AH84, a program was started to evaluate items such as gaskets, obturator pads and coated fabric for Army medical shelters. To date, prototype microphones, strain gauges and pulse measurement device have been fabricated using organic films as sensors and are showing considerable advantage over previous sensor materials. The program to design and fabricate refractory coated gun liners is alleviating

barrel erosion problems, and has resulted in the successful plating of a 105mm M68 barrel. Work to produce aligned discontinuous fiber aluminum/graphite composites by pultrusion, extrusion and pressure sintering has produced superior lightweight structural components. Prototype I-beams have been constructed by an intergral dip brazing approach.

2. FY 1977 Program: The materials scale-up of structural foams is being directed toward prototype development of polysulfone and polyethersulfone resin foams reinforced with glass and carbon fibers to improve the strength of structural components. The work on polyphosphazene fluoroelastomers is concentrating on the testing and durability evaluation of quick-disconnect pipeline couplings, and on determining the fire resistance of coated fabrics for shelter applications. In the program on gun barrel erosion, liners coated with promising erosion resistant metallic coatings will be evaluated by test firing. Graphite/aluminum doubler plates will be bonded to a CH-47 transmission housing and their effectiveness in reducing noise and vibration will be assessed. I-beams that have been reinforced with graphite/aluminum will be evaluated for flexural strength, modulus and fatigue. Work will be initiated on scaling-up the slip casting process and fabricating 18-inch prototype reaction bonded silicon nitride radomes. Work is being initiated to scale-up composites for lightweight bridging by the pultrusion process.

3. FY 1978 Planned Program: In FY 1978, there will be a major redirectioning of program element to scale-up/evaluation of materials for two major systems: (1) high density penetrators for 726, 735, 774 type projectiles, and (2) vibration-wear reduction in CH47C and UTTAS type helicopter transmission housings. Increased funding to provide the necessary resources to execute scheduled simultaneous and consecutive tasks that must be conducted to demonstrate full feasibility. Existing high density penetrator materials deficient in reproducibility and are costly. Specifications will be determined for materials composition and processing and fabrication procedures in scaled-up state. Helicopter transmission housing deflection under load major cause of accelerated wear of gears, bearings, splines, connections and joints. Scaled-up advanced metal-matrix composites reinforcements will be fabricated and fully evaluated to provide 42% lifetime cost reduction per helicopter.

4. FY 1979 Planned Program: Complete programs for materials scale-up/evaluation of high density penetrators and for helicopter transmission wear reduction. Scale-up/evaluation program will be initiated for spall protection liners for tanks, other ground combat vehicles and Army aircraft. Severe behind-the-armor effects within combat vehicles caused by kinetic energy and other projectiles generate high percentages of casualties and damage to critical components. Scaled-up spall suppression liners will be fabricated and fully evaluated to reduce back spall and penetration of secondary particles and to increase survivability of personnel and critical components. Increased funding will be applied to new program.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.31.03.A

Title Fluidics Advanced Development

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	0	0	0	500	Continuing	Not Applicable
D501	Fluidic Advanced Development	0	0	0	0	500	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program element will be a coordinated Army program to exploit fluidics technology via demonstrations of technical feasibility in prototype applications.

BASIS FOR FY 1978 RDTE REQUEST: Program does not start until FY 1979.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Not Applicable.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ Employees	0	0	0
(2) Contractor Employees	0	0	0
Total	0	0	0

DETAILED BACKGROUND AND DESCRIPTION: This program will continue the fluidic developments begun in 6.21.14.A for turret stabilization, turbine fuel control, turbine engine control, advanced fluidic flight controls, and dampers for tactical and combat vehicles. Developments will be carried through for project manager acceptance on major and non-major Army systems.

Budget Activity #2 - Advanced Technology Development

Program Element # 6.31.03.A Title Fluidics Advanced Development

RELATED ACTIVITIES: This program follows 6.21.14 Fluidic Technology Investigations and relates to 6.32.06.A Aircraft Weapons, and 6.36.08.A Weapons and Ammunition (Tank Gun Development) - Turret and Cupola Mounted Stabilized Systems. The program is coordinated with the Air Force, Navy, National Aeronautics and Space Administration, and Energy Research and Development Administration through the Government Fluidics Coordinating Group and the Joint Technical Coordinating Group - Fluidics.

WORK PERFORMED BY: This program will be directed by Harry Diamond Laboratories, Washington, D.C., with other Army laboratories (in-house) doing work directly related to their mission. The US Army Missile Research and Development Command, Redstone Arsenal, Alabama; US Army Armament Research and Development Command (ARRADCOM), Dover, New Jersey; ARRADCOM, Rock Island, Illinois; Tank Automotive Research and Development Command, Warren, Michigan; Air Mobility Research and Development Laboratory, Fort Eustis, Virginia; and the Mobility Equipment Research and Development Command, Fort Belvoir, Virginia, will all work closely with Harry Diamond Laboratories. Approximately 40% of the effort will be contractual with anticipated bidders being Honeywell Incorporated, Minneapolis, Minnesota; AiResearch Incorporated, Wayne, New Jersey; Martin-Marietta Corporation, Orlando, Florida; Bendix Corporation, Detroit, Michigan; and General Electric, Schenectady, New York, among others.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Not Applicable

2. FY 1977 Program: Not Applicable

3. FY 1978 Planned Program: Not Applicable

4. FY 1979 Planned Program: The turret stabilization design and turbine fuel and engine control designs will be carried through advanced development for final design and evaluation. A fluidic damper design and prototype will be finalized and selected for use on selected tactical and combat vehicles. Coordination will continue at Harry Diamond Laboratories to insure there is no duplication of effort among other Services or agencies of the government.

5. Program to Completion: This is a continuing effort.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.32.01.A Title Aircraft Power Plants and Propulsion

Category Advanced Development Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	1077	575	3857	4067	10000	Continuing	Not Applicable
DB72	Propulsion Components	100	105	930	1162	3000	Continuing	Not Applicable
D447	Demonstrator Engines	977	470	2927	2905	7000	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The program objective is to demonstrate the integration and potential of advanced turbomachinery components and drive train technology through tests of engines and transmissions.

BASIS FOR FY 1978 RDTE REQUEST: The advanced transmission components development for which contracts were awarded in late FY 1976 will be continued and testing initiated. The Common Helicopter Integrated Propulsion Systems (CHIPS) program will be initiated. Analyses to identify and select a design approach for common propulsion system components and the beginning of detailed design will be started. Efforts which began in FY 1976 to develop an advanced technology demonstrator engine in the 800 shaft horsepower class will be continued.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Increased funding is required primarily because of initiation of a program to select a design approach for common propulsion system components.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	15	0	15
(2) Contractor Employees	80	0	80
Total	95	0	95

Budget Activity #2 - Advanced Technology Development

Program Element # 6.32.01.A Title Aircraft Power Plants and Propulsion

DETAILED BACKGROUND AND DESCRIPTION: The objective of this program element is to demonstrate the integration and potential of advanced turbomachinery components and drive train technology through tests of engines and transmissions. The program provides for design, fabrication, and testing of advanced propulsion systems. Advanced component technology from Army exploratory development and other Government and company-sponsored programs will be applied to advanced gas generators, engines, and drive trains in demonstration and validation tests. Primary emphasis will be placed on those areas that will benefit near term aircraft development programs. The critical flow path components are validated under the Small Turbine Advanced Gas Generator (STAGG) program, whereby advanced technology components are integrated. Complete engine subsystems are integrated and tested under the Advanced Technology Demonstrator Engine (ATDE) program. The Helicopter Advanced Drive Train (HADT) program will provide the systems approach for a multi-disciplinary effort and place drive train technology on a par with the many advances made in aircraft turbine engines.

RELATED ACTIVITIES: Mutual exchanges of information occur with the United States Air Force, the United States Navy, and National Aeronautics and Space Administration. Agencies are advised of program progress by semi-annual meetings, a Tri-Service Aircraft Propulsion Technology Coordinating Paper, an informal Tri-Service Coordination Group, and visits to industry. Related Program Elements are 6.22.09.A, Aeronautical Technology, and 6.42.06.A, Utility Tactical Transport Aircraft System (T-700 Engine Project).

WORK PERFORMED BY: Boeing-Vertol, Philadelphia, PA; Bell Helicopter, Fort Worth, Texas; Sikorsky Division, United Technologies, Stratford, CT, and engine manufacturers to be selected from Garrett-AiResearch, Phoenix, AZ; Detroit Diesel Allison Division, General Motors Corporation, Indianapolis, IN; AVCO Lycoming Engine Group, Stratford, CT; and General Electric, Aircraft Engine Group, Lynn, MA. The program is the responsibility of the Eustis Directorate, US Army Air Mobility Research and Development Laboratory, Fort Eustis, Virginia.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976 and Prior Accomplishments: Two 1500 shaft horsepower (SHP) demonstrator engines were fabricated and tested. Goals of increased power to weight ratio and reduced fuel consumption were met and one engine was selected for the Utility Tactical Transport Aircraft System and the Advanced Attack Helicopter. Four contracts were let in 1971 for the Small Turbine Advanced Gas Generator (STAGG)--two in each horsepower range (200-300 and 500-800 SHP). The program was completed in FY 1976 and the objectives of decreased specific fuel consumption and increased specific power (shaft horsepower/pound) were met. The combustor and turbine technology was applied to the A-10 aircraft auxiliary power unit and a 30 KW generator set. Casting techniques developed for ZE-41 material have been incorporated in the Utility Tactical Transport Aircraft System and the CH-47 Modernization Program. A cooperative program with the Navy was initiated in FY 1976 to test ceramic bearings in the Variable Speed Target Trainer (VSTT) engine. Critical components for the advanced drive train components program were identified and three contracts were awarded in FY 1976. Effort under this program will include design, fabrication, and testing of components for an advanced main rotor gear box for contemporary helicopters.

2. FY 1977 Program: The contracts to validate advanced drive train components and concepts are continuing. Design goals include: 20% weight reduction (pound/ shaft horsepower (SHP)); a 100% increase in mean time between removal to 3000 hours; a capability to operate 30 minutes at gear box torque limit without lubricant in the main lube system; and 20% reduction in recurring production cost. The 800 SHP class demonstrator engine program will be initiated. Small Turbine Advanced Gas Generator (STAGG)-type program will continue through initiation of a cooperative Army/Air Force evaluation of a cast radial turbine in a STAGG.

3. FY 1978 Planned Program: FY 1978 activity will include continuation of the advanced drive train components program to include fabrication of critical component hardware for the main rotor gear box. The Navy will participate in this program. Initiate the Common Helicopter Integrated Propulsion System (CHIPS) program and the lightweight variable pitch directional control fan program. The CHIPS program will exploit potential advantages which should be available by the multiple application of common propulsion components to one, two, or three engine helicopters. The 800 SHP class demonstrator engine program will continue. The increase in funding in FY 78 is required by contractual effort on the CHIPS program and new efforts in a directional control fan.

4. FY 1979 Planned Program: Testing in the advanced drive train components program will be completed. Fabrication and procurement of test hardware and component testing in the CHIPS program will be initiated. The lightweight directional control fan program will progress to component fabrication. A high temperature transmission program and demonstration tests of a free planet transmission will be initiated. Snow and ice environmental tests to determine the effectiveness of engine inlet particle separators will be initiated. The increase in funding is due primarily to major hardware procurement and increased testing in the demonstrator engine program and the CHIPS program and initiation of high temperature and free planet transmission programs.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.32.01.A

Title Aircraft Power Plants and Propulsion

Project #DB72

Title Propulsion Components

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

DETAILED BACKGROUND AND DESCRIPTION: The objective is to develop advanced helicopter transmission systems and thrust producer concepts and to: demonstrate these concepts with respect to performance, reliability, survivability, and maintainability; define concept capabilities; evaluate applicability to future generation Army aircraft; and provide to industry improved design technology. Efforts will include design, fabrication and testing of advanced drive train and thrust producer concepts comprised of components proven feasible under exploratory development programs. Demonstration of system capabilities shall be accomplished through bench, ground and flight testing. A transmission program to demonstrate significant advancement provides advanced "on-the-shelf" technology prior to future aircraft development programs.

RELATED ACTIVITIES: Mutual exchanges of information occur with the US Air Force, the US Navy, and National Aeronautics and Space Administration. Agencies are advised of program progress by semi-annual meetings, an informal Tri-Service Coordination Group, and visits to industry. A related program element is 6.22.09.A, Aeronautical Technology.

WORK PERFORMED BY: Sikorsky Aircraft Division, United Technologies Corporation, Stratford, CT; Boeing Helicopters, Philadelphia, PA; Bell Helicopter Textron, Ft. Worth, TX. The program is the responsibility of the Eustis Directorate, US Army Air Mobility Research and Development Laboratory, Ft. Eustis, VA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: A roller gear transmission development program was initiated in FY 69. This transmission was designed for 3000 shaft horsepower (SHP) at the main rotor and was ground tested on an NSH-3A aircraft. Goals of planet gear power sharing were met, as well as improved reliability due to 75% reduction in the number of bearings. This program also indicated that the vertical height of the transmission could be decreased, thus providing an aircraft drag improvement. This program was technically completed in FY 76. One of the major accomplishments under the program was the first application of ZE-41 Magnesium castings. The ZE-41 material is easily cast and results in a lower cost casting. The developed casting technology is currently being utilized in the Utility Tactical Transport Aircraft System and CH-47 Modernization program. In the final quarter of FY 76 and in FY 7T, three contracts were awarded for the development of advanced technology transmission critical components, which could be incorporated in a 1980-1990 aircraft system. It is expected that these components, when integrated within a complete transmission, will provide significant improvement over current designs with respect to specific weight, performance, reliability, maintainability and survivability.

2. FY 1977 Program: Design and initial fabrication efforts begun on advanced technology transmission components will be continued. In-house efforts to investigate the feasibility and analyze potential benefits of a Common Helicopter Integrated

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.01.A Title Aircraft Power Plants and Propulsion

Project #DB72 Title Propulsion Components

Propulsion Systems (CHIPS) program will be initiated. The effort will be directed at the exploitation of advantages which should be available by the multiple application of common propulsion components to one, two, or three engine Army aircraft.

3. FY 1978 Planned Program: Testing of advanced technology transmission components will continue. Contracts for the Common Helicopter Integrated Propulsion Systems (CHIPS) program will be awarded, with the initial effort aimed at analysis to determine the optimum design concept for such a propulsion system, to identify and select a design approach for common propulsion system components, and to initiate the detailed design of selected common components. In-house analyses of advanced propulsion (thrust producers) system concepts will be conducted. Determine the nature and magnitude of improvements available through the adoption of these concepts and the technology required to validate these improvements. Candidate concepts include the convertible fan-shaft engine, propellers, fans, and ejectors for vertical/short takeoff and landing (V/STOL) aircraft. Award contracts for the development of lightweight components for a variable pitch directional control fan. Initial effort will be concentrated on the analysis of the impact this type device would have on Army helicopter performance, weight, range, stability, safety, survivability, and reliability. Increased funding in FY 78 is required because of the contractual effort on the CHIPS program and the new effort in advanced propulsion systems and the directional control fan.

4. FY 1979 Planned Program: Complete the technical efforts begun on advanced technology transmission components. Review the proposed conceptual designs for CHIPS from the FY 1978 contracts and award two contracts for complete drive train subsystems and begin detailed design. Efforts in the area of a high temperature helicopter transmission which will operate above 400°F will be initiated. Specific items to be investigated include advanced lubrication schemes, materials evaluation, and improved heat-resistant bearing assemblies. Higher temperature operating capability of the transmission is required to be compatible with the current trends to increase speeds and reduce the size and weight for application in future high performance Army helicopters. Benefits of this effort include reduced lubrication system requirements, increased survivability, and reduced vulnerability of aircraft transmission systems. Efforts to demonstrate the feasibility of the free planet transmission concept by designing, fabricating, and testing a transmission suitable for use in a light or medium powered helicopter drive system will be initiated. Previous research has indicated that the free planet transmission is one of the most competitive concepts yet devised for power transmission for small, high reduction ratio drive systems. Fabrication of the lightweight variable pitch directional control fan will be completed and testing will be started. Increased funding in FY 79 is required because of increased hardware fabrication and testing in the CHIPS program, initiation of high temperature transmission tests, initiation of the demonstration of the free planet transmission, and increased contractual effort for the development of components for a variable pitch directional control fan.

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.01.A Title Aircraft Power Plants and Propulsion

Project #DB72 Title Propulsion Components

5. Program to Completion: This is a continuing program.

RESOURCES ($ in Thousands):

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	100	105	930	1162	3000	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.32.01.A Title Aircraft Power Plants and Propulsion

Project #D447 Title Demonstrator Engines

Category Advanced Development Budget Activity #2 - Advanced Technology Development

DETAILED BACKGROUND AND DESCRIPTION: The objective of this project is to provide a validated technology base for small (less than 20 pounds per second airflow) engines through full scale demonstration. The Army is the largest user and the lead Service for development of small engines. Although the Army will receive the most benefit from this project, the technology is applicable DOD wide. The approach consists of design, fabrication, and ground and flight testing of advanced engine configurations. Advanced component technology from Government exploratory development and industry-sponsored programs will be applied to advanced gas generators and experimental engines for demonstration and evaluation tests. The program also includes evaluation and application of advanced materials and validation of cost reduction concepts. Developmental aircraft must use advanced technology propulsion systems if future aircraft systems are to satisfy projected mission requirements at minimum cost and with minimum utilization of critical fuels and manpower. This project will experimentally validate the applicability and potential of engines utilizing advanced component technology. Successful completion of the 1500 Shaft Horsepower (SHP) demonstrator engine program, which resulted in minimizing of T700 engineering development program cost and risk, validates this approach.

RELATED ACTIVITIES: Mutual exchanges of information occur with the US Air Force, the US Navy, and National Aeronautics and Space Administration. Agencies are advised of program progress by semi-annual meetings, a Tri-Service Aircraft Propulsion Technology Coordinating Paper, an informal Tri-Service Coordination Group, and visits to industry. Examples include the use of this technology in a US Army Mobility Equipment Research and Development Command 30 Kilowatt generator set and the auxiliary power unit for the USAF A-10 aircraft. Related program elements are 6.22.09.A, Aeronautical Technology, and 6.42.06.A, Utility Tactical Transport Aircraft System (T-700 Engine Project).

WORK PERFORMED BY: Engine manufacturers to be selected from Garrett-AiResearch Corp., Phoenix, AZ; Detroit Diesel Allison Division, General Motors, Indianapolis, IN; AVCO Lycoming Engine Group, Stratford, CT; and General Electric, Aircraft Engine Group, Lynn, MA. The program is the responsibility of the Eustis Directorate, US Army Air Mobility Research and Development Laboratory, Ft. Eustis, VA.

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.01.A Title Aircraft Power Plants and Propulsion

Project #0447 Title Demonstrator Engines

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Two 1500 shaft horsepower (SHP) demonstrator engines were fabricated and tested. Goals of increased power to weight ratio and reduced fuel consumption were met and one engine was selected for the Utility Tactical Transport Aircraft System and the Advanced Attack Helicopter. Four contracts were let in 1971 for the Small Turbine Advanced Gas Generator (STAGG) — two in each horsepower range (200-300 and 500-800 SHP). The program was completed in FY 1976 and the objectives were met, and the technology was applied to the A-10 aircraft auxiliary power unit and the 30 KW generator set. A cooperative program with the Navy was initiated in FY 1976 to test ceramic bearings in the Variable Speed Target Trainer (VSTT) engine.

2. FY 1977 Program: A competitive 800 SHP class demonstrator engine program will be initiated following a Tri-Service evaluation of proposals. Goals for this program include 20-25% improvement in specific fuel consumption, 40-60% improvement in specific power and 10% reduction in cost per shaft horsepower over current production engines as well as improved reliability, maintainability and survivability. Hardware fabrication for component testing will be initiated in the fourth quarter. Initiate planning for a new round of STAGG gas generators utilizing advanced 6.2 components such as compressors, turbines, and controls and initiate a cooperative effort with the Air Force to evaluate a cast radial turbine in the STAGG.

3. FY 1978 Planned Program: The efforts begun on the 800 SHP class demonstrator engines will continue. Gas generator testing will be initiated in 4Q FY 1978 and assembly of first complete engine will begin.

4. FY 1979 Planned Program: The 800 shaft horsepower (SHP) class demonstrator engine program will continue. First engine testing will begin in the first quarter. A total of 200 hours gas generator testing and 250 hours of engine testing will be accumulated. Ice and snow environmental tests of an engine inlet particle separator will be conducted at the Climatic Test Facility Eglin Air Force Base, FL. An in-house task on thermal control turbine shrouds will be initiated. The large increase in funding in FY 1979 is due to major hardware procurement and increased testing of the 800 SHP demonstration engine.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	977	470	2927	2905	7000	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.32.06.A

Title Aircraft Weapons

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	4309	1100	1717	940	4501	Continuing	Not Applicable
D043	Aircraft Weapons Fire Control	1727	388	888	867	1875	Continuing	Not Applicable
D044	Aircraft Gun Type Weapons	939	277	300	73	1676	Continuing	Not Applicable
DK62	Aircraft Rocket Type Weapons	1643	435	529	0	750	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program element provides data to support engineering development of new helicopter armament systems and components.

BASIS FOR FY 1978 RDTE REQUEST: The mast mounted sight will be developed for the OH-58 scout helicopter. Investigation of present fire control systems to determine suitability of engaging moving targets will be completed and improvements breadboarded if necessary. The breadboard of the automatic target cueing system (ATCS) will be completed.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Level of effort reduced in technology base programs due to reduced scope of programs and to address specific technology opportunities in aircraft fire control.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	29	0	29
(2) Contractor Employees	25	0	25
Total	54	0	54

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.06.A Title Aircraft Weapons

DETAILED BACKGROUND AND DESCRIPTION: The objective of this program element is to obtain data upon which to base engineering development of new helicopter armament systems and components. This program was established to design, fabricate, test and evaluate experimental hardware components of heliborne armament. This Program Element has three active projects: Aircraft Weapons Fire Control, Aircraft Gun Type Weapons, and Aircraft Rocket Type Weapons.

RELATED ACTIVITIES: Close liaison is maintained with other military services and industry. The Army participates in the tri-service Joint Technical Coordinating Group for Air Launched Non-Nuclear Ordnance, an organization chartered at the major field command level. This group provides a medium for exchange of technical information and determination of joint use implications. An Army representative serves on the Air Munitions Requirements and Development Committee, an organization within the Office of the Secretary of Defense. One function of this committee is the establishment of joint service requirements and development of air munitions. Related Exploratory Development is conducted under Program Element 6.22.01.A, Aircraft Weapons Technology, and Engineering Development is under Program Element 6.42.02.A, Aircraft Weapons.

WORK PERFORMED BY: US Army Armament Research and Development Command, Rock Island, IL; US Army Missile Research and Development Command, Huntsville, AL; US Army Test and Evaluation Command, Aberdeen Proving Ground, MD; US Army Aviation Research and Development Command, St. Louis, MO. Contractors: General Electric Company, Binghamton, NY; Emerson Electric, St. Louis, MO; Hughes Helicopter Company, Culver City, CA; Honeywell Inc., Minneapolis, MN; Martin Marietta, Orlando, FL; Baird-Atomic, Boston, MA; Boeing Vertol, Philadelphia, PA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Feasibility of 30mm and 40mm airburst fuzes and 30mm aluminum cased ammunition was established. Investigated the feasibility of heliborne anti-radiation missile and use of semi-active lasers for guidance of point target weapons. Hardware models of laser rangefinders and moving target indicator radars were developed. Computers for Multi-Weapons Fire Control and helmet sighting systems were developed and tested. Completed tests and evaluation of use of air launched REDEYE missile against ground targets. Evaluated specifications for external stores/suspension equipment for Army aircraft. The COBRA Night Fire Control System incorporating Low Light Level Television on the AH-1G was fabricated and evaluated. Infrared technology was utilized for weapon sighting systems at low level and under adverse weather conditions, and test bed aircraft were used to address target engagement ranges and employment techniques. Demonstrated compatibility of a special purpose electronic processing unit to operate from television and Forward Looking Infrared (FLIR) type video formats for automatic tracking of targets with remote view sighting systems. Completed integration and testing of laser rangefinder into the improved rocket fire control and XM-65 TOW sight. Conducted flight evaluations of helmet mounted displays and heads-up displays. The pantograph mounted laser rangefinder was acquired and flight test completed. The stabilized mirror system for ranging and tracking was fabricated and tested. The flight evaluation of the automatic tracking processor was conducted. The high impulse test bed for the constant recoil mechanism was completed. Investigated the utilization of an airborne laser tracker with both pantograph laser and the stabilized mirror systems. Completed aircraft integration of modularized day/night sight. Flight tested closed loop Fire Control feasibility model. Developed design criteria for helmet sighting systems based on results of Army and Navy test.

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.06.A Title Aircraft Weapons

Integrated and flight tested a modified 20mm turret with a flight qualified hydraulic constant recoil mechanism on the multi-weapon fire control system. Fabricated breadboard model of mount for development phase of high impulse recoil attenuation hardware. Evaluated shallow cone shaped charge (SCSC) for High Energy Dual Purpose round. Final report completed for the Selected Effects Armament System. Successfully fabricated and flight tested a mast mounted sight.

2. FY 1977 Program: The 20mm hydraulic constant recoil program data analysis will be completed and a final report published. The high impulse recoil attenuation program will begin testing. Integration of the lighweight helmet into the helmet sighting system will be accomplished. The final report of the design study and the design specifications for the next generation hardware for the mast mounted sight will be completed. The initial design review of the automatic target cueing system that completed exploratory development will lead to a final breadboard design. The multi-purpose submunition warhead for the 2.75 inch rocket will complete advanced development.

3. FY 1978 Planned Program: Investigations will be conducted to determine the suitability of existing helicopter fire control hardware for effective use in engaging moving targets. If the investigation provides successful results, a breadboard utilizing existing hardware where possible will begin fabrication. An austere advance helmet sight system will be developed, using the lightweight helmet, for testing target acquisition, handoff and other associated operations. A mast mounted sight for the OH-58 scout helicopter will begin development. A breadboard of the automatic target cueing system (ATCS) will be completed. Delaying the high performance turret investigations are reflected by reduced funding.

4. FY 1979 Planned Program: The design and integration of previous efforts consisting of recoil mechanism, weapon, feed system, and turret into a breadboard high impulse weapon subsystem will begin and is reflected by the increase in funding. A moving target fire control system will be breadboarded and flight tested. The multi-year program to develop low cost-low profile head-up displays, helmet mounted sight/displays, and sensors for helicopters continuas. The ATCS will be integrated with the aircraft and flight tested. Two mast mounted sights will complete fabrication and testing for installation on the OH-58 scout aircraft will begin. The mast mounted sight and high impulse weapon system hardware procurement and integration is reflected by increased funding in this program. The reference marker warhead for the 2.75 inch rocket will begin advanced development.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.32.07.A

Title Aircraft Avionics Equipment

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	2682	300	2039	2560	3194	Continuing	Not Applicable
DB96	Aircraft Navigation and Control Equipment	672	0	280	387	0	Continuing	Not Applicable
DB97	Avionics Equipment	2010	300	1759	2173	3194	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This Program Element provides for advanced development leading to engineering development of airborne and ground avionics equipment.

BASIS FOR FY 1978 RDTE REQUEST: The FY 1978 request is based on advanced developments which include nap-of-the-earth (NOE) communication systems, aircraft antennas, low airspeed system, advanced displays, obstacle detection equipment and a lightweight inertial navigation system.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The increase in FY 1978 is due to increased effort in communications instrumentation and advanced avionics system engineering.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement) is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	27	0	27
(2) Contractor Employees	7	0	7
TOTAL	34	0	34

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.07.A Title Aircraft Avionics Equipment

DETAILED BACKGROUND AND DESCRIPTION: This advanced development avionics program provides the basis for future engineering development of aviation electronics equipment and systems to support Army aviation. It includes both aircraft and supporting ground equipment developments. Principal interest is focused on Army helicopters and improving their capability to operate at low level nap-of-the-earth (NOE) altitudes while supporting ground combat forces at night and during adverse weather. The Program Element is composed of two projects: Aircraft Navigation and Control Equipment (DB96) and Avionics Equipment (DB97). Included are developments in the areas of navigation, landing, communications, instrumentation, avionics systems engineering and obstacle avoidance.

RELATED ACTIVITIES: Related programs of other Services and the Federal Aviation Agency are monitored by the Army through participation in committees and working groups to avoid duplication of effort. This Program Element is related to Program Elements 6.22.02.A (Aircraft Avionics Technology) and 6.42.01.A (Avionics Systems).

WORK PERFORMED BY: US Army Aviation Research and Development Command, Avionics Laboratory (Project DB97) and Project Manager Navigation and Control (Project DB96), Ft Monmouth, NJ. Contractors include: Xetron, Inc., Cincinnati, OH; Marchand Electronics, Greenwich, CT; and Stanford Research Institute, Menlo Park, CA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976 and Prior Accomplishments: A rotor blade radar was designed and military potential tests completed. A commercial model of a broad band automatic direction finding device was evaluated to determine its military potential. The use of liquid crystal displays for helicopter instrumentation was investigated. An evaluation of conventional flight director systems was conducted. Computer modeling of aircraft vulnerability, survivability, performance, and avionics reliability was accomplished. Feasibility investigation of increased transmitter power to enhance nap-of-the-earth (NOE) communications was completed. Advanced development of voice gating circuitry was completed. An experimental "whine filter" to filter out helicopter transmission noise was developed. Noise reduction microphones were designed. Various cockpit lighting techniques were evaluated. Investigation of state-of-the-art low airspeed sensing and display systems was initiated.. The Army participated in Air Force and Navy developments of advanced inertial navigation systems. Flight tests of civil versions of National Microwave Landing System (NMLS) airborne equipment were initiated with a "quick look" test in an Army helicopter. Preparations were made for development of tactical versions of the NMLS. Equipment and test plans were prepared for the NOE communication system field test program. Demonstration effort for a single frequency retransmission system was completed. Acoustical and electrical noise data obtained in exploratory development was analyzed. Design of an improved ear cup transducer assembly was initiated. A multiple frequency notch filter ("whine filter") began advanced development. The laser obstacle terrain avoidance warning system was successfully flight tested in the wire detection mode. Programmable symbol generator, multifunction display, low airspeed system and solid state altimeter developments were initiated. A system for tactical hover, using already developed sensors, was flight tested. A joint Avionics Laboratory - Night Vision Laboratory effort to integrate a Doppler navigator with a target acquisition system was initiated to assess the feasibility of target coordinate determination and navigation computer updating.

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.07.A Title Aircraft Avionics Equipment

2. FY 1977 Program: Development of an inertial navigation system (Adaptation of Air Force standard inertial system) will be initiated. Civil versions of the National Microwave Landing System (NMLS) will undergo more extensive testing. The nap-of-the-earth (NOE) communication system field test program will be complete and guidelines for further system development will be formulated. Analysis of acoustical and electrical noise data will continue. Advanced development of a multi-band automatic direction finder (ADF) for search and rescue will be initiated. Alternate electronic counter-countermeasure (ECCM) techniques for helicopter applications will be investigated. Audio systems analysis efforts will continue. NOE communications alternative techniques will be analyzed. Advanced development of the multiple notch filter will be completed. Development requirements for improved microphone and ear cup transducers will be established. The night navigation and pilotage system and the target location and navigation system will be evaluated. Development of the programmable symbol generator, multifunction display and low airspeed system will continue. Advanced development of an automatic data transfer system for target hand off and other applications will be initiated.

3. FY 1978 Planned Program: Inertial navigation system advanced development will be completed. Electronic counter-countermeasures (ECCM) and audio systems analysis efforts will continue for new aircraft application. Advanced development of the low cost hover sensor will be completed. A nap-of-the-earth (NOE) communication system advanced development program will be initiated. Alternate NOE communication techniques will continue to be analyzed. The programmable symbol generator and multi-function display will complete advanced development. Standard control display unit development will be initiated. Evaluation of the night navigation/pilotage system and the target location/navigation systems will continue. The increase in FY 1978 is due to increased effort in communications, instrumentation and advanced avionics system engineering.

4. FY 1979 Planned Program: Analysis of ECCM, audio systems and NOE communication technologies will continue. Advanced development of the NOE communication system and automatic data transfer system will continue. Advanced development of the multi-band automatic direction finder (ADF) will be completed. Advanced development of the laser low level flight system will be initiated. The night navigation and pilotage system will be integrated into a demonstration aircraft using Digital Modular Avionics Program (DIMAP) system architecture. The increase in FY 1979 is due to increased effort in communications accessories/antennas and obstacle avoidance.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.32.07.A

Title Aircraft Avionics Equipment

Project #DB97

Title Avionics Equipment

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

DETAILED BACKGROUND AND DESCRIPTION: This advanced development avionics program provides the basis for future engineering development of aviation electronics equipment and systems to support Army aviation. It includes both aircraft and supporting ground equipment developments. Principal interest is focused on Army helicopters and improving their capability to operate at low level NOE altitudes while supporting ground combat forces at night and during adverse weather.

RELATED ACTIVITIES: Related programs of other Services and the Federal Aviation Agency are monitored by the Army through participation in committees and working groups to avoid duplication of effort. This Program Element is related to Program Element 6.22.02.A (Aircraft Avionics Technology) and 6.42.01.A (Avionics Systems), and to Project DB96 (Aircraft Navigation and Control Equipment) in this program element.

WORK PERFORMED BY: US Army Aviation Research and Development Command, Avionics Laboratory, Ft. Monmouth, NJ. Contractors include: Xetron Inc., Cincinnati, OH; Marchand Electronics, Greenwich, CT; and Stanford Research Institute, Menlo Park, CA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, 1976 and Prior Accomplishments: A rotor blade radar was designed and military potential tests completed. A commercial model of a broad band automatic direction finding device was evaluated to determine its military potential. The use of liquid crystal displays for helicopter instrumentation was investigated. An evaluation of conventional flight director systems was conducted. Computer modeling of aircraft vulnerability, survivability, performance, and avionics reliability was accomplished. Feasibility investigation of increased transmitter power to enhance nap-of-the-earth (NOE) communications was completed. Advanced development of voice gating circuitry was completed. An experimental "whine filter" to filter out helicopter transmission noise was developed. Noise reduction microphones headsets were designed. Various cockpit lighting techniques were evaluated. Investigation of state-of-the-art low airspeed sensing and display systems was initiated. Equipment and test plans were prepared for the NOE communication system field test program. Demonstration effort for a single frequency retransmission system was completed. Acoustical and electrical noise data obtained in exploratory development was analyzed. Design of an improved ear cup transducer assembly was initiated. A multiple frequency notch filter (whine filter) began advanced development. The laser obstacle terrain avoidance warning system was successfully flight tested in the wire detection mode. Programmable symbol generator, multifunction display, low airspeed system and solid state altimeter developments were initiated. A system for tactical hover, using already developed sensors, was flight tested. A joint Avionics Laboratory - Night Vision Laboratory effort to integrate a Doppler navigator with a target acquisition system was initiated to assess the feasibility of target coordinated determination and navigation computer updating.

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.07.A Title Aircraft Avionics Equipment

Project #DB97 Title Avionics Equipment

2. FY 1977 Program: The nap-of-the-earth (NOE) communication system field test program will be completed and guidelines for further system development will be formulated. Analysis of acoustical and electrical noise data will continue. Advanced development of a multi-band automatic direction finder (ADF) for search and rescue will be initiated. Alternate electronic counter-countermeasures (ECCM) techniques for helicopter applications will be investigated. Audio systems analysis efforts will continue. NOE communications alternative techniques will be analyzed. Advanced development of the multiple notch filter will be completed. Development requirements for improved microphones and ear cup transducers will be established. The night navigation and pilotage system and the target location and navigation system will be evaluated. Development of the programmable symbol generator, multi-function display and low airspeed system will continue. Advanced development of an automatic/data transfer system for target hand off and other applications will be initiated.

3. FY 1978 Planned Program: ECCM and audio systems analysis efforts will continue for new aircraft applications. Advanced development of the low cost hover sensor will be completed. An NOE communications system advanced development program will be initiated. Alternate NOE communication techniques will continue to be analyzed. The programmable symbol generator and multi-function display will complete advanced development. Standard control display unit development will be initiated. Evaluation of the night navigation/pilotage system and the target location/navigation system will continue. The increase in FY 1978 is due to increased efforts in communications, instrumentation and advanced avionics system engineering.

4. FY 1979 Planned Program: Analysis of electronic counter-countermeasures (NOE), audio systems and nap-of-the-earth (NOE) communication technologies will continue. Advanced development of the NOE communication system and automatic data transfer system will continue. Advanced development of the multi-band automatic direction finder (ADF) will be completed. Advanced development of the laser low level flight system will be initiated. The night navigation and pilotage system will be integrated into a demonstration aircraft using Digital Modular Avionics Program (DIMAP) system architecture. The increase in FY 1979 is due to increased effort in communication accessories/antennas and obstacle avoidance.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	2010	300	1759	2173	3194	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.32.08.A

Title Aircraft Survivability Concepts

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	2550	330	2383	1453	4750	Continuing	Not Applicable
DB52	Aircraft Survivability Concepts	2550	330	2383	1453	4750	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The program element is directed toward advanced development (AD) of passive aircraft survivability equipment for Army aircraft when operating in a hostile air defense environment composed of radar, infrared (IR) and optically directed weapons.

BASIS FOR FY 1978 RDTE REQUEST: Development of low reflective paint in various light colors (desert and arctic paint) will continue. IR countermeasure effectiveness analysis and signature predictions of aircraft survivability equipment will continue. Laboratory support of vulnerability reduction (VR) contracts will continue and range test support will be provided. IR measurements for development testing/operational testing (DT/OT) requirements will be taken on the AH-1 and UH-1 suppressors.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Efforts in ultraviolet/long wavelength infrared (UV/LWIR) countermeasures and radar cross section reduction will be at a lower level in FY 1978.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	9	0	9
(2) Contractor Employees	19	0	19
Total	28	0	28

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.08.A Title Aircraft Survivability Concepts

DETAILED BACKGROUND AND DESCRIPTION: This project was established to develop infrared (IR) suppression concepts for Army aircraft in response to the appearance of the Soviet built SA-7 ground-to-air missile. The objective of this task is the development and concept feasibility demonstration of aircraft survivability equipments required for protection of Army aircraft in a hostile air defense environment composed of radar, infrared, and optically directed weapon systems. The approach is the development of prototype electromagnetic radiation suppression; ballistic hardening and complementing ground support equipments; the development of measurement and evaluation techniques, standards and equipments; and the conduct of test measurements and evaluations required to demonstrate the feasibility of the prototype aircraft survivability equipments.

RELATED ACTIVITIES: This program is conducted in conjunction with active survivability measures under Program Element #6.37.11.A, D653, Tactical Self-Protection Electronic Warfare Equipment, also managed by the Project Manager for Aircraft Survivability Equipment (PM-ASE), and Program Element #6.32.15.A, Joint Survivability Investigations, of which PM-ASE is the senior Army representative.

WORK PERFORMED BY: US Army Aviation Research and Development Command (AVRADCOM), St. Louis, MO; US Army Air Mobility Research and Development Laboratory, Ft. Eustis, VA; US Army Test and Evaluation Command, Aberdeen Proving Ground, MD; US Army Armament Research and Development Command (ARRADCOM), Ballistic Research Laboratories, Aberdeen Proving Ground, MD; US Army Electronics Research and Development Command, Office of Missile Electronic Warfare, White Sands Missile Range, NM; US Army Aviation Test Board, Ft. Rucker, AL. Contractors: Westinghouse, Baltimore, MD; CALSPAN, Buffalo, NY; Stanford Research Institute, Palo Alto, CA; General Dynamics Corp., San Diego, CA; Bell Helicopter, Ft. Worth, TX; Boeing Vertol, Philadelphia, PA; Hughes Helicopter Co., Culver City, CA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: This program was initiated in 1972 in response to the appearance of the Soviet SA-7 infrared heat-seeking missile. IR suppression kits were produced for AH-1, UH-1, OH-58 and CH-6 aircraft which reduced IR signatures of the aircraft. These kits proved to be an effective countermeasure. From exploitation of captured missiles it was determined that the missile could home on solar energy reflected from the aircraft as well as heat emitted by the engine components. A low reflectance IR paint was developed to complement the suppressor. Definition of a development program for aircraft survivability systems to include ballistic protection was initiated in 1973. Advanced development was initiated/completed for hot metal plus plume suppression for the AH/UH, OV-1 and CH-47 aircraft. Developments were initiated to reduce the radar cross section of rotor blades. Efforts included investigations, designs and tests to reduce the ballistic vulnerability of flight controls, engines, transmissions and rotor blades to make them tolerant to hits by anti-aircraft weapons. Fabrication of low glare canopies for the OH-58 and AH-1 aircraft were completed. Design and fabrication of advanced instrumentation to support field testing of IR countermeasures under nap-of-the-earth conditions were initiated in FY 1976.

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.08.A Title Aircraft Survivability Concepts

2. FY 1977 Program: The "See Safe" and Helo air-to-air analysis conducted to determine the aircraft survivability equipment (ASE) requirements for US Army Security Agency special mission aircraft will be completed in FY 1977 resulting in a definitive development and production program for protective hardware. An extensive infrared (IR) field measurement program in support of on-going suppressor, jammer and decoy developments will be conducted. A program to develop and test low reflectance paint for desert and arctic conditions will be initiated. Models of high survivability tail booms and transmissions for the AH-1 helicopter will complete testing.

3. FY 1978 Planned Program: Measurements will be taken to fulfill the Development Test/Operational Test (DT/OT) II requirements for the AH/UH suppressors. Efforts initiated in FY 1977 for development of desert and arctic paint will continue. IR countermeasure effectiveness analysis and signature predictions of ASE equipment will continue.

4. FY 1979 Planned Program: The increase in the FY 1979 program will provide for reactivation of projects in ultraviolet/long wavelength infrared (UV/LWIR) and radar cross section (RCS) reduction, both deferred from FY 1977 and FY 1978 due to funding constraints. Other measurements and aircraft survivability definition efforts deferred from FY 1978 will be accomplished along with systems engineering contract support. The work in low reflectance paint, vulnerability reduction (especially against 30mm weapons) and laser countermeasures will continue.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.32.09.A

Title Air Mobility Support

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	5273	605	2700	3053	5979	Continuing	Not Applicable
DB31	Manufacturing Technology	0	0	0	290	700		
DB32	Ground Support Equipment	50	10	50	49	100		
DB33	Cargo Handling Equipment	354	130	150	49	350		
DB38	Reliability & Maintainability	909	130	0	0	0		
DB39	Flight Simulator Components	300	120	950	1414	1700		
DB66	Diagnostic & Inspection Equip	3260	115	485	0	1179		
D103	Helicopter De-icing/Anti-icing	0	0	425	550	1100		
D266	Airdrop Equipment & Techniques	400	100	640	701	850		

BRIEF DESCRIPTION OF ELEMENT: Program element supports advanced development of equipment, excluding aircraft, that supports the Army air mobility concept. The support equipment is applicable to Army aircraft as well as to Air Force aircraft in joint operations.

BASIS FOR FY 1978 RDTE REQUEST: Manufacturing Technology: Will develop and optimize manufacturing processes and techniques to assure cost effectiveness in the manufacturing of advanced development programs. Ground Support Equipment: Evaluation of off the shelf ground support equipment for military adaptability. Cargo Handling Equipment: Continue development of a container top-lift device. Reliability and Maintainability: Terminated in FY 1977. Synthetic Flight System Components: Will develop a wide angle laser scan system, study Computer Generated Imagery for helicopters and a 360° annular visual system. Will initiate advanced development of a flight simulation facility for systems integration and handling qualities research. Diagnostics: No effort in FY 1978. Helicopter Anti/De-icing: Develop and test anti-icing and de-icing systems for rotor blades, airframes and weapons systems. Airdrop: Continue development of ultra High Level Container Airdrop System (HLCADS). Complete prototype development to move the Staged Personnel Parachute to engineering development. Flight test the prototype for ramp delivery of airdrop bundles.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The DB31 project was initiated as a new start. The DB39 project was increased to support the advanced development of a rotorcraft systems integration simulator.

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.09.A Title Air Mobility Support

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	19	0	19
(2) Contractor Employees	24	0	24
Total	43	0	43

DETAILED BACKGROUND AND DESCRIPTION: This ongoing program develops and evaluates advanced development equipment that: enhances ground support; improves airdrop capability; adds fidelity to flight simulation components; and de-icing and anti-icing systems for helicopters. It contains the following projects: Ground Support Equipment: Studies and develops equipment to improve the servicing and maintenance of Army aircraft. Cargo Handling Equipment: Develops internal and external cargo handling equipment for aircraft. Flight Simulation Components: Develops advanced flight simulation components and systems for high fidelity flight simulation training systems, visual research simulation systems, systems integration and handling qualities research, and an advanced computer language keyed to nap-of-the-earth flight for day/night and adverse weather operations. Diagnostics and Condition Monitoring: Develops Automatic Diagnostic and Condition Monitoring systems designed to diagnose mechanical malfunctions and impending failures, reduce inspection time, permits conditional maintenance of components, reduces life cycle costs, and enhances safety of flight. Helicopter De-icing/Anti-icing: Develops and evaluates helicopter de-icing/anti-icing capability that permits helicopter flight in moderate icing conditions. Airdrop Equipment and Techniques: Develops selected methods of delivery of cargo and personnel from United States Air Force aircraft to include a high level container delivery system and air delivery of land mines. Generic efforts are also included in mechanical and textile prototype development of parachutes, air items, energy disipators and rigging devices.

RELATED ACTIVITIES: Aeronautical Technology, Program Element 6.22.09.A; Airdrop Technology, Program Element 6.22.10.A; Program Element 6.27.27.A, Non Systems Training Device Technology; Air Mobility Support Equipment, Program Element 6.42.04.A.

WORK PERFORMED BY: Singer-Link Corp., Binghamton, NY; United Technologies (Sikorsky Air-United Technologies (Sikorsky Air Craft)), Stratford, CN; Boeing Vertol, Morton, PA; Bell Helicopters, Hurst, TX; Hughes Helicopters, Culver City, CA; Lockheed Aircraft, Los Angeles, CA; AVCO Corp., Lycoming Division, Stratford, CN; General Electric Co., Lynn, MA; US Army Aviation Research and Development Command, AVRADCOM, St. Louis, MO; Eustis Directorate, Air Mobility Research and Development Laboratory, Ft. Eustis, VA; US Army Natick Research and Development Command (NARADCOM) Center, Natick, MA; Harry Diamond Laboratory, Washington, DC; US Army Training Devices Agency, Naval Training Equipment Center, Orlando, FL.

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.09.A Title Air Mobility Support

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Ground Support Equipment: Completed in-house evaluations of concepts for ground movement devices for helicopters and killed the program. Cargo Handling Equipment: Initiated development of a container top-lift device. Flight tested the external load stabilization system. Airdrop: Continued development of the High Level Container Airdrop System (HLCADS). Initiated development of a Bundle Delivery System for delivery of accompanying parachutist equipment from Air Force aircraft. Initiated development of a two stage personnel parachute system. Reliability and Maintainability (R&M): Completed advance fuselage reliability and maintainability investigations and simple inexpensive diagnostic tools. Initiated extended subsystem testing of the advanced rotor isolation, vibration test concept, and hydraulic distribution concept. Simulator Components: Initiated development of a laser scan visual system, established measures of simulator training effectiveness, and wide angle field of view studies. Diagnostics: Completed UH-1 diagnostics prototype tests and evaluated Utility Tactical Transport Aircraft System (UTTAS) and Advanced Attack Helicopter (AAH) diagnostics interface studies.

2. FY 1977 Program: Ground Support Equipment: Continue in-house evaluations of off the shelf material for helicopter ground support equipment for military adaptation. Cargo Handling Equipment: Continue development of a militarized container handling top lift device. Complete flight test of the external load stabilization system. Evaluate the US Air Force YC-14 Advanced Medium STOL Transport (AMST) prototype for potential utility. Airdrop Equipment: Continue development of the Bundle Delivery System and the staged personnel parachute system. Conduct a concept evaluation of high glide capacity personnel parachute. Continue design development of the Ultra High Level (altitude) Container Delivery System (UHLCADS). Flight Simulator Components: Start development of a wide angle laser scan system, a 360° annular visual system, evaluate Computer Generated Imagery for helicopters and continue field of view evaluations. Diagnostics: Evaluate the airline condition monitoring concepts and develop a hand-held oil filter monitor. Continue development of fatigue monitoring devices. Helicopter De-icing/Anti-icing: Evaluation of helicopter de-icing and anti-icing components will continue at the Ottowa, Canada, spray rig facility and in-flight icing test will be undertaken.

3. FY 1978 Planned Program: Manufacturing Technology: Efforts will be started to improve the manufacturing techniques and producibility of spiral bevel gears. Ground Support Equipment: Continue in-house evaluation of off the shelf equipment for military adaptability to the family of helicopters. Cargo Handling Equipment: Complete evaluation of the YC-14 and YC-15 AMST prototypes. Airdrop Equipment: Complete feasibility testing and prototype design for engineering development (ED) of the UHLCADS. Evaluate the staged personnel parachute and recommend design for ED. Continue development of the Bundle Delivery System. Flight Simulation Components: Continue development of the wide angle laser scan system, the 360° annular visual system and initiate a simulation programing language for Computer Generated Imagery. Initiate advanced development of the Rotorcraft Systems Integration Simulator based on results of previously completed exploratory development studies.

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.09.A Title Air Mobility Support

The ice-protected UH-1H helicopter will be used as a flying test bed to determine icing characteristics and evaluate ice protection equipment for other critical subsystems such as weapons, gunsights, guidance optics, and engine inlets. The increase in funding for FY 1978 over that in FY 1977 is to support the initiation of D&31, Manufacturing Technology, and to support the advanced development of the Rotorcraft Systems Integration Simulator for handling qualities and systems integration research.

4. FY 1979 Planned Program: Manufacturing Technology: The efforts in spiral bevel gears will continue and new efforts in composite rotor hub and composite structure and fasteners will be initiated. Cargo Handling Equipment: Complete design and fabricate test item for the Gondola system - conduct validation testing. Initiate internal restraint hardware design. Prepare for Advanced Medium STOL Transport full scale development testing efforts. Airdrop Equipment: Fabricate hardware for ground assembly aid and initiate validation testing. Complete prototype design of aircraft door bundles for engineering development (ED) and continue development of aircraft ramp bundle design. Support airdrop testing of the AMST. Diagnostic and Inspection Equipment: Development of a real time oil analysis capability will be initiated. Efforts to adapt commercial equipment and to improve the conventional diagnostic capability will be renewed. Helicopter De-icing/Anti-icing: Efforts to evaluate the microwave and vibration concepts of de-icing will be initiated. Flight Simulation Components: Research will continue on wide angle visual systems and computer generated imaging computational systems and programing language to meet the Army's needs for nap-of-the-earth flight simulation. The increase in funding for FY 1979 over that in FY 1978 is to support increased emphasis to the Manufacturing Technology program, to support new initiations in the Cargo Handling Equipment program, to provide for expanded efforts in Diagnostic and Inspection Equipment, and to support the evalation of two new concepts for helicopter de-icing.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.32.11.A

Title Advanced Vertical Take-Off and Landing (VTOL)

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES PROJECT LISTING: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	5282	1905	6328	2808	6000	Continuing	Not Applicable
DB41	Advanced Structures	1427	795	1830	775	1975	Continuing	Not Applicable
D157	Advanced Rotors/ Flight Control	3855	1110	4498	2033	4025	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The Army's advanced vertical take-off and landing (VTOL) advanced development program provides for the development and demonstration of a large scale aircraft components and subsystems for advanced rotor concepts and demonstration of improvements in rotary wing aircraft flight controls. This program provides for the development and demonstration of a second generation comprehensive helicopter analysis system for predicting leads, aeroelastic stability, stability and control, and performance for helicopters. Advanced structural technology will be developed and demonstrated that provide increased survivability, improved reliability and maintainability, lower weight and longer life.

BASIS FOR FY 1978 RDTE REQUEST: The request provides support for Rotor Systems Research Aircraft (RSRA) operations and advanced rotors, development of advanced flight control systems, in-flight simulator research, and planning for the second generation comprehensive helicopter analysis system. It supports development of advanced composite structures and multitubular spar rotor blades, development of an advanced composite hub and the evaluation of environmental effects on composite structures.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The decrease in FY 1978 funding results from a lower level of effort on Advanced Structures and Rotors/Flight Control.

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.11.A Title Advanced Vertical Take-Off and Landing (VTOL)

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	80	0	80
(2) Contractor Employees	12	0	12
Total	92	0	92

DETAILED BACKGROUND AND DESCRIPTION: The Advanced Vertical Take-off and Landing (VTOL) program provides for the development, verification, and demonstration of technology for areas currently restricting the success of Army airmobile systems. This continuing program is formulated on the basis that advances in state-of-the-art technology will only be made if technology is validated in component or system demonstration in actual or simulated flight conditions. The program includes efforts in rotors and control systems, and in the application of composite structures. The current program includes: advanced rotor technology, rotor and control improvements, and full scale evaluation of major composite structural components. Foreign state-of-the-art trends, potential threats to the present and future materiel systems throughout the Research and Development cycle have been considered.

RELATED ACTIVITIES: The technology being developed and demonstrated in this program is related to Navy, Air Force and National Aeronautics and Space Administration (NASA) programs. Coordination with these agencies and others is accomplished on a continuing basis through: program reviews; exchange of data sheets and reports; The Technical Cooperation Program; NASA Research and Technology Committees; North Atlantic Treaty Organization Standardization Agreements; and the Advisory Group on Aerospace Research and Development. This program is included in the Tri-Service Aeronautical Vehicle and Structures Technology Coordinating Papers. Efforts under this program are related to activities under Program Element 6.22.09.A, Aeronautical Technology; 6.32.09.A, Air Mobility Support; and 6.32.12.A, Tilt Rotor Research Aircraft as well as major Army aircraft systems development.

WORK PERFORMED BY: This work is accomplished in-house by the Army Air Mobility Research and Development Laboratory (AMRDL), Moffett Field, CA; AMRDL Ames Directorate, Moffett Field, CA; AMRDL Eustis Directorate, Ft. Eustis, VA; and AMRDL Langley Directorate, Hampton, VA. The top ten contractors are: Hughes Helicopters, Culver City, CA; Technology Incorporated, Dayton, OH; Sikorsky Aircraft, Stratford, CT; Honeywell, Minneapolis, MN; Lockheed-California, Burbank, CA; Boeing Vertol Company, Philadelphia, PA; Kaman Aerospace Corporation, Bloomfield, CT; Sperry Rand Corporation, Phoenix, AZ; Calspan, Buffalo, NY; and Bell Helicopter Textron, Ft. Worth, TX. Work is performed in related activities at the NASA Ames and Langley Research Centers.

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.11.A Title Advanced Vertical Take-Off and Landing (VTOL)

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: A fan-in-fin antitorque and directional control system was evaluated in flight test. A hydrofluidic stability augmentation system for light helicopters was developed and tested and a simulation control system for ground based and in-flight simulators was developed and tested. An all composite tail boom for the AH-1G was designed, ground tested, and successfully flight tested. Three advanced composite drive shafts were designed, fabricated and tested. The Advancing Blade Concept (ABC) research aircraft was designed, fabricated, and completed a 50 hour flight test in the helicopter mode. The Bearingless Main Rotor (BMR) program was initiated. A simulation control system for ground-based and in-flight simulators was developed, tested, and initially flown in a UH-1H research helicopter. An advanced composite multi-tubular spar (MTS) rotor blade design for improved survivability completed all laboratory whirl and flight tests. Flight tests of the MTS blades have demonstrated a 2 to 3 percent in helicopter hover performance. Design studies for an improved main rotor blade for the AH-1S helicopter were completed. These studies have led to a low rate initial production program for the AH-1S blades. A bearingless flexbeam tail rotor was qualified and flight tested, providing the basis for the designs of the tail rotors for both competitors in the Utility Tactical Transport Aircraft System (UTTAS) program.

2. FY 1977 Program: The Advancing Blade Concept (ABC) program will continue. Preliminary design of the Bearingless Main Rotor (BMR) will continue. Support will be provided for initial Rotor Systems Research Aircraft (RSRA) operations. The in-flight UH-1H simulator will be used to study helicopter handling qualities and Instrument Flight Rules (IFR) approach requirements and displays. Preliminary design studies of the second generation comprehensive helicopter analysis system will be performed and a final system specification prepared. Design studies for UH-1H and OH-58C helicopter composite structure rotor blades will be initiated. Environmental effects and durability of composite aft fuselage and composite multi-tubular spar blade will be evaluated. The structural integrity monitoring system will be installed in ten aircraft for demonstration and evaluation, and a design investigation of structural components for improved crash/impact load absorption will be initiated.

3. FY 1978 Planned Program: The program to evaluate the load and stability characteristics of the Bearingless Main Rotor (BMR) will continue.. Operation of the RSRA will be supported. The advanced flight control system concept feasibility/development program will continue as an in-house effort. The in-flight simulator will be used to perform tasks in the low-level night operation conditions. The evaluation of environmental effects on durability of advanced composite structures will continue. Additional capabilities will be evaluated for the structural integrity monitoring system. The UH-1H and OH-58C helicopter composite rotor blade programs will continue.

4. FY 1979 Planned Program: The flight evaluation of loads and stability characteristics of the BMR will be continued. The continuing operations of the Rotor Systems Research Aircraft will be supported. Development of the executive system and the primary modules of the second generation comprehensive helicopter analysis system will be initiated. Evaluation of environmental effects

on advanced composite structures will continue. Fabrication and flight test of an advanced composite rotor hub will be initiated. A contract program for the advanced flight control system concept feasibility/development program will be initiated. The UH-1H and OH-58C helicopter composite rotor blade programs will continue. Investigation of low-level night operation tasks with the in-flight simulator will continue. The increase in funding for the FY 1979 program over the FY 1978 program is due to the flight evaluation of the Bearingless Main Rotor System and the advanced development initiation of the comprehensive helicopter analysis system.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.32.11.A Title Advanced Vertical Take-Off and Landing (VTOL)

Project #D157 Title Advanced Rotor/Flight Controls

Category Advanced Development Budget Activity #2 - Advanced Technology Development

DETAILED BACKGROUND AND DESCRIPTION: The advanced vertical take-off and landing (VTOL) program provides for the development, verification, and demonstration of technology for areas currently restricting the success of Army airmobile systems. Technology validation through component or system demonstration in actual or simulated flight conditions is required to provide design criteria for future Army aircraft. This program is directly related to the Army's planned aircraft systems development program. The program encompasses: development and demonstration of large scale aircraft components and subsystems for advanced rotor concepts; demonstration of improvements in rotary wing aircraft flight controls; and development of second generation comprehensive helicopter analysis systems. The results of this program lead to improved mission capability, survivability, reliability, maintenance and cost effectiveness. Foreign technology trends, and potential threats to present and future materiel or systems throughout the R&D cycle have been considered.

RELATED ACTIVITIES: The technology being developed and demonstrated in this program is related to Navy, Air Force and National Aeronautics and Space Administration (NASA) programs. Coordination with these agencies and others is accomplished on a continuing basis through program reviews; exchange of data sheets and reports; The Technical Cooperation Program; NASA Research and Technology Committees; and North Atlantic Treaty Organization Standardization Agreements and the Advisory Group on Aerospace Research and Development. This program is included in the Tri-Service Aeronautical Vehicle Technology Coordinating Paper. Efforts under this program are related to activities under Program Elements 6.22.09.A, Aeronautical Technology; 6.32.09.A, Air Mobility Support; and 6.32.12.A, Tilt Rotor Research Aircraft as well as major Army aircraft systems developments.

WORK PERFORMED BY: This work is accomplished in-house by the Army Air Mobility Research and Development Laboratory (AMRDL), Moffett Field, CA; AMRDL Eustis Directorate, Ft. Eustis, VA; and AMRDL Langley Directorate, Hampton, VA. Contractors are: Sikorsky Aircraft, Stratford, CT; Honeywell, Minneapolis, MN; Lockheed-California, Burbank, CA; Boeing Vertol Company, Philadelphia, PA; Kaman Aerospace Corporation, Bloomfield, CT; Sperry Rand Corporation, Phoenix, AZ; Calspan, Buffalo, NY; and Bell Helicopter Textron, Ft. Worth, TX.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: A fan-in-fin antitorque and directional control system was evaluated in flight test confirming improved reliability, reduced maintenance, reduced hazard to ground personnel, and decreased vulnerability to contact at the expense of added power and weight. A hydrofluidic stability augmentation system was successfully developed and flight tested on an OH-58 helicopter to provide the Army with a highly reliable, survivable, maintainable, low-cost unit for light helicopters. Development of a simulation control system for ground-based and in-flight simulators which can vary aircraft stability

characteristics and simulate various guidance and control display concepts was undertaken. Initial flight checkout in a UH-1H was conducted after extensive ground checkout and simulation. The Advancing Blade Concept (ABC) research aircraft was designed, fabricated, and successfully demonstrated throughout the helicopter flight envelope in a 50 hour test program. Detail design of a Bearingless Main Rotor (BMR) was initiated in a program for full-scale flight demonstration of the concept which eliminates all flap, lag and feathering bearings from the rotor hub. Preliminary design studies for an advanced aero/acoustic rotor for the Rotor Systems Research Aircraft (RSRA) were undertaken. An advanced composite multi-tubular spar (MTS) rotor blade design for improved survivability completed all laboratory whirl and flight tests. Flight tests of the MTS blades have demonstrated a 2 to 3 percent in helicopter hover performance. Design studies for an improved main rotor blade for the AH-1S helicopter were completed. These studies have led to a low rate initial production program for the AH-1S blades. A bearingless flexbeam tail rotor was qualified and flight tested, providing the basis for the designs of the tail rotors for both competitors in the Utility Tactical Transport Aircraft System (UTTAS) program.

2. FY 1977 Program: The Advancing Blade Concept (ABC) program will continue. Work will continue on the fabrication and component test of the Bearingless Main Rotor (BMR). Support of operations of the RSRA will commence during this year. Preliminary design studies of advanced control systems concepts will be performed. The in-flight UH-1H simulator will be used to study handling qualities and Instrument Flight Rules (IFR) approach procedures and displays. Work will continue on a similar simulator control system for the XV-15 Tilt Rotor Research Aircraft. Design studies for UH-1H and OH-58C helicopter composite structure rotor blades will be initiated.

3. FY 1978 Planned Program: The program to evaluate the loads and stability characteristics of the Bearingless Main Rotor (BMR) system will continue. Support for initial operations of the RSRA will be provided. The advanced flight control system concept feasibility/development program, which evaluates flight control concepts against mission requirements will continue as an in-house effort and a contract program will be initiated. The in-flight simulator will be used to perform tasks in the low-level night operation condition to evaluate nap-of-the-earth, non-terminal approach to hover and landing, and evasive flight conditions. The UH-1H and OH-58C helicopter composite rotor blade programs will continue.

4. FY 1979 Planned Program: The flight evaluation of the BMR system will be continued. Operations of the RSRA will be supported and baseline data on the delivered rotor will be obtained. The advanced flight control system will continue. Flight evaluations using the in-flight simulator in the nap-of-the-earth environment will continue. Development of the second generation comprehensive helicopter analysis system will be initiated. The increase in funding for the FY 1979 program over the FY 1978 program is due to the flight evaluation of the BMR system and the advanced development initiation of the comprehensive analysis system executive routine.

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.11.A Title Advanced Vertical Take-Off and Landing (VTOL)

Project #D157 Title Advanced Rotor/Flight Controls

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	3855	1110	4498	2033	4025	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.32.12.A

Title Tilt Rotor Research Aircraft

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	3315	900	2574	871	900	0	*21,800
DB74	Tilt Rotor Research Aircraft	3315	900	2574	871	900	0	*21,800

*Like amount provided by National Aeronautics and Space Administration (NASA)

BRIEF DESCRIPTION OF ELEMENT: This joint Army/NASA program is to demonstrate the tilt rotor concept through flight testing of the XV-15 Tilt Rotor Research Aircraft to verify that tilt rotor technology will allow subsequent development of an operational tilt rotor aircraft.

BASIS FOR FY 1978 RDTE REQUEST: The funds requested for FY 1978 provide for the completion of the basic proof of concept program, including contractor and government flight testing.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Funding in FY 1978 is reduced because contractor fabrication and testing is expected to be essentially complete.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is a follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	12	0	12
(2) Contractor Employees	10	0	10
Total	22	0	22

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.12.A Title Tilt Rotor Research Aircraft

DETAILED BACKGROUND AND DESCRIPTION: The tilt rotor aircraft combines the hover efficiency and maneuverability of the helicopter with the performance and productivity of a fixed wing turboprop aircraft to meet anticipated future Army air mobility and civil aviation requirements. The program is considered essential in the evolution of a prototype tilt rotor aircraft, making possible research well beyond the "demonstration of feasibility." The research aircraft will be used for investigations throughout the tilt rotor flight envelope of aerodynamics, dynamics, structural and environmental characteristics, military mission compatibility, aircraft handling qualities, Vertical/Short Take-Off and Landing (V/STOL) characteristics, and near terminal operational procedures. In addition, completion of the proof-of-concept flight testing will provide a proven Vertical Take-Off and Landing (VTOL) aircraft with a wide transition corridor for general research and development of VTOL terminal operations and traffic control, including evaluation of automatic guidance systems, and handling qualities research.

RELATED ACTIVITIES: The Department of the Army and the National Aeronautics and Space Administration (NASA) initiated a joint research program to develop the technology for tilt rotor vehicles. In view of the need for technology and operational data to support development of civil and military vehicles with VTOL capability, the Army and NASA have agreed by Memorandum of Agreement, that the combined objectives are best served by the conduct of a joint Army/NASA tilt rotor research aircraft program. The US Air Force, US Navy, and US Marine Corps are actively monitoring the program and participating in the periodic reviews. The Department of Transportation and the Federal Aviation Agency are monitoring agencies to the program with interest displayed in the transportation/navigation/avionics area. Related technology in exploratory development under Program Element 6.22.09.A (Aeronautical Technology) and in advanced development under Program Element 6.32.11.A (Advanced VTOL) supports the research and technology efforts in this program.

WORK PERFORMED BY: US Army Air Mobility Research and Development Laboratory and the NASA/Ames Research Center, Moffett Field, CA; and Bell Helicopter Textron, Fort Worth, TX. Major subcontractors include: Rockwell International, Tulsa, OK; Calspan Corporation, Buffalo, NY; AVCO Lycoming, Stratford, CT; Hydraulic Research Textron, Valentia, CA; SPECO Division, Kelsey-Hayes, Springfield, OH; Rockwell International-Columbus, Columbus, OH.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: A systematic approach for advancing tilt rotor technology has been pursued jointly by the Army and NASA over the past nine years. Certain fundamental criteria are essential in considering application of any advanced technology to Army aircraft systems requirements. These criteria include: relatively long hover time with good efficiency and low downwash velocities, low noise levels, and nap-of-the-earth maneuverability and agility with sufficient dash speed for increased effectiveness. The Army and NASA concluded in the mid-1960's that the tilt rotor concept satisfied these criteria better than any other known VTOL concept. These conclusions led to research and testing of aeroelastically scaled rotors and of a twenty-five foot flightworthy rotor in the Ames 40 X 80 foot wind tunnel. Success of these tests led the Army and NASA to the next

logical step, which was flight demonstration for "proof-of-concept". In 1972, based upon the completion of preliminary design studies, a Request for Proposal (RFP) was released to industry for Phase I of the program which included detail analysis, refined preliminary design, and program planning for the follow-on Phase II program. Industry responses to the Request for Proposal were evaluated and Bell and Boeing-Vertol were selected to conduct the three month Phase I effort in October 1972. The proposals for Phase II were submitted in January 1973, and in April Bell was selected by a joint Army/NASA Source Evaluation Board. The full Phase II program was approved in September 1973. The engineering design, material procurement and tooling efforts for the design, fabrication, and test of the research aircraft continued through FY 74. Manufacturing and assembly of components were initiated, as were component development and systems tests. By the end of FY 74, all major subcontracts were awarded and two additional simulations of the aircraft using the Flight Simulator for Advanced Aircraft (FSAA) were completed. Supporting research and technology efforts during the period included preparation of full scale rotor tests in the 40 X 80 foot wind tunnel and continued analysis of the flight control system. In FY 75, one additional simulation of the XV-15 was completed on the Flight Simulator for Advanced Aircraft. The Final Design Review was completed by mid FY 75 and 98 percent of the drawings were released during the year. The majority of the tooling was completed and detail parts fabrication was initiated for the wing, blades, hubs, nacelles, primary controls, and fuselage. Final assembly of the fuselage progressed. The Automatic Flight Control System (AFCS) was completed. In FY 76 engines and fuselages for both aircraft were delivered by major subcontractors. Fabrication of detail parts was virtually completed. Qualification testing of components and assemblies was completed. Emergency egress system tests and full scale rotor tests were 95 percent completed. By the end of FY 7T period, final assembly of Aircraft Number 1 was 95 percent complete and Aircraft Number 2 was 30 per cent complete.

2. FY 1977 Program: Complete integrated systems tests and rollout of both Aircraft. Complete first hover flight in the second quarter and full scale wind tunnel test in the Ames 40 X 80 foot wind tunnel in the third quarter. Conduct last scheduled simulation for pilot procedural training prior to first flight. Begin contractor flight tests with Aircraft Number 2 and deliver Aircraft Number 1 to the government in the fourth quarter.

3. FY 1978 Planned Program: Conduct government proof-of-concept flight test program to assess performance, stability and control, handling qualities, characteristics, and dynamic structural stability of the XV-15 to satisfy program objectives of assessing tilt rotor technology for future operatonal aircraft. Complete contractor flight testing and deliver Aircraft Number 2 to the government in the fourth quarter. Funding in FY 1978 is decreased because contractor fabrication and testing is expected to be essentially complete.

4. FY 1979 Planned Program: Military mission suitability tests will be conducted based upon results of the proof-of-concept and contractor flight testing. The tests will be conducted within the established flight envelope to determine the capability of the aircraft to perform selected military mission profiles.

5. Program to Completion: Program is expected to be completed in FY 1979.

Budget Activity #2 - Advanced Technology Development

Program Element #6.32.12.A Title Tilt Rotor Research Aircraft

6. Major Milestones:

		Date	Estimated RDTE Cost to Reach Events (Cumulative)
a.	Phase I Design Contracts	October 1972	500
b.	Phase II Fabrication/Test Contracts	August 1973	1500
	- Final Design Review	December 1974	5800
	- Rollout Number 1 Aircraft	October 1976	16956
	- First Hover Flight	2 Qtr FY 77	17236
	- Wind Tunnel Test	3 Qtr FY 77	17565
	- Begin Contractor Flight Tests	4 Qtr FY 77	18840
	- Deliver Aircraft Number 1	4 Qtr FY 77	18840
	- Deliver Aircraft Number 2	4 Qtr FY 78	20000
c.	Complete Initial Flight Research	1 Qtr FY 79	20900
d.	Complete Military Mission Suitability Testing	4 Qtr FY 79	21800

MAJ Stephenson/A. Brown
DAMA-CSM/55594/TR 96-76

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.33.06.A

Title Terminal Homing Systems

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	3385	22	3000	4841	10500	Continuing	Not Applicable
D070	Long Range Prec Desig	2785	22	1000	0	0	Not Applicable	Not Applicable
D236	Artillery Terminal Guidance	600	0	2000	4841	10500	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program element consists of one project. Artillery Terminal Guidance is structured to further the development of advanced terminal homing systems for application to both cannon and rocket/missile delivery means. Principal effort is the development of a passive infrared seeker. Other efforts include development of a dual mode semi-active laser/ terminal infrared homing system for application to the COPPERHEAD (Cannon Launched Guided Projectile) and continued investigation of the feasibility and utility of other concepts.

BASIS FOR FY 1978 RDTE REQUEST: Fabrication of three complete infrared seekers by each of two competitive contractors. Laboratory and captive flight testing of these seekers to demonstrate their ability to perform the automatic search, acquisition, discrimination and tracking functions. Conduct infrared (IR) systems simulations and systems analysis for application to both projectiles and rockets/missiles. Conduct measurements of infrared target, background and clutter signatures. Laboratory and flight test of three feasibility models of the dual mode seekers.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Efforts during FY 1977 were centered on the design and fabrication of the infrared clutter test sensor. The FY 1978 effort will integrate this sensor into a full-up design and fabrication of infrared seekers for the automatic search, acquisition, discrimination and tracking of infrared targets.

Budget Activity #2 - Advanced Technology Development

Program Element #6.33.06.A Title Terminal Homing Systems

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	21	0	21
(2) Contractor Employees	35	0	35
Total	56	0	56

BACKGROUND AND DISCUSSION: A requirement exists to provide field artillery cannon and missile/rocket units with terminally guided munitions which are capable of homing on and destroying stationary and moving hard point targets at long ranges and under conditions of terrain and weather where active target designation is not possible. The Artillery Terminal Guidance Project is the non-systems oriented consolidation of the development effort within the program. Primary emphasis has been placed upon the development of a passive infrared seeker which will acquire and home on the infrared signatures of tanks and other tactical targets in a wide variety of backgrounds and atmospheric conditions. This is a non-systems oriented development which has been structured to provide a passive infrared seeker which will have application to both cannon projectile and missile/rocket delivery systems. The second major effort in this program consists of the development of a dual mode (semi-active laser/terminal infrared) homing system for application to the COPPERHEAD (Cannon Launched Guided Projectile). The concept definition of the dual mode seeker will be evaluated to serve as the basis for the design and fabrication of a non-hardened seeker for laboratory and captive flight tests. Investigations into the feasibility of other advanced techniques such radio-frequency homing, and millimeter wave homing are also being conducted.

RELATED ACTIVITIES: The Artillery Terminal Guidance Project (D236) is the consolidation of two previous project: Dual Mode Seeker (DF27) and Terminal Guided Submissiles (D086).

WORK PERFORMED BY: In-house work is being performed by the US Army Missile Research and Development Command, Huntsville, Alabama and the US Army Armaments Research and Development Command, Rock Island, Illinois. Competitive contracts for the development of the infrared seeker have been awarded to General Dynamics, Pomona, CA and Raytheon, Bedford, MA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Evaluation of proposals for the passive infrared seeker and the award of competitive development contracts to General Dynamics and Raytheon.

Budget Activity #2 - Advanced Technology Development

Program Element #6,33,06.A Title Terminal Homing Systems

2. FY 1977 Program: Design, fabrication and test of a passive infrared sensor that will demonstrate the capability to acquire and discriminate tactical targets in a variety of background environments and that will reject false targets.

3. FY 1978 Planned Program: Integrate the passive infrared sensor with signal processors into a full-up infrared seeker. Fabricate three seekers by each of two competitive contractors that will perform the automatic search, acquisition, discrimination and tracking functions. Preparation of a design package for a full-up seeker which will be optimized for application to specified delivery vehicles (e.g., General Support Rocket System, COPPERHEAD). Conduct laboratory and flight tests of feasibility models of the dual mode seeker for application to cannon projectiles. Funding increase in FY 1978 over FY 1977 is attributable to the design, fabrication and testing of all-up infrared seekers to include the electronics for signal processing.

4. FY 1979 Planned Program: Fabrication of 20 full-up, flight worthy seekers for application to and testing with the delivery vehicles for which designed. Four dual mode seekers which have been hardened and are flightworthy will be fabricated and integrated into the COPPERHEAD projectiles for testing and finalization of the full-up design. The increase in funding required from FY 1978 to FY 1979 is due to the fabrication of appropriately hardened and flightworthy seekers for application to and testing with the intended delivery system.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.33.13.A Title Missile/Rocket Components

Category Advanced Development Budget Activity #2- Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	8196	550	4892	4210	9500	Continuing	Not Applicable
D087	Missile Rocket	5396	550	4000	968	3500	Continuing	Not Applicable
D142	Tri-Service Fire and Forget RF Seeker	0	0	0	1162	1700	Continuing	Not Applicable
D691	Advanced Munitions	2800	0	892	2080	4300	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program provides feasibility demonstrations of technology advancements in various missile and rocket system components such as propulsion, guidance and control, and warheads. It obtains experimental prototype data necessary to prepare a Required Operational Capability for new rocket and missile components. The program determines storage reliability of missile components. Development of tactical software verification and validation techniques are also included. This program element investigates methods of providing increased effectiveness and other improvements in Missile/Rocket nonnuclear munitions. Efforts are concentrated in three areas: Antimateriel Munitions; Antiarmor Munitions and Air Defense Munitions. This program element also provides the Army's portion of an active Radio Frequency (RF) seeker technology demonstration by the three Services.

BASIS FOR FY 1978 RDTE REQUEST: Continue storage reliability investigations, complete fabrication and test of the hemispheric coverage antenna, continue tactical software investigations, continue antiarmor and antimateriel munitions developments for use in missiles and rockets and continue support of the Tri-Service active RF seeker effort.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Decrease results because hardware deliveries of hemispheric coverage radar (HCA) are to be completed in FY 1977 and the HCA is scheduled to undergo testing.

Budget Activity #2 - Advanced Technology Development

Program Element #6.33.13.A Title Missile/Rocket Components

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1977 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ Employees	99	0	99
(2) Contractor Employees	44	0	44
Total	143	0	143

DETAILED BACKGROUND AND DESCRIPTION: This program element contains three projects: Missile/Rocket Components, a Tri-Service active Radio Frequency (RF) seeker technology demonstration, and Missile/Rocket Munitions. There are four efforts conducted under this Program Element: (1) Development of a 360° hemispheric coverage antenna for advanced surface-to-air air missile systems; (2) Generation of techniques and procedures to accurately predict the storage reliability potential of missile system components and associated materials; (3) Demonstration of an active RF fire and forget seeker; (4) Investigate new and more complex shaped charge lethal mechanisms directed towards defeat of projected future armor.

RELATED ACTIVITIES: This Program Element is related to efforts conducted in Program Element 6.23.03.A, Missile Technology, PE 6.26.03, Armaments Technology, PE 6.26.16, Fuzes Technology, PE 6.26.17, Munitions, and PE 6.33.58.N, Weaponizing (Prototype)

WORK PERFORMED BY: US Army Missile Research and Development Command, Huntsville, Alabama; US Army Armament Research and Development Command, Dover, New Jersey; and US Army Materiel Systems Analysis Agency, Aberdeen, Maryland. Contractors are Sperry Gyroscope, Raytheon, McDonnell Douglas, Martin Marietta, and Motorola.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments:

The Hemispheric Coverage Antenna (HCA) was initiated in FY 1974. A cost plus fixed fee, sole source contract was awarded to Sperry Gyroscope in November 1973 for the design, fabrication, and testing of the antenna. The conceptual design of the antenna was completed and approved in March 1974. The Storage Reliability of Missile Components program was initiated and three contracts were awarded, two to Raytheon, and one to McDonnell Douglas to study reliability of PATRIOT semi-conductor devices and collection and analysis of storage reliability of all classes of missile materiel. The Advanced Munitions project commenced in FY 1971. A Tri-Service seeker effort was determined to be a potentially beneficial joint undertaking and monitorship commenced. Submissile Release and Dispersion Methods were investigated. Sled ejection tests and flight demonstrations were conducted with LITTLE JOHN

rocket test vehicles to demonstrate complete warhead section performance under representative flight conditions. A Munition Delivery System effort was directed towards development of a lethal antiarmor mechanism. Static ejection tests were conducted; fuze designs were completed and drop tests were conducted. A focused blast fragmentation task was initiated. Antimaterial warhead efforts were initiated with technology transfer to the improved Nonnuclear LANCE and General Support Rocket System programs.

The Storage Reliability Effort consisted of coordination and management of the three contract efforts initiated in FY 1974. The first is for microelectronic and semiconductor devices representative of the components being designed into on-going air defense systems, a second contract is for a specifically designed, accelerated test and analysis program to determine the storage reliability of solid state devices. The third contract is for collection of existing storage reliability data on a wide variety of missile materiel. Hardware purchased under the contracts was delivered in 3d and 4th Qtr FY 1975. In-house efforts consisted of the planning for the establishment of the Storage Reliability Data Bank and the initiation of testing of PATRIOT devices by McDonnell Douglas. The Hemispheric Coverage Antenna conceptual design was completed and approved. Safe and arming devices were designed, fabricated, and tested. A Preliminary Fuze concept evaluation was completed.

Fabrication of the Hemispheric Coverage Antenna (HCA) was initiated. The antenna consists of a planar phased array containing about 4500 elements covered by a dome containing about 22,000 passive phasers, a beam steering unit, a monopulse receiver and recorders required for testing. Storage reliability of missile materiel continued with accelerated testing and data analysis related to PATRIOT components. The Storage Reliability Data Bank was put into full operation. In-house failure analysis was expanded utilizing SAFEGUARD integrated circuit packages. Data on SPRINT and MINUTEMAN was collected and analyzed. Storage Prediction Methodology for STINGER, HELLFIRE, and CLGP were developed.

2. FY 1977 Program: Expansion and increased utilization of the Storage Reliability Data Bank will be accomplished, contractual efforts initiated during FY 1976 will be completed, and results incorporated into the data bank. A follow-on contract effort is planned for applying the developed storage reliability prediction methodology to one or more of the new systems under development (STINGER, HELLFIRE, PATRIOT). Continuation of the in-house efforts in failure analysis is planned with expansion of the effort into areas other than microelectronics and materials. The effort planned for the HCA is completion of antenna fabrication followed by testing to determine its performance characteristics. These tests will include pattern measurements, side-lobe levels, gain, beamwidths, and pointing accuracy. Initiation of the testing is scheduled for July 1977. Follow-on efforts will concentrate on developing and integrating a transmitter to drive the antenna. A broad front investigation of tactical software will be conducted in five major thrust areas (requirements, analysis, software design, support software design, Quality Assurance, and Reliability). These investigations will be used to determine solutions to be implemented in a laboratory environment for verification. Specific topics for investigation are: Specification language, structured programing, general purpose simulation of subsystems, reliable programing practices, software instrumentation validation and reliability measures, proof of correctness, automatic test data generation, redundancy, and recovery. In-house and other agency investigations will be combined into a program that is focused towards air defense and land combat tactical software. An antiarmor munitions program will be initiated to develop new and more complex shaped charges for attack of future armor. A prototype weaponized warhead will be demonstrated in static firing tests.

Budget Activity #2 - Advanced Technology Development

Program Element #6.33.13.A Title Missile/Rocket Components

3. FY 1978 Planned Program: The Hemispheric Coverage Antenna (HCA) will be field tested and data analyzed. The Tri-Service active Radio Frequency (RF) seeker technology demonstration effort will continue leading to captive flight demonstration in late FY 1978 or early FY 1979. Antiarmor munition concept designs will be advanced to functional baseline configuration and testing begun. The storage reliability program will continue.

4. FY 1979 Planned Program: Potential system application for the Hemispheric Coverage Radar will be investigated based on test results in FY 1978 and integration with a transmitter begun. Tri-Service active RF seeker program will essentially be completed and system applications will be investigated. Antiarmor munition component interfacing will be completed to establish an integrated warhead and fuzing system functional baseline. The storage reliability program will continue.

5. Program to Completion: These programs, except the Tri-Service active RF seeker, are continuing efforts. Missile Component Reliability investigations will be continued, expanded, an refined. The HCA will be integrated with a transmitter to demonstrate a 360° phased array radar. The antiarmor effort will continue with a goal of developing a more lethal, lighter weight, antiarmor munition.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.33.13.A Title Missile/Rocket Components

Project #D087 Title Missile/Rocket Components

Category Advanced Development Budget Activity #2- Advanced Technology Development

DETAILED BACKGROUND AND DESCRIPTION: This project contains three tasks: (1) Development of a hemispheric coverage antenna (HCA) for advanced surface-to-air air missile systems; (2) Generation of techniques and procedures to accurately predict the storage reliability potential of missile system components and associated materials; and (3) Development of software for an interactive computer system analyzer to aid in software verification and validation in the concept validation and advanced development phases of system development.

RELATED ACTIVITIES: This Program Element is related to efforts conducted in Program Element 6.23.03.A, Missile Technology.

WORK PERFORMED BY: US Army Missile Research and Development Command, Huntsville, Alabama. Contractors are Sperry Gyroscope, Raytheon, McDonnell Douglas, and Martin Marietta.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments:

The Hemispheric Coverage Antenna (HCA) program was initiated in FY 1974. A cost plus fixed fee, sole source contract was awarded to Sperry Gyroscope in November 1973 for the design, fabrication, and testing of the antenna. The conceptual design of the antenna was completed and approved in March 1974. The Storage Reliability of Missile Components program was initiated and three contracts were awarded, two to Raytheon, and one to McDonnell Douglas to study reliability of PATRIOT semi-conductor devices and collection and analysis of storage reliability of all classes of missile materiel.

The Storage Reliability Effort consisted of coordination and management of the three contract efforts initiated in FY 1974. The first is for microelectronic and semi-conductor devices representative of the components being designed into on-going air defense systems, a second contract is for a specifically designed, accelerated test and analysis program to determine the storage reliability of solid state devices. The third contract is for collection of existing storage reliability data on a wide variety of missile materiel. Hardware purchased under the contracts was delivered in 3d and 4th Qtr FY 1975. In-house efforts consisted of the planning for and the establishment of the Storage Reliability Data Bank and the initiation of testing of PATRIOT devices by McDonnell Douglas. The HCA conceptual design was completed and approved. Detailed design laboratory verification of components was completed and approved.

Fabrication of the HCA was initiated. The antenna consists of a planar phased array containing about 4500 elements covered by a dome containing about 22,000 passive phasers, a beam steering unit, a monopulse receiver and recorders required for testing.

Budget Activity #2 - Advanced Technology Development

Program Element #6.33.13.A Title Missile/Rocket Components

Project #D087 Title Missile/Rocket Components

Fabrication is to be completed in January 1977. Storage reliability of missile materiel continued with accelerated testing and data analysis related to PATRIOT components. The US Army Missile Research and Development Command Storage Reliability Data Bank was put into full operation. In-house failure analysis was expanded utilizing SAFEGUARD integrated circuit packages. Data on SPRINT and MINUTEMAN will be collected and analyzed. Storage Prediction Methodology for STINGER, HELLFIRE, and Cannon Launched Guided Projectile were developed.

2. FY 1977 Program: Expansion and increased utilization of the Storage Reliability Data Bank will be accomplished, contractual efforts initiated during FY 1976 will be completed, and results incorporated into the data bank. A follow-on contract effort is planned for applying the developed storage reliability prediction methodology to one or more of the new systems under development (STINGER, HELLFIRE, CLGP). Continuation of the in-house efforts in failure analysis is planned with expansion of the effort into areas other than microelectronics and materials. The effort planned for the hemispheric coverage antenna (HCA) is completion of antenna fabrication followed by testing to determine its performance characteristics. These tests will include pattern measurements, sidelobe levels, gain, beamwidths, and pointing accuracy. Initiation of the testing is scheduled for July 1977. Follow-on efforts will concentrate on developing and integrating a transmitter to drive the antenna. A broad front investigation of tactical software will be conducted in five major thrust areas (requirements, analysis, software design, support software design, Quality Assurance, and Reliability). These investigations will be used to determine solutions to be implemented in a laboratory environment for verification. Specific topics for investigation are: Specification language, structured programming, general purpose simulation of subsystems, reliable programing practices, software instrumentation validation and reliability measures, proof of correctness, automatic test data generation, redundancy, and recovery. In-house and other agency investigation will be combined into a program that is focused towards air defense and land combat tactical software.

3. FY 1978 Planned Program: Conduct extensive tests and analyses of the Hemispheric Coverage Radar. Continue the storage reliability program. Decrease because hardware delivered in FY 1977 is undergoing comprehensive testing.

4. FY 1979 Planned Program: Potential system application for the Hemispheric Coverage Radar will be investigated based on test results in FY 1978 and integration with a transmitter begun. Continue storage reliability program.

5. Program to Completion: These programs are continuing efforts. Missile Component Reliability investigations will be continued, expanded, and refined. The HCA will be integrated with a transmitter to demonstrate a 360° phased array radar.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	5396	550	4000	968	3500	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.33.13.A Title Missile/Rocket Components

Project #D691 Title Advanced Munitions

Category Advanced Development Budget Activity #2 - Advanced Technology Demonstration

DETAILED BACKGROUND AND DESCRIPTION: The objective of this project is to investigate entirely new concepts of shaped charge lethal mechanisms for High Explosive Anti-Tank (HEAT) weapons. The investigation shall be directed toward providing the capability of defeating projected future armor. The investigation will involve high density base metals and alloys of high density for shaped charge liners and the formulation of high energy explosive compositions, tailored to optimum performance matching with new liner materials. The major activity of this program will be applying this technology to munitions for future major weapon system programs.

RELATED ACTIVITIES: This project is related to Program Element 6.26.17.A, Munitions Technology, and Program Element 6.26.18.A, Ballistics Technology, where non-nuclear warhead exploratory development is conducted to assess feasibility of advanced munition concepts.

WORK PERFORMED BY: The in-house work is performed by the US Army Armament Research and Development Command, Dover, New Jersey; and the US Army Materiel Systems Analysis Agency, Aberdeen, Maryland. Contractors are unidentified at this time.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Advanced munitions efforts prior to FY 1977 consisted of detailed study, design, testing and analysis of advanced concepts that could lead to technology that is transferrable to weapon system integration. Notable efforts included investigation and testing on focused blast fragmentation warheads for surface-to-air missiles, design and fabrication of improved antimateriel warheads for surface-to-surface missiles and early investigations of kinetic and chemical energy armor defeating mechanisms. The anti-tank munitions work described in this summary was initiated in FY 1977 and is directed toward defeat of the armor of the 1980's.

2. FY 1977 Program: The engineering effort shall include concept evaluation, feasibility confirmation and munition design analysis. It is expected that the most effective lethal mechanisms shall be identified in the 6.2 activity. Anti-armor munition designs shall be formulated to adapt and apply the concept technology for future weapon systems. A limited quantity of selective testing shall be conducted to evaluate critical performance and effectiveness capabilities of the candidate munition designs.

Budget Activity #2 - Advanced Technology Demonstration

Program Element #6.33.13.A Title Missile/Rocket Components

Project #D691 Title Advanced Munitions

3. FY 1978 Planned Program: Proven anti-armor munition concept designs shall be advanced to functional base line configuration status. Functional performance characteristics shall be designed in conformance with designated weapon system operational and non-operational environmental performance parameters. Component qualification Development Tests/Operational Tests shall be conducted in accordance with Army acquisition policy requirements. The increased funding level over FY 1977 is required to support the extensive test program for component qualification and the continuing activity in weaponizing advanced countermeasure munitions for direct and indirect fire against armor and other hard point targets.

4. FY 1979 Planned Program: Component interfacing shall be completed to establish an integrated warhead and fuzing system functional base line technical data package to meet the design requirements of the designated weapon system. The increase in funding requirements over FY 1978 reflect acquisition cost of warhead and fuzing system test hardware and the cost of dynamic testing on the sled track and the weapon system vehicle. Munition design activity will continue in the weaponization of lethal mechanism concepts for direct and indirect fire against armor and other hard point targets. Applicable functional base line technical data documentation and integrated system engineering data shall be formulated for designated future weapon systems.

5. Program to Completion: Continue munition design, test and evaluation activities to qualify and exploit effective lethal mechanisms conceived and formulated in the exploratory development program. Establish base line designs, functional performance requirements and weapon systems integration applicable to designated future weapon systems. In all such activities all of the necessary experimental work shall be performed, tested and validated to demonstrate that the proposed system is ready for full scale development.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	2800	0	892	2080	4300	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.33.14.A

Title High Energy Laser Components

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	26,000	8,200	21,000	13,749	20,975	Continuing	Not Applicable
D093	High Energy Laser Components	26,000	8,200	21,000	13,749	20,975	Continuing	Not Applicable
Military Construction		259	0	0	33,499[1/]	6,394	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program has three major thrusts: (1) Expansion (in concert with other Services and the Defense Advanced Research Projects Agency) of the High Energy Laser (HEL) technology base; (2) Exploration of HEL Weapon System (HELWS) potential for a variety of Army Roles and Missions; (3) Verification (in concert, where possible, with the other Services) Army applications.

BASIS FOR FY 1978 RDTE REQUEST: Previous efforts focused on development of the HEL technology base. The Army has concentrated both baseline Applied Technology and Special Laser Technology Development Program (SLTDP) funding on the

1/ Total MILCON funding for the DOD High Energy Laser Systems Test Facility (HELSTF) which supports the HEL programs of all three Services.

Budget Activity #2 - Advanced Technology Development

Program Element #6.33.14.A Title High Energy Laser Components

BASIS FOR CHANGE IN FY 1978 OVER FY 1977

PERSONNEL IMPACT:

The average number of employees supported with the requested FY 1978 funds (RDTE and Procurement) is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	[ ]	[ ]	[ ]
(2) Contractor Employees			
Total			

DETAILED BACKGROUND AND DESCRIPTION: A High Energy Laser Weapon System (HELWS) has several unique generic properties: (1) small beam divergence - (2) speed of light delivery - (3) rapid engagement of threat; (4) low "ammunition" (fuel) mass per shot - allows a large number of stored shots (large magazine). These properties, in conjunction with an ability to switch rapidly between threats, also give the HELWS great potential Comprehensive mission analyses will further evaluate HELWS potential. The FY 1978 program will focus mainly on laser device technology, Other technologies under development include Beam Control Device (Pointer/tracker, fire control system, and command/control system). Also included is evaluation of laser radiation transmission and interaction with materials and components.

RELATED ACTIVITIES: Complementary programs to expand the technology base and evaluate High Energy Laser effectiveness are being carried on by the Air Force, Navy and the Defense Advanced Research Projects Agency (DARPA). The different battle environments and HEL platforms for each Service result in significantly different technology requirements. The Service programs are closely coordinated by the Office of the Director of Defense Research and Engineering through quarterly meetings of the High Energy Laser Review Group (HELRG). This coordination extends to the working levels both through meetings of HELRG panels dealing with specific topics and through conferences, meetings and symposia, as well as through interservice programs such as the Unified Navy Field

Test Program (UNFTP). In addition, by direction of the Deputy Secretary of Defense, a Department of Defense Special Laser Technology Development Program (SLTDP) was established in FY 1975.

Technical coordination for the SLTDP is provided by DARPA. In prior years, Army HEL development was funded under program elements 6.21.38.01.A (High Energy Laser Research), 6.23.03.A (High Energy Laser Research), 6.26.03.A (High Energy Laser Research), 6.26.09.A (Project Eighth Card), 6.26.12.A (Project Eighth Card), 6.27.03 (High Energy Laser Research), 6.27.05 (High Energy Laser Research), 6.26.21.A (Laser Technology and Applications), and 6.36.11 (High Energy Laser Development, Advanced Laser Development, and Project Eighth Card).

WORK PERFORMED BY: The top ten contractors are: Avco Everett Research Lab., Everett, MA; TRW Systems Group, Redondo Beach, CA; Rockwell International Corp., Canoga Park, CA; Bell Aerospace Company, Buffalo, NY; Pratt & Whitney Aircraft, West Palm Beach, FL; General Electric Company, Philadelphia, PA; Hughes Aircraft Company, Culver City, CA; Lockheed Missile & Space Company, Inc., Palo Alto, CA; RCA Corp, Moorestown, NJ; Northrop Corp., Anaheim, CA. There are 16 additional contractors with a total dollar value of contracts of $3,108,000. Principal Army government organizations conducting this development program are the High Energy Laser Systems Project Office, and the US Army Missile Research and Development Command, (MIRADCOM), Huntsville, AL. Additional work is being accomplished at other government facilities such as the Army Mobility Equipment Research and Development Command, Fort Belvoir, VA; USA Armament Research and Development Command (ARRADCOM), Aberdeen, MD; the Army Electronics Research and Development Command, Fort Monmouth, NJ and White Sands Missile Range, NM; Lawrence Livermore Laboratories, Livermore, CA; the Army Materials and Mechanics Research Center, Watertown, MA; and ARRADCOM, Watervliet, NY.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Acccomplishments:

Summary - Key technologies necessary for High Energy Laser weapons were identified and partially developed through research, sub-scale demonstrations, and selected scaling experiments. Systems studies established potential Army applications and advantages over alternate weapons.

Laser Device Technology - The Army is responsible, within the DOD, for the majority of

Budget Activity #2 - Advanced Technology Development

Program Element #6.33.14.A Title High Energy Laser Components

Beam Control Device Technology -

Propagation/Effects/Lethality -

Systems Analysis - The feasibility of HEL systems for air defense, ground-to-ground, and air-to-ground applications was established.

Budget Activity #2 - Advanced Technology Development

Program Element #6.33.14.A Title High Energy Laser Components

Mobile Test Unit (MTU) -

2. FY 1977 Program:

Summary - The Technology programs initiated previously will be completed and integration of many of the resulting advanced components into brassboard demonstrators will be initiated. System studies will further define and prioritize specific Army missions and indicate necessary follow-on technology programs.

Laser Device Technology -

Beam Control Device Technology - The primary thrust of the Beam Control Program is the development of techniques for

Budget Activity #2 - Advanced Technology Development

Program Element #6.33.14.A Title High Energy Laser Components

Propagation/Effects/Lethality - The emphasis in propagation is centered upon a study of the impact of

Systems Analysis - Studies and analyses will be conducted to address

Mobile Test Unit (MTU) -

3. FY 1978 Planned Program:

Summary - Several major technology programs will be completed and critical hardware will undergo final testing. The investigation of major components will be performed. System studies will emphasize

Laser Device Technology - In the laser area, the technologies developed in FY 1976, 197T and 1977 will be brought together into a module demonstration called Modular Army Demonstration System (MADS).

Budget Activity #2 - Advanced Technology Development

Program Element #6.33.14.A Title High Energy Laser Components

Newer technologies, will be evaluated in light of previous Navy and Defense Advanced Research Projects Agency programs.

Beam Control Device Technology -

Propagation/Effects/Lethality - The major thrust of the propagation effort in FY 1978 is anticipated to be in three areas: the completion of the study of

Systems Studies - Preliminary systems design for a system will be conducted. Feasible technical approaches will be determined for systems concepts identified as a result of the comprehensive mission analysis.

Mobile Test Unit (MTU) -

4. FY 1979 Planned Program:

Summary - The program plan calls for a

Budget Activity #2 - Advanced Technology Development

Program Element #6.33.14.A Title High Energy Laser Components

Laser Device Technology - The exact nature of the laser device programs will depend upon the choice of device

Beam Control Device Technology - The technology efforts previously funded will be continued.

Propagation/Effects/Lethality - The propagation effort will continue to support the lethality and systems definition efforts. Also, a broader analysis will be pursued which extrapolates the results to a wide spectrum of environments and scenarios. In addition, upon successful

Systems Studies -
Technical approachs for systems will be examined in an operational environment. Selection will be made of best-technical approaches and preliminary system designs will be initiated

5. Program to Completion: It is anticipated that a

6. Major Milestones: Major milestones (Army System Acquisition Review Council/Defense System Acquisition Review Council (ASARC/DSARC)) have

Budget Activity #2 - Advanced Technology Development

Program Element #6.33.14.A Title High Energy Laser Components

TEST AND EVALUATION DATA:

1. Development Test and Evaluation:

Schedule:

Mobile Test Unit	Start	Completion

2. Operational Test and Evaluation:

Budget Activity #2 - Advanced Technology Development

Program Element #6.33.14.A Title High Energy Laser Components

3. System Characteristics:

	Design Goal	Demonstrated

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.36.02.A Title Advanced Land Mobility Systems Concepts

Category Advanced Development Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	0	3200	4841	7000	Continuing	Not Applicable
D118	Advanced Land Mobility Systems Concepts	0	0	3200	4841	7000	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The purpose of this program is to develop conceptual combat vehicles and experimental test bed vehicles. These conceptual test-bed vehicles will incorporate new and advanced technology components, some developed under other programs, that will enhance the ground mobility and combat effectiveness of combat vehicles. Conceptual vehicles employing advanced mobility concepts will be developed to determine feasibility. This program will alleviate many of the problems previously encountered in incorporating components representing new technology into system-oriented developmental vehicles. Continuation of this program will expand the combat vehicle technology base for exploitation by the Army.

BASIS FOR FY 1978 RDTE REQUEST: This funding will support the fabrication of two experimental chassis with weapons stations. Funding also will support fabrication and evaluation of an extended M113 Armored Personnel Carrier. Initial design studies for a new innovative test bed vehicle will be begun.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The predominance of the fabrication of the two test-bed vehicles will occur during FY 1978 which results in an increase in funding requirements. The initial design study for a new innovative test bed vehicle will be initiated.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ Employees	20	0	20
(2) Contractor Employees	50	0	50
Total	70	0	70

Budget Activity #2 - Advanced Technology Development

Program Element # 6.36.02.A Title Advanced Land Mobility Systems Concepts

DETAILED BACKGROUND AND DESCRIPTION: The Army has a continuing requirement to increase its ground mobility technology base through examination of various promising concepts of combat vehicles. Program encompasses development and evaluation, in non-system experimental prototypes, of combat vehicles incorporating the very latest technology and innovative concepts. Objective is to increase the mobility and effectiveness of future combat vehicles while decreasing developmental costs and time. Continuous upgrading of the technology will enable the United States to maintain mobility superiority over combat vehicles fielded by other countries. In a continuing program, concepts will be designed and fabricated to insure that automotive and weapon station components are available to meet forthcoming needs; and the effect of integrating these components into total systems will be assessed.

RELATED ACTIVITIES: Specific programs related to the technical areas of this program element (PE) are: PE 6.11.02.A, Project F22, Research in Vehicle Mobility, PE 6.21.05.A, Materials; 6.26.03.A, Large Caliber and Nuclear Technology; PE 6.26.06.A, Advanced Concepts Laboratory; PE 6.27.33.A, Mobility Equipment Technology; PE 6.26.18.A, Ballistics Technology; PE 6.31.02.A, Materiels Scale-Up; PE 6.32.01.A, Aircraft Power Plants, Project 477, Demonstrator Engines; PE 6.26.08.A, Tank Gun Development and Tank Ammunition; PE 6.36.21.A, Vehicle Engine Development; and PE 6.36.25.A, Armored Cavalry Vehicle. Close relationship is maintained with other Services and governmental agencies. Research and development information concerning Combat, Tactical and Special Purpose Vehicles is also being exchanged via data exchange agreements with allied countries. Close coordination prior to any budgetary decision is physically maintained and exchange of technical reports through the data exchange agreements is achieved.

WORK PERFORMED BY: In-house efforts will be performed by the US Army Tank-Automotive Research and Development Command, Warren, Michigan. Major contractors such as FMC Corporation, San Jose, California; AAI Corporation, Baltimore, Maryland; Lockheed Corporation, Sunnyvale, California; PACCAR, Renton, Washington; General Motors, and Chrysler Corporation, Detroit, Michigan; and others are expected to participate in this program.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Not Applicable

2. FY 1977 Program: This program a new start in FY 1977. The initial activity a joint program with the Defense Advanced Research Projects Agency for the High Survivability Test Vehicle - Lightweight (HSTV-L). Design and initial fabrication will occur during this year. Fabrication and evaluation of an extended M113 will be completed during this year for concept validation purposes.

Budget Activity #2 - Advanced Technology Development

Program Element # 6.36.02.A Title Advanced Land Mobility Systems Concepts

3. FY 1978 Planned Program: The increase in funding will support the majority of the fabrication of the HSTV-L during this period. The funding increase will also support concept formulation of new innovative test-bed vehicles and integration of new weapon systems.

4. FY 1979 Planned Program: Complete fabrication of HSTV-L (High Survivability Test Vehicle - Lightweight) and conduct evaluation by the user of this new concept. The increase in funding will support the initial design study contracts for a new innovative test-bed vehicle.

5. Program to Completion. This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.36.04.A

Title Nuclear Munitions and Radiacs

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT						Continuing	Not Applicable
	Quantities*							
D089	Nuclear Burst Detection System (NBDS)							
D135	Nuclear Weapon Development Support						Continuing	Not Applicable
D390	Tactical Earth Penetration Warheads						Continuing	Not Applicable
D443	Nuclear Projectiles						Continuing	Not Applicable
D483	Radiological Detection and Measuring Equipment						Continuing	Not Applicable

* Not Feasible to list.

** Project includes all RDTE funds for the NBDS. It is planned to transition to Engineering Development in FY 1979.

BRIEF DESCRIPTION OF ELEMENT: Advanced development of nuclear artillery projectiles, missile warhead sections, earth penetration warheads, and radiological detection and measurement equipment. Prototype systems and subsystems are developed, tested, and evaluated to establish system feasibility and enable approved systems to enter engineering development with lower risk. Support is provided to joint Energy Research and Development Administration-DOD Phase Two Nuclear Weapons Feasibility Studies.

BASIS FOR FY 1978 RDTE REQUEST: Advanced development of cost effective technical improvements in nuclear projectile technology. Development of improved capability radiation detection and measuring devices will continue with principal emphasis on an automatic nuclear burst detection and reporting system.

Budget Activity #2 - Advanced Technology Development

Program Element #6.36.04.A Title Nuclear Munitions and Radiacs

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The net decrease is due to the realignment of funding profiles for the nuclear burst detector system.

PERSONNEL IMPACT

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	32	0	32
(2) Contractor Employees	21	0	21
Total	53	0	53

DETAILED BACKGROUND AND DESCRIPTION: This program element supports system and nonsystem advanced development of nuclear artillery projectiles, missile warhead sections, earth penetration weapons, and radiological detection and measurement equipment. Emphasis in nuclear weapons developments is on achieving improved effectiveness against military targets; reduced levels of collateral damage; and improved safety, security, and command and control. Radiological detection and measurement equipment is developed to help protect troops and equipment from the hazards of a nuclear battlefield and to enable Army forces to function safely and effectively in such an environment.

RELATED ACTIVITIES: This program complements and is closely coordinated with Energy Research and Development Administration (ERDA) development of nuclear devices. Joint ERDA-DOD study groups are established to conduct feasibility studies and accomplish coordination and liaison. This PE is related to PE 6.26.03.A, Large Caliber and Nuclear Technology, where exploratory development of concepts and components is conducted and to PE 6.46.03.A, Nuclear Munitions, and PE 6.47.06.A, Radiological Defense Equipment, where selected systems advance to engineering development. The PE is also related to PE 6.33.11.A, PERSHING II. Support for Project Manager, Nuclear Munitions was formerly performed in PE 6.57.08, D135.

WORK PERFORMED BY: US Army Armament Research and Development Command, Dover, New Jersey; Harry Diamond Laboratories, Washington, DC; US Army Materiels and Mechanics Research Center, Watertown, Massachusetts; and US Army Electronics Research and Development Command, Fort Monmouth, New Jersey. Principal contractors include Bendix Corporation, South Bend, Indiana, and Sandia Laboratories, Albuquerque, New Mexico.

Budget Activity #2 - Advanced Technology Development

Program Element #6.36.04.A Title Nuclear Munitions and Radiacs

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Advanced development of two artillery projectiles, the XM517 (155mm) and the XM673 (8-inch), was completed in FY 1970 and FY 1971, respectively. A new adaption kit for use in Surface-to-Surface missiles, and an advanced Firing System (XM50) for Atomic Demolition Munitions (ADMs) underwent advanced development. Joint Energy Research and Development Administration (ERDA) DOD feasibility studies of two new ADMs, improving the 155mm nuclear artillery capability and new warheads for the PERSHING II were conducted in FY 1975 and 1976. Advanced development of three radiac devices was supported (digital radiacs, data annotation for an aerial radiac, and an X-ray probe for a survey meter). A joint US-Canadian advanced development of a fixed installation fallout detection system was completed in FY 1975. Studies and advanced development of Tactical Earth Penetrator Warheads (TEPW) was consolidated with related efforts in PE 6.33.11.A, PERSHING II, and advanced development of a Nuclear Burst Detector System (NBDS), to provide critical data to commanders, were begun in FY 1976.

2. FY 1977 Program: Further development of an improved 155mm nuclear capability will be held in abeyance during this fiscal year pending Congressional approval and funding for FY 1978. Fabrication of a prototype Nuclear Burst Detection System consisting of a central data processing console and three remote sensors will begin. Advanced development of the digital radiac, the X-ray probe, and the aerial radiac interface will continue.

3. FY 1978 Planned Program: The decrease in funding is due to the realignment of funding profiles to accommodate high priority projects and to the initiation of funding for the Project Manager, Nuclear Munitions. Technology programs include medium and large scale integration of fuze and adaption kit electronics and development and testing of joints in projectiles that will enable modular designs to increase effectiveness and/or range. Previous work will have demonstrated feasibility of such concepts, and the additional development and testing in this program will establish the cost effectiveness of the concepts and will identify systems to which the technology could be applied. Fabrication of the prototype NBDS will be completed and tested. The X-ray probe, the data annotation interface for the aerial radiac and the digital radiac will transition to engineering development.

4. FY 1979 Planned Program: Advanced development of the NBDS is expected to be completed and a transition made to engineering development. Advanced development of Large Scale Integrated (LSI) circuitry for the existing family of Army radiac instruments will begin. Based on expected TEPW technology feasibility demonstrated as part of the PERSHING II program under PE 6.33.11.A, advanced development work to adapt TEPW technology to other missile and cannon systems will begin. The increased funding is due to the increase in TEPW work, and to the resumption of full funding for the nuclear burst detector system.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.36.06.A

Title Landmine Warfare

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	4500	1297	3240	4408	3877	Continuing	Not Applicable
D036	Landmine Warfare	4500	1297	3240	4408	3877	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Provides for advanced development of components and concepts applicable to landmine warfare and scatterable mines.

BASIS FOR FY 1978 RDTE REQUEST: Continue efforts on improved mine sensor components, controllable minefield components, the Wide Area Mine (WAM), and anti-countermeasures systems.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Increased funding required to develop WAM components.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	9	0	9
(2) Contractor Employees	100	0	100
Total	109	0	109

Budget Activity #2 - Advanced Technology Development

Program Element #6.36.06.A Title Landmine Warfare

DETAILED BACKGROUND AND DESCRIPTION: The objective of this program element is to develop components and concepts applicable to land mine warfare, and in particular, to the family of self-destructing scatterable mines. These components, when integrated, will provide a system of mines and delivery means meeting Army requirements and compatible with the hardware being developed under Program Element 6.46.19.A, Landmine Warfare. The effort in this program element is currently undergoing a transition from component to system oriented development.

RELATED ACTIVITIES: Engineering development is performed in Program Element 6.46.19.A. The Army participates in the tri-service Joint Technical Coordination Group for Munitions Development. This agency integrates and coordinates a variety of tests conducted on scatterable mines for all services. The Department of Defense Air Munitions Requirements and Development Committee monitors and coordinates the air delivered scatterable mines program of the services with a view towards avoiding duplication.

WORK PERFORMED BY: The Project Manager for Selected Ammunition, Picatinny Arsenal, New Jersey, is the responsible agent for Landmine Warfare systems. Other government agencies involved in the program are: The Army Materiel Systems Analysis Agency, The Ballistic Research Laboratory, Harry Diamond Laboratories, and the Mobility Equipment Research and Development Command. Contractors include: Honeywell, Inc., Hopkins, Minnesota; Aerojet Ordnance and Manufacturing Company, Downey, California; Hughes Aircraft, Fullerton, California; Martin-Marietta, Orlando, Florida; Chrysler Corporation, Detroit, Michigan; Raytheon Corporation, Andover, Massachusetts; Vought Corporation, Warren, Michigan; and Chamberlain Corporation, Waterloo, Iowa.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Artillery delivered antitank (AT) and antipersonnel (AP) mine systems and a helicopter delivered AT system were developed and moved into engineering development. Comprehensive systems effectiveness studies were conducted. Components for the ground emplaced mine scattering system (GEMSS) were developed. Power supplies and sensor components were developed. In FY 1975, investigations were initiated towards the development of remote control components wide area mine sensing and kill mechanisms were investigated. Systems effectiveness studies and field tests continued. In FY 1976 and 7T, studies continued in off-route and controllable mine systems. Design work on improved power supplies and influence sensors continued. A prototype command and control module for scatterable mines was developed. The modular pack mine system (MOPMS) concept was validated and moved to engineering development.

2. FY 1977 Program: Complete command destruct capability for scatterable mines. Continue development of wide area mine components. Study concepts for command and control of scatterable mines.

Budget Activity #2 - Advanced Technology Development

Program Element #6.36.06.A Title Landmine Warfare

3. FY 1978 Planned Program: Continue efforts on wide area mine and test first prototypes. Test concepts for command and control of scatterable mines. Initiate efforts on improved tank sensors and continue anti-countermeasure systems. Increase in funding required to procure prototype hardware for wide area mine.

4. FY 1979 Planned Program: Complete command and control module for scatterable mines. Test improved tank sensor prototype. Complete advanced development of wide area mine and transition to engineering development. Decrease in funding reflects completion of advanced development of the wide area mine.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.36.07.A Title Army Small Arms Program

Category Advanced Development Budget Activity #2 - Advanced Technology Development

RESOURCES/PROJECT LISTING: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	4968	2441	2718	695	3452	Continuing	Not Applicable
D013	Infantry Weapon System Dev	511	750	323	0	0	Continuing	Not Applicable
D609	Armor Machine Gun	1108	80	200	0	2000	Continuing	Not Applicable
D627	Small Arms Components	545	599	100	695	1452	Continuing	Not Applicable
D640	Light Machine Gun	2220	812	2095	0	0	Continuing	Not Applicable
D642	Special Purpose Weapon	584	200	0	0	0	None	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program element (PE) covers the only development projects that support the Army Small Arms effort. Projects in this PE include: individual weapons, armor machineguns, small arms components, light machineguns, and special purpose weapons. Objectives of this PE include technology advances for the Infantry rifles, testing of an improved coaxial tank machinegun, and development of a lightweight, one-man, automatic weapon for use in the squad.

BASIS FOR FY 1978 RDTE REQUEST: Preparatory work on improved 5.56mm ammunition and US weapon contender for the NATO Small Arms testing will continue. The US has indicated that it will enter the M16A1 rifle and improved 5.56mm ammunition as contenders for the standardization of ammunition and weapon calibers within NATO for the Post-1980 time period. Non-system concept work in support of individual weapons and machineguns will continue. The squad automatic weapon development will continue.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The lower funding level reflects reduction of small arms advanced development efforts brought about by the substantial reduction in the light machinegun development effort.

PERSONNEL IMPACT: The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	5	0	5
(2) Contractor Employees	0	0	0
Total	5	0	5

Budget Activity #2 - Advanced Technology Development

Program Element #6.36.07.A Title Army Small Arms Program

DETAILED BACKGROUND AND DESCRIPTION: The program element (PE) provides for Army Small Arms advanced development (AD). These projects include efforts in individual weapons, component development, crew served weapons and special purpose weapons. Major thrusts include: conceptual prototype testing of Future Rifle System candidates; burst dispersion, reliability and accuracy tests; testing and evaluation of Squad Automatic Weapon (SAW); testing and evaluation of armor machinegun concepts for use in the tank coaxial role, and development of 40mm grenade training rounds. A specific area of interest is the investigation of an improved 5.56mm round which could meet both SAW and rifle (M16) requirements. The M16A1 weapons system and the improved 5.56mm ammunition will be US contenders in the NATO Small Arms Tests. These tests are aimed at a target date for a standardization decision in early 1980.

RELATED ACTIVITIES: The various projects in this PE represent the only source of military small arms AD for all services. These tasks are monitored by other services with representatives attending AD Hoc meetings called by the US Army Armament Research and Development Command (USAARADCOM).

WORK PERFORMED BY: In-house work is performed by the USAARADCOM, Dover, NJ and the US Army Test and Evaluation Command (TECOM) Aberdeen Proving Ground, MD. Major contractors: Olin-Mathison Chemical Corp, New Haven, CT; AAI Corp, Cockeysville, MD; Maremont, Saco, ME, Ford Aerospace and Communications Corp, Newport Beach, CA; General American Transportation (GATX), Chicago, IL; PRC System Sciences Company, Englewood Cliff, NJ.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments:

a. Infantry Weapon Systems - Low level light sight assemblies using promethium as illuminants were provided for the M16A1 rifle. Advanced technology was applied in designing and providing M16A1 rifles for user evaluation with muzzle compensation, burst control and a single point (reflex collimator) sight. The user evaluation demonstrated improved target acquisition and hit probability. Concepts for an advanced individual weapon with a point and area fire capability are under investigation. These investigations have demonstrated functional performance and potential of a mechanism for effective controlled burst fire, demonstrated a saboted bulleted cartridge and provided essential data to form a basis for further development, provided an integrated weapon (4.32mm point fire and 30mm area fire) for initial user evaluation, and have provided imperical data heretofore not available for these advanced concepts to be used in systems analysis, integration and development.

b. Armor Machine Gun - A blank firing attachment (BFA) for recoil operated mechanisms has been demonstrated and provided in limited quantities to support user evaluation and training programs. This BFA represents a breakthrough in the state of the art and provides a feasible and reliable concept for use with recoil operated weapons. Evaluation of several armor machinegun concepts have resulted in identifying mechanisms that have the potential for higher reliability and lower maintenance than standard fielded weapons. These concepts are a hybrid self-powered/externally powered, a rod receiver self-powered, and cam operated

externally powered approaches. Evaluation and testing of US and foreign weapons identified the M60E2 and the Belgium MAG-58 as having the highest potential to meet the requirements for an interim armor machinegun. Comprehensive testing and evaluation of these two mechanisms has been completed.

c. Small Arms Components - Barrel wear and erosion investigations have resulted in demonstrating significant improvement in life. A chrome plated, rotary swaged 4.32mm barrel has demonstrated satisfactory performance through 5000 rounds. A rotating anode process is being developed to accomplish the chrome plating. 30mm grenade cartridge and component configurations have been established. Cartridges have been provided to support weapon concept evaluation. Alternative approaches for a 40mm training round are being developed to reduce costs.

d. Automatic Weapon - Parametric system studies identified a system that would meet the user's requirements. Through contractural and in-house efforts three US and two foreign mechanisms were submitted to a user evaluation. The XM235 and the Fabrique Nationale "minimi" were selected for further development. The cartridge used in the initial development was 6mm. Following tests activities have addressed 5.56mm and 7.62mm. An improved 5.56mm ball projectile that extends helmet penetration range and a tracer that extends visible trace range have been demonstrated. These two cartridges have been submitted to the NATO small caliber cartridge evaluation as contenders. The feasibility of converting the XM235 to 5.56mm has been demonstrated. Precontract activities for development of the XM235 have resulted in proposals and evaluation is in process.

e. Special Purpose Weapon - Engineering tests on the 40mm system training round were completed.

2. FY 1977 Program: A mechanism for 5.56mm improved ammunition will be examined for the Squad Automatic Weapon (SAW) in consideration of NATO standardization agreements. Lethality investigation efforts will be completed and tracer investigations will be completed. Low impluse projectile evaluations will continue. Investigations will be initiated into new concepts of magazine design. Investigation of non-metallic materials for use in lightweight components was initiated. Contract will be awarded for 18 weapons based on the XM235 5.56mm weapon.

3. FY 1978 Planned Program: Continue investigations of an improved 5.56mm round for use in the M16A1 rifle, a contender in NATO rifle standardization tests. Projectile shapes which demonstrate potential advantage for use in the rifle and machinegun role will be investigated. Efforts will continue in barrel development, lightweight materials investigations, and muzzle devices fabrication. Investigations will begin on alternative methods of weapon actuation for improved performance as related to reliability, durability and maintainability of the system. Increased support of NATO small arms testing scheduled for FY 1977-1979. SAW weapon development will be significantly reduced.

4. FY 1979 Planned Program: Conduct parametric design analysis of future Armor Machine Gun. Initiate design and fabrication of system concepts applicable to combat vehicles and personnel carriers. Evaluate applicable foreign material and data. Administer contracts, evaluate unsolicited proposals and review technology to expand our small arms capability. Parametric design analysis

will be accomplished to support and identify small caliber system components which would have the greatest payoff resulting from design activities. Based on results design, fabricate and test prototypes (gas system receivers, dynamic weapon components and foreign materiel and data) primarily through contract with in-house support. Increase in funding for FY 1979 over FY 1978 is a result of initiation of the future Armor Machine Gun program mentioned above.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.36.08.A

Title Weapons and Ammunition

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	0	1898	4791	2575	Continuing	Not Applicable
	Quantities (Not Feasible to list due to number of diverse items.)							
D160	Infantry Munitions	0	0	225	679	673	Continuing	Not Applicable
D161	Tank Ammunition	0	0	1673	2659	1202	Continuing	Not Applicable
D162	Tank Ammunition (Target Practice)	0	0	0	1453	700	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program supports design and development of more reliable and effective cannon, mortar, and tank weapons and munitions.

BASIS FOR FY 1978 RDTE REQUEST: To provide for advanced development of: a family of 60 millimeter projectiles for the new Lightweight Company Mortar System, an improved 105mm tank projectile, and a 105mm target practice round for tank cannon.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Project D162, Tank Ammunition (Target Practice), for the development of a tank gun, target practice round is a new start in FY 1978. The increased funding in Project D161, Tank Ammunition, is necessary for fabrication and testing of 105mm tank projectiles. The increased funding in FY 1978 for Project D160 Infantry Munitions is for the initiation of RDTE efforts for ammunition compatible with the Lightweight Company Mortar System.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	17	0	17
(2) Contractor Employees	55	0	55
Total	72	0	72

Budget Activity #2 - Advanced Technology Development

Program Element #6.36.08.A Title Weapons and Ammunition

DETAILED BACKGROUND AND DESCRIPTION: This program has been restructured. Projects for large caliber weapons and ammunition (D007 and D008) have been transferred to Program Element 6.36.28.A, FA Weapons and Ammunition Development. Project DE82 for development of fleme, smoke, and incendiary munitions has transferred to Program Element 6.36.27.A, Combat Support Munitions. Project D060 for tank gun development is now in Program Element 6.36.16.A, Tank Gun Cooperative Development. Three active projects remain. The development of a family of 60 millimeter mortar projectiles will provide a significant improvement in range and effectiveness for the infantry. The development of an improved fin-stabilized projectile for 105mm tank guns will increase the effectiveness of M60 and XM1 tanks. Development of a target practice round for 105mm tank guns is needed for training on these weapons.

RELATED ACTIVITIES: Projects in this program are supported by exploratory development in Program Element 6.26.03.A, Large Caliber and Nuclear Technology. Developments in this program element are compatible with US Marine Corps requirements, and are closely coordinated to preclude duplication of effort. To avoid proliferation of programs within each of the Tri-Services, all new programs are coordinated with appropriate Joint Technical Coordinating Groups.

WORK PERFORMED BY: In-house agencies include US Army Armament Research and Development Command, Rock Island, IL; the US Army Armament Research and Development Command (AARADCOM), Dover, NJ; and AARADCOM, Edgewood, MD. Contractors include Honeywell, Minneapolis, MN; Chamberlain Manufacturing Corporation, Waterloo, IA; Battelle-Northwest Laboratories, Richland, WA; Sandia Livermore Laboratories, Livermore, CA; Rockwell International, Denver, CO; National Lead Company of Ohio, Fernald, OH; Flinchbaugh Products, Incorporated, Red Lion, PA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Developmental work during this period included investigations for improved artillery projectiles. New explosive fills for high explosive projectiles were evaluated. The multiple warhead (bomblet) projectile was developed. Projectile shapes were streamlined for extended range. Advanced development of 105mm, 155mm, and 8 inch artillery projectiles with an improved high-explosive fill was completed. An investigation was made toward desensitizing standard high explosive fills. Advanced development of dual-purpose ammunition (anti-personnel and anti-armor) continued. A soft-recoil mechanism for towed and self-propelled guns was tested. Development of a 155mm smoke projectile experienced problems with aberrant flight dynamics. A new start based on other technologies is planned in Program Element 6.36.28.A FA Weapons and Ammunition Development for FY 1977. A field test demonstration of candidate gun systems for the XM1 tank was conducted. The US 105mm system and FRG and UK 120mm systems were found to warrant further evaluation.

Budget Activity #2 - Advanced Technology Development

Program Element #6.36.08.A Title Weapons and Ammunition

2. FY 1977 Program: The 105mm tank gun system will be investigated for use in the near future, and the FRG & UK 120mm tank gun sys. will be investigated as a counter to future threats. This project transfers to Program Element 6.36.16.A Tank Gun Cooperative Development in FY 78. Advanced development of a dual-purpose grenade for use on rifle-mounted launchers will be initiated. Development of a 40mm training round for safer and less costly training will be completed. The design of an improved 105mm projectile for tank guns will be validated in formal tests.

3. FY 1978 Planned Program: Fabrication and formal developmental testing of the improved 105mm tank gun projectile will continue throughout the year. Development will be initiated for a tank gun target practice round. This will be a one year advanced development. Initiate Development of an illuminating round for the lightweight company mortar system (60mm). This round is a companion round for the system which will be type classified standard February 1977 with only the high explosive rounds. Previous decrements have delayed development of this round.

4. FY 1979 Planned Program: Development of the 105mm tank gun projectile will continue. Development of the mortar round will continue. Decrease in funding due to the major portion of RDTE activity having been completed.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.36.13.A Title Advanced Fuze Design

Category Advanced Development Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	1760	450	2267	862	1409	Continuing	Not Applicable
DE 55	Advanced Artillery and Mortar Fuzing	1760	450	2096	572	1097	Continuing	Not Applicable
DE 59	Supporting Advanced Fuze	0	0	171	290	312	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program provides for the development of advanced fuzing technology into prototype components, systems, and subsystems for artillery, mortar, 2.75 inch rockets, and tank ammunition.

BASIS FOR FY 1978 RDTE REQUEST: Design and test prototype hardware toward full-scale development of four fuzing concepts: a fuzing system which will satisfy all projected rocket fuzing requirements for attack helicopters, a more accurate and responsive fuze for tank ammunition, a fuze for precise release of multiple warheads (bomblets) in guided and unguided artillery projectiles and rockets, and improved impact sensors for impact-type fuzes.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: A reduced level of effort in FY 1978 due to deferrment of a portion of the high burst fuze RDTE efforts.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	32	0	32
(2) Contractor Employees	4	0	4
TOTAL	36	0	36

Budget Activity #2 - Advanced Technology Development

Program Element #6.36.13.A Title Advanced Fuze Design

DETAILED BACKGROUND AND DESCRIPTION: This program element provides for the development of advanced fuzing technology into prototype components, systems, and subsystems for artillery, mortar, aerial rockets, and tank ammunition. A primary goal is to increase operational effectiveness (e.g., lethality, reliability, flexibility) of present muntions, as well as improve mission cost-effectiveness. New technologies are being applied to improve existing components, such as impact switches, safety and arming devices, and power supplies. Wireless data transmission techniques are being developed to set fuzes (to a given range or function mode), thereby increasing response time and reducing human error. Another objective is the development of new fuzes to meet the requirements of advanced weapons. New fuzes are needed for multiple warhead aerial rockets and guided and unguided artillery rounds, illuminating and smoke dispensing rockets and mortar shells. An auxiliary project, DE 59, supporting Advanced Fuzing, supports these fuze developments via improving techniques for testing fuzes and monitoring their operation and environment, thereby reducing development time and cost.

RELATED ACTIVITIES: This element supports the development of fuzing to meet the requirements of munitions funded by the following program elements: 6.46.01.A, Project 029, Lightweight Company Mortor System; 6.36.08.A/6.46.02.A, Weapons and Ammunition; 6.36.27.A/6.46.09.A Combat Support Munitions; and 6.36.28.A/6.46.05.A/6.46.27.A Field Artillery Weapons and Ammunition. In addition, a task to develop more effective rocket fuzes supports 6.32.06.A/6.42.02.A Aircraft Weapons. Another task for the development of a high bursting fuze supports elements 6.33.03.A, Surface to Surface Rocket System; 6.33.06.A; Terminal Homing System, 6.33.06.A; and 6.33.13.A, Missile/Rocket Components. Coordination of all programs is monitored by the established Fuze Selection Advisory Board along with the Joint Technical Coordinating Group.

WORK PERFORMED BY: In-house agencies: Harry Diamond Laboratories, Adelphi, MD/US Army Electronics Research and Development Command, Fort Monmouth, NJ (or successor agencies), US Army Armament Research and Development Command (AARADCOM), Dover, NJ/US Army Armament Command, Rock Island, IL (or successor agencies), AARADCOM, Edgewood, MD. Contractors will include General Electric Company, Burlington, VT and Syracuse, NY.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976 and Prior Accomplishments: Advanced development of a multi-option fuze (selectable functions include high and low air burst, impact, and delayed function after impact) for 60mm and 81mm mortars was completed. This fuze has since completed all development, and is now scheduled for production. A beehive fuze (for releasing nail-like submissiles), which was funded by this program element, is now in full-scale development. High explosvie antitank fuzes in stockpile have been modified following improvements developed in this program element. A task to develop a non-chemical, air-driven (fluidic) power source has resulted in the adaptation of this concept in several fuze developments. Advanced development began on 3 fuze systems. Studies and tests were conducted to determine the effects of hostile environments on a tank ammunition fuze which is remotely set via radio. Prototype remotely set fuzes for rockets using an inductive link were designed and successfully tested. A prototype sensor for a high bursting fuze demonstrated the system's concept in air-drop tests.

Budget Activity #2 - Advanced Technology Development

Program Element #6.36.13.A Title Advanced Fuze Design

2. FY 1977 Program: Detailed design of the remotely set fuze for tank ammunition will continue, with an emphasis on optimizing cost-effectiveness. The remotely set fuze for rockets will be tested and modified in 3 iteraticns. Design and testing of the high bursting fuze will continue. Project DE59, Supporting Advanced Fuze, will commence with the development of a telemetry system for a ballistic rail gun facility (an artillery simulator for fuze testing). A program will be initiated utilizing the latest state-of-the-art for a power supply (battery) and a safing-arming mechanism for an electronic time fuze. This fuze is used with artillery ammunition 105mm thru 8 inch on high explosive and cargo carrying projectiles.

3. FY 1978 Planned Program: Laboratory testing of the remotely set fuze for tank ammunition will be conducted. Remotely set rocket fuzes will be fabricated and tested in preparation for entrance into full scale development. Design of components only for the high bursting fuze will focus on miniaturizing. RDTE efforts for this complete fuze will be initiated in FY 1979. A new task will focus on design and testing of impact switches which are insensitive to rainfall.

4. FY 1979 Planned Program: This fiscal year shows increased funding requirements because of a new start for an investigation of handsetting techniques for an artillery electronic time fuze, and the resumption of DE59, Supporting Advanced Fuze. Continue design and testing of the remotely set fuze for tank ammunition. Complete advanced development testing of the remotely set rocket fuze. Award contracts for advanced development models for field testing of the high bursting fuze. Begin design of an improved impact fuze. Initiate development of an artillery electronic time fuze which can be set by hand (without a setting device). Resume DE59, Supporting Advanced Fuze, with the development of telemetry systems for artillery fuzes, and an investigation of accelerometer characteristics.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.36.14.A

Title Incapacitating Chemical Munitions Concepts

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	9	0	332	0	754	Continuing	Not Applicable
DE73	Incapacitating Cml Mat	9	0	195	0	442	Continuing	Not Applicable
DE74	Incapacitating Cml Agt Process	0	0	137	0	312	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program supports advanced development (AD) on incapacitating agent munitions, and small scale pilot units for incapacitating agents generated under exploratory development.

BASIS FOR FY 1978 RDTE REQUEST: Not Applicable.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: FY 1978 funding not required.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	0	0	0
(2) Contractor Employees	0	0	0
Total	0	0	0

DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is to conduct AD on improved non-lethal incapacitating chemical agents which exhibit potential for casualty production through either the respiratory tract and/or penetration of environmental and protective clothing. Small scale pilot units are designed and installed to obtain process engineering data for application in future production facilities. Chemical warfare munitions concepts that employ the binary principle are investigated.

Budget Activity #2 - Advanced Technology Development

Program Element #6.36.14.A Title Incapacitating Chemical Munitions Concepts

RELATED ACTIVITIES: No comparable work is done by the other Services on incapacitating chemical agent processes. Information is exchanged and the efforts are coordinated through exchange of RDTE documents, liaison officers and by joint technical coordinating groups.

WORK PERFORMED BY: US Army Armament Research and Development Command (ARRADCOM), Dover, NJ and US Army Test and Evaluation Command, Aberdeen, MD.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: AD was initiated on the 2.75-inch air-to-ground rocket and the 155mm artillery projectile with agent EA 3834A. A base ejection 155mm projectile design was selected for delivery of EA 3834. Systems effectiveness studies identified 48 submunitions as optimum number for the projectile/agent system. Simulant filled projectiles were fired at Dugway Proving Ground, UT, and validated the design and functioning principles of the ignition and ejection systems and the ballistics of the round. Technology from 2.75-inch Riot Control Agent CS rocket was the foundation for design work on the 2.75-inch incapacitating agent projectile. Work continued on finalizing design and functioning of the 155mm projectile and 2.75-inch rocket. Emphasis was placed on the 155mm projectile pending a decision on the caliber of the air-to-ground system being considered to replace the 2.75-inch rocket. Analysis and tests were conducted on the projectile to determine its adherence to transportation and storage safety standards. Tests showed the projectile design needed further work in order to provide 100 percent assurance that the agent would not be released if the projectile was involved in a catastrophic event. Submunitions designs were modified and tested to improve dissemination efficiency and reduce the burning time of EA 3834 pyrotechnic mixture in the submunition. Experimental tooling was designed and fabricated for the filling of submunitions and assembly in the 155mm projectile. In FY 75 the process for the manufacture of agent EA 3834A has been optimized in a series of small pilot plant runs. Experimental tooling was designed and fabricated for the AD filling of submunition configurations. Filling, closure and assembly equipment was purchased and installed.

2. FY 1977 Program: Production, filling and loading processes will continue to be studied.

3. FY 1978 Planned Program: Not Applicable.

4. FY 1979 Planned Program: Effort will complete studies to provide design criteria for eventual limited production facilities to manufacture EA 3834A to be used in the new families of munition's disseminating this agent e.g., artillery, serial systems. Candidate binary system reactants will be investigated to establish a manufacturing technology base.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.36.15.A

Title Lethal Chemical Munitions Concepts

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES: /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	771	880	855	618	1043	Continuing	Not Applicable
	Quantities							Not Applicable
DE76	Lethal Chemical Materiel	500	840	619	320	522	Continuing	Not Applicable
DE77	Lethal Chemical Agent Process	271	40	236	298	521	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program supports advanced development on binary lethal chemical agent munitions and small scale pilot units to obtain process engineering data for possible application to future production facilities.

BASIS FOR FY 1978 RDTE REQUEST: Funds will support continued evaluation of binary rocket concepts and a binary warhead for the 155mm intermediate volatility agent (IVA) projectile. Additionally, supportative process design and pilot production studies will continue.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Slight decrease due to reduction in study efforts.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	6	0	6
(2) Contractor Employees	0	0	0
Total	6	0	6

[illegible] Advanced Technology Development

Program Element 62307A Title Lethal Chemical Munitions Concepts

DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is to conduct advanced development on binary lethal chemical agents which have advanced from exploratory development by exhibiting potential for casualty production through either the respiratory tract and/or penetration of environmental and protective clothing. Small scale pilot units are designed and installed to obtain process engineering data for application to future production facilities. Chemical warfare munitions concepts that employ the binary principle are evaluated.

RELATED ACTIVITIES: No comparable work is done by the other services on lethal chemical agent processes. Information is exchanged and the efforts are coordinated through exchange of RDTE documents, liaison officers and by joint technical coordinating groups.

WORK PERFORMED BY: US Army Armament Research and Development Command (ARRADCOM), Edgewood, Maryland is the primary Army developer for lethal chemical munitions with participation by ARRADCOM, Dover, New Jersey, and Dugway Proving Ground, Utah. ARRADCOM, Edgewood, Maryland performs all toxic chemical agent development work for the Department of Defense.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Data developed in the lethal chemical agent processes project was used in construction of chemical agent production facilities at Rocky Mountain Arsenal, Colorado, and Newport Ammunition Plant, Indiana. Procedures for designing equipment for filling, closing and leak testing of chemical munitions were developed. Production techniques for lethal binary chemical agent non-toxic intermediates were studied and small quantities of some intermediates were prepared. Studies were conducted on submunition concepts for missile warhead applications. In FY 1970 advanced development was initiated on the 155mm, binary GB, projectile. In FY 1971, process chemistry studies for production of the binary intermediates for GB were completed and prototype filling and sealing equipment for binary 155mm projectile developed. In FY 1972 advanced development was completed on the 155mm binary GB projectile. In FY 73, advanced development was initiated on the 8-inch binary VX projectile. Process studies for the production of binary VX were initiated. In FY 74 advanced development on the 8-inch binary lethal chemical agent projectile was completed. Process studies and pilot production studies for binary intermediates were continued. Sub-pilot investigation of binary VX components disposal by means of incineration was conducted and feasibility demonstrated. Criteria were developed for a pilot filling machine for loading of 8-inch projectile, also a development test (DT) VX filling line was completed early in FY 74. Basic design parameters based on DT hardware were made available for subsequent production design. In FY 75 the exploratory development efforts on a binary intermediate volatility agent project, air-to-ground munitions, and missile and rocket warheads were closely monitored to provide the design base for advanced development effort. Design criteria for a pilot filling line for the 8-inch binary VX projectile was completed. Process and pilot production evaluations continued. In FY 76 effort was initiated to determine feasibility of a binary warhead for ground-to-ground rocket systems.

NOT REPRODUCIBLE

Budget Activity #2 - Advanced Technology Development

Program Element #6.36.15.A Title Lethal Chemical Munitions Concepts

2. FY 1977 Program: Evaluation of the binary feasibility of rocket systems will continue. Influence on bulk-liquid fill on missile flight performance, conceptual design of segmented warhead systems, and binary warhead logistical implications will be investigated. Bulk liquid mixing and dissemination techniques will be developed and evaluated. Design concepts will be system analyzed for optimization and air experimental warhead will be fabricated as a prelude to concept demonstration. Advanced development efforts on an 155mm intermediate volatility agent (IVA) projectile will begin in 4QFY77. In support of these programs, efforts will be carried out to develop or improve techniques for binary ingredient production and process waste disposal.

3. FY 1978 Planned Program: The advanced development effort on a binary warhead for ground-to-ground rocket systems will be completed through concept formulation. Advanced development on the 155mm IVA projectile will continue as will the supportive process design and pilot production studies.

4. FY 1979 Planned Program: The advanced development effort on the 155mm IVA projectile will be completed. Development of a binary warhead for an air-to-ground rocket system will begin. Supportive process and production technology will continue to be developed and assessed to include filling and closure studies for rocket and missile munition systems. The increase in funds are needed to procure hardware to support evaluation of a binary air-to-ground rocket system; and to continue to improve binary ingredient production and process waste disposal.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.36.19.A

Title Countermine and Barriers

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	4911	407	2118	6243	4886	Continuing	Not Applicable
	Quantities	Consists of a large number of diverse items.						
D606	Countermine and Barrier Systems	4911	407	2118	3495	2448	Continuing	Not Applicable
D608	Countermine and Barrier Developments	0	0	0	2748	2438	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The objective of this program is to improve the Army countermine capabilities by investigating and exploiting materials, techniques, and equipment and examine advanced tactical barrier techniques and concepts evolving from exploratory development.

BASIS FOR FY 1978 RDTE REQUEST: Funds will support development of the airborne metal reradiation (METRRA) minefield detector, the manportable explosive mine neutralizer (MANPLEX), the magnetic signature duplicating device, and the chemical neutralization of explosives. Initiate advanced development of the surface launched mine rocket (SLUMINE).

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Increase in funding reflects the initiation of advanced development of SLUMINE.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	45	0	45
(2) Contractor Employees	15	0	15
Total	60	0	60

Budget Activity #2 - Advanced Technology Development

Program Element #6.36.19.A Title Countermine and Barriers

DETAILED BACKGROUND AND DESCRIPTION: This program element contains tasks designed to provide the Army with a family of mutually supporting countermine devices and techniques to meet the identified threat. Mine detection and neutralization are examined based on tactical scenarios and conditions and translated into prototype developmental items by exploiting technologies developed during exploratory development. Current efforts include both manportable and vehicle mounted devices for detection and neutralization of antipersonnel and antitank mines in on-road and off-road environments. Barrier efforts are directed towards the use of the most advanced non-explosive technology to deny or reduce enemy mobility on the battlefield. Efforts include engine interference, tractive entanglements, and optical coatings.

RELATED ACTIVITIES: Exploratory development is conducted under Program Element 6.27.33.A, Mobility Equipment Technology, and engineering development is conducted under Program Element 6.46.12.A, Countermine and Barriers. Interface with the other Services is maintained through the Joint Technical Coordinating Group for Bombs and Mines to avoid duplication of efforts.

WORK PERFORMED BY: The US Army Mobility Equipment Research and Development Command, Fort Belvoir, Virginia, is assigned responsibility for Countermine and Barriers. Other governmental agencies involved in the program are: Naval Weapons Center, China Lake, California; US Army Missile Research and Development Command, Huntsville, Alabama; US Army Test and Evaluation Command, Aberdeen, Maryland; and the Project Manager for Selected Ammunition, US Army Armament Research and Development Command, Dover, New Jersey. Contractors include: Chrysler Corporation, Detroit, Michigan; Teledyne McCormick Selph, Hollister, California; Goodyear Aerospace, Akron, Ohio; Honeywell, Hopkins, Minnesota; and Cubic Corporation, San Diego, California.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: In the area of mine detection, the potential of pulse radar reradiation, X-ray, and gamma ray excitation, passive infrared devices, microwave techniques, and trace gas detection devices were evaluated. The ability of dogs to detect the explosives in landmines and booby traps was demonstrated and the canine mine detection manual was completed. Field tests were conducted on the airborne metal reradiation radar (MIBRA) to determine capability for standoff detection of scatterable minefields. A prototype evaluation of the route interdiction mine detector (RIMD) was concluded and project moved into engineering development. In mine neutralization, fuel-air explosives (FAE) have been shown to be an effective minefield clearing device. A prototype launcher, the Surfaced Launched Unit, Fuel-Air Explosives (SLUFAE) was built, tested and progressed to engineering development.

2. FY 1977 Program: Exploit Soviet technology on mine clearing rollers. Build and conduct component tests for an expedited mine clearing roller program. Build and test the rapid field resettable fuze for the SLUFAE mine neutralization system.

Budget Activity #2 - Advanced Technology Development

Program Element #6.36.19.A Title Countermine and Barriers

3. FY 1978 Planned Program: Initiate advanced development on the airborne metal reradiation (METRRA) mine detection system for standoff detection of scatterable minefields. Initiate advanced development on a manportable mine neutralizer system (MANPLEX), a magnetic signature duplicating device, and chemical neutralization of explosives. Initiate and complete testing of an advanced tractive entanglement device to supplement tactical barriers. Initiate advanced development on an optical coating device for obscuring vision from tracked vehicles. Procure prototype hardware for the surface launched mine rocket system (SLUMINE). Increased funding reflects initiation of SLUMINE development.

4. FY 1979 Planned Program: Continue advanced development on the airborne METRRA. Test and evaluate advanced METRRA prototype against various scatterable minefields. Initiate advanced development of the off-route minefield detector (ORMID). Complete advanced development on sprayed fuel-air explosives (SPRAYFAE). Test the magnetic signature duplicator. Continue efforts on vehicle component hardening to resist mine blast. Decrease in funds reflects progression of SLUMINE into engineering development.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.36.19.A Title Countermine and Barriers

Project #D606 Title Countermine and Barrier Systems

Category Advanced Development Budget Activity #2 - Advanced Technology Development

DETAILED BACKGROUND AND DESCRIPTION: This program element contains tasks designed to provide the Army with a family of mutually supporting countermine devices and techniques to meet the identified threat. Mine detection and neutralization are examined based on tactical scenarios and conditions and translated into prototype developmental items by exploiting technologies developed during exploratory development. Current efforts include both manportable and vehicle mounted devices for detection and neutralization of antipersonnel and antitank mines in on-road and off-road environments. Barrier efforts are directed towards the use of the most advanced non-explosive technology to deny or reduce enemy mobility on the battlefield. Efforts include engine interference, tractive entanglements, and optical coatings.

RELATED ACTIVITIES: Exploratory development is conducted under Program Element 6.27.33.A, Mobility Equipment Technology, and engineering development is conducted under Program Element 6.46.12.A, Countermine and Barriers. Interface with the other Services is maintained through the Joint Technical Coordinating Group for Bombs and Mines to avoid duplication of efforts.

WORK PERFORMED BY: The US Army Mobility Equipment Research and Development Command, Fort Belvoir, Virginia, is assigned responsibility for Countermine and Barriers. Other governmental agencies involved in the program are: Naval Weapons Center, China Lake, California; US Army Missile Research and Development Command, Huntsville, Alabama; US Army Test and Evaluation Command, Aberdeen, Maryland; and the Project Manager for Selected Ammunition, US Army Armament Research and Development Command, Dover, New Jersey. Contractors include: Chrysler Corporation, Detroit, Michigan; Honeywell, Hopkins, Minnesota; and Cubic Corporation, San Diego, California.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: In the area of mine detection, the potential of pulse radar reradiation, X-ray, and gamma ray excitation, passive infrared devices, microwave techniques, and trace gas detection devices were evaluated. The ability of dogs to detect the explosives in landmines and booby traps was demonstrated and the canine mine detection manual was completed. Field tests were conducted on the airborne metal reradiation radar (METRRA) to determine capability for standoff detection of scatterable minefields. A prototype evaluation of the route interdiction mine detector (RIMD) was concluded and project moved into engineering development. In mine neutralization, fuel-air explosives (FAE) have been shown to be an effective minefield clearing device. A prototype launcher, the Surfaced Launched Unit, Fuel-Air Explosives (SLUFAE) was built, tested, and progressed into engineering development.

Budget Activity #2 - Advanced Technology Development

Program Element #6.36.19.A Title Countermine and Barriers

Project #D606 Title Countermine and Barrier Systems

2. FY 1977 Program: Exploit Soviet technology on mine clearing rollers. Build and conduct component tests for an expedited mine clearing roller program. Build and test the rapid field resettable fuze for the Surfaced Launched Unit, Fuel-Air Explosives (SLUFAE) mine neutralization system.

3. FY 1978 Planned Program: Initiate advanced development on the airborne metal reradiation (METRRA) mine detection system for standoff detection of scatterable minefields. Initiate advanced development on a manportable mine neutralizer system (MANPLEX), a magnetic signature duplicating device, and chemical neutralization of explosives. Procure prototype hardware for the surface launched mine rocket system (SLUMINE). Increased funding reflects initiation of SLUMINE development.

4. FY 1979 Planned Program: Continue advanced development on the airborne METRRA. Test and evaluate advanced METRRA prototype against various scatterable minefields. Initiate advanced development of the off-route minefield detector (ORMID). Complete advanced development on sprayed fuel-air explosives (SPRAYFAE). Test the magnetic signature duplicator. Decrease in funds reflects progression of SLUMINE into engineering development.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

		FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE:	Funds	4911	407	2118	3495	2448	Continuing	Not Applicable
	Quantities	Consists of a large number of diverse items.						

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.36.21.A

Title Vehicle Engine Development

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	4779	1454	3997	4729	9566	Continuing	Not Applicable
D395	Vehicle Transmissions/ Steering	366	179	270	591	2000	Continuing	Not Applicable
DG07	Vehicle Engine Development	4163	1150	3365	3770	6500	Continuing	Not Applicable
A424	Other Vehicle Components	250	125	362	368	1066	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program element provides for advanced development for vehicle engines, transmissions and other components that are not commercially available.

BASIS FOR FY 1978 RDTE REQUEST: Initiate efforts to develop an innovative hydromechanical continuously-variable transmission that will advance technology in the area of transmissions for 20-ton combat vehicles. Additionally, continue those efforts in vehicle engine development that are not available commercially yet are drastically needed to improve combat effectiveness, improve fuel economy and provide multi-fuel capability.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The increase in funding results from work which will be initiated in advanced turbine components and fabrication of an advanced turbine demonstrator engine.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ Employees	35	0	35
(2) Contractor Employees	42	0	42
Total	77	0	77

Budget Activity #2 - Advanced Technology Development

Program Element # 6.36.21.A Title Vehicle Engine Development

DETAILED BACKGROUND AND DESCRIPTION: This program element is the Army's only effort in developing vehicular propulsion systems and other components not commercially available. The program goals are to develop for the future combat and tactical vehicles those components that will (1) increase fuel tolerance, (2) improve fuel economy, (3) improve horsepower-per-ton ratio, and (4) improve maintenance, reliability and availability characteristics of vehicle components.

RELATED ACTIVITIES: PE 6.26.01.A, Tank and Automotive Technology; PE 6.36.02.A, Advanced Land Mobility System Components. Foreign state-of-the-art trends in military propulsion systems are constantly monitored by the Tank-Automotive Research and Development Command and data are exchanged with allied countries via data exchange agreements. Close coordination to any budgetary decision is physically accomplished to preclude duplication of efforts with other Services.

WORK PERFORMED BY: US Army Tank-Automotive Research Development Command, Warren, Michigan, is responsible for the development in this program element. Major contractors are: White Motor Corporation, Canton, Ohio; Southwest Research Institute, San Antonio, Texas; Teledyne Continental Motors, Muskegon, Michigan; Detroit Allison, Indianapolis, Indiana; Texaco Research, Beacon, New York; AVCO Lycoming, Stratford, Connecticut, Power-Matic, Salt Lake City, Utah; American Bosch Corporation, Springfield, Massachusetts; General Electric, Pittsfield, Massachusetts; Donaldson Corporation, Minneapolis, Minnesota; FMC, San Jose, California; AiResearch, Phoenix, Arizona; and Engine Research Corporation, Cincinnati, Ohio.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1978, and Prior Accomplishments: Development and transfer of the technology for the AGT 1500 gas turbine engine to Chrysler Corporation for Chrysler's candidate XM1 main battle tank. Development of the multi-fuel 2 1/2-ton truck engine and the 1/4-ton truck "jeep" engine. Completed test-bed testing for the X-300-4A power train for new and product-improved track-laying vehicles. Evaluated a torque-proportioning, full-time, all wheel drive system. Testing of new mini-cooled turbocompounded engine and self-cleaning air filters was conducted. Cycle investigation and design studies the advanced turbine cycles were initiated. Design, fabrication and testing of reheat combustors was performed. Research on combustion systems of turbine engines and variable area turbocharger for diesel engines continued for the purpose of developing future engines that offer fuel economy, high fuel tolerance and increased power. Fabrication of nine prototype stratified charge engines and subsequent testing was begun for the purpose of finding a low emission, multi-fuel engine that is compatible with the 1/4-ton truck "jeep" and still provide good fuel economy. The design, fabrication, and initial testing of second generation of mechanical continuously-variable transmission for lightweight vehicles was completed.

Budget Activity #2 - Advanced Technology Development

Program Element # 6.36.21.A Title Vehicle Engine Development

2. FY 1977 Program: Advanced development in diesel, turbine, rotary and stratified charge engine technology will be continued to obtain reliable power plants that can be used to product improve present combat vehicles or to power successor vehicles in the 20 to 50-ton class. Special emphasis will be made in accelerating the work being performed on the variable area turbocharger, and turbocompounding of diesel engines. Additionally, the second generation of stratified charge engines will be built and subsequently tested for the 1/4-ton "jeep" role. Due to Environmental Protection Agency requirements, this program is being accelerated in order to have a clean engine for "jeeps" procured after 31 December 1978. Concept selection and the development program for the advanced family of continuously-variable transmission/steer systems will be initiated. System analysis studies to support transmission/steer unit systems applications for track and wheeled vehicles will continue. Initiate work on the universal regulator.

3. FY 1978 Planned Program: Complete investigation in diesel technology and begin evaluation of results to determine component technology to be incorporated in follow-on demonstrator engine programs. Continue development of the mini-cooled engine. Continue design of the innovative continuously-variable transmission system and fabricate critical components. Continue variable pump effort and provide systems analysis of transmission/steering systems for both wheeled and track vehicles. Initiate work on improved damper with testing at Test and Evaluation Command, Aberdeen, MD. Testing of universal regulator and track and system components will occur. Initiate work on new armor configurations. The increase in funding results from the fabrication of test beds to test the new cooling and air filtration units.

4. FY 1979 Planned Program: Continue development of the innovative continuously-variable transmission system and the mini-cooled engine. Continue work on gas turbine and diesel technology. Complete the testing on the universal regulator. Complete laboratory and field tests of a long durability track. Initiate development of self compensating idler which will contribute to longer track life. Will initiate carbon fiber technology in metal and plastic matrices. The increase in funding will support the development of the 1/4-ton "jeep" engine which is required to meet Environmental Protection Agency emission standards.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.36.21.A

Title Vehicle Engine Development

Project # DG07

Title Vehicle Engine Development

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

DETAILED BACKGROUND AND DESCRIPTION: This project involves the development of engines for combat and tactical vehicles that are not commercially available. The objective is to produce power plants for the future vehicle fleet that offer improved fuel economy, multi-fuel capability, high output power per space and weight, low emissions and improved maintenance characteristics.

RELATED ACTIVITIES: PE 6.36.02.A, Advanced Land Mobility System Components and PE 6.26.01.A, Tank and Automotive Technology. Turbine and diesel engine development for ground vehicle application is accomplished by the US Army for all the Services. Foreign state-of-the-art trends are constantly monitored and data are exchanged with allied countries by the use of Data Exchange Agreements.

WORK PERFORMED BY: US Army Tank-Automotive Research and Development Command, Warren, Michigan, is responsible for the developments in this project. Major contractors are: White Motor Corporation, Canton, Ohio; Southwest Research Institute, San Antonio, Texas; Teledyne Continental Motors, Muskegon, Michigan; AVCO Lycoming, Stratford, Connecticut; Cummings Engine Company, Incorporated, Columbus, Indiana; Donaldson Corporation, Minneapolis, Minnesota; Engine Systems Incorporated, Cincinnati, Ohio; and Texaco Research, Beacon, New York.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Development and transfer of the technology for the AGT-1500 gas turbine engine enabling Chrysler Corporation to use the engine in their XM1 main battle tank candidate. Development of the multi-fuel engine for 2 1/2-ton truck and the engine for the 1/4-ton "jeep" truck. Conducted evaluation on advanced turbocharging, universal fuel injection and turbocompounding on an AVCR 1360 diesel engine. Fabrication of 5L-183 stratified charge engines and completion of 1600 hours of dynamometer durability testing of three of these engines. Two of the engines were installed in vehicles and road tested for 36,000 miles. Cycle investigation and design studies for the advanced turbine cycles were intiated. Design, fabrication and testing of reheat combustors was performed. Research on the kinetics of heavy fuel combustion, combustor systems, heat exchangers, compressors, turbine wheels and accessory drive was conducted with the primary objective of improving fuel economy and fuel tolerance for future high output combat vehicle engines.

2. FY 1977 Program: Advanced development in diesel technology will continue with the objective to extend fuel tolerance, increase horsepower and fuel economy without increasing engine size for future combat vehicles. Major thrust in the area of turbine engines will be in advanced component test demonstration. Evalutions of commercial rotary and turbine engines, both foreign and domestic,

Budget Activity #2 - Advanced Technology Development

Program Element # 6.36.21.A Title Vehicle Engine Development

Project # DG07 Title Vehicle Engine Development

will continue to determine applicability to Army requirements. Alternate engines will be studied to include high pressure supercharging of the diesel, turbinizing of the variable compression ratio engine and the variable displacement engine as future high performance power plants. The major requirements for the funding increase to this program FY 1977 to FY 1978 is to accelerate the work connected with variable area turbocharging, universal fuel injection system and turbocompounding of diesel engines in all weight ranges. Additionally, the development of the replacement jeep engine has been accelerated. Test-bed vehicles incorporating advanced engines to establish maintenance and reliability data will be initiated.

3. FY 1978 Planned Program: Complete investigations in diesel technology and begin evaluation of results to determine component technology to be incorporated in follow-on demonstrator engine programs. Continue development of the mini-cooled engine. The increase in funding supports the initiation of fabrication of test-bed vehicle incorperating advancements in diesel technology as well as air filtration and cooling systems.

4. FY 1979 Planned Program: Continue the advancement of those component concepts that have shown promise towards application for future vehicle requirements. The increase in funding will support the development of a replacement 1/4-ton "jeep" engine which is required to meet Environmental Protection Agency emission standards.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	4163	1150	3365	3770	6500	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.36.24.A

Title Mobility

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	0	0	0	4617		
DH17	High Mobility Weapons Carrier	0	0	0	0	2133	1650	3783
DH64	High Mobility Tactical Vehicle	0	0	0	0	2484	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program element provides for conceptual and experimental test-bed vehicles oriented towards tactical support vehicles. These conceptual and experimental test-bed vehicles will incorporate new and advanced components, and will serve as a means of integrating and demonstrating advanced technology and innovative concepts. Novel configurations of existing componentry also will be examined. Advanced mobility concepts and innovative battlefield survivability features looking at broad areas of protection will be developed to determine feasibility and effectiveness. This program will serve as a means of accurately defining new system requirements in conjunction with the Army user community.

BASIS FOR FY 1978 RDTE REQUEST: Not Applicable. This Program will be funded in FY 1979.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Not Applicable.

PERSONNEL IMPACT: Not Applicable.

DETAILED BACKGROUND AND DESCRIPTION: The Army has a continuing requirement to increase its ground mobility technology base through examination of various promising concepts of tactical support vehicles. This element is a continuation of the effort to provide an inventory of proven integrated subsystems for low risk and low lead time exploitation by developers of a high mobility tactical fleet designed according to the guidelines laid down in the 1972 Department of the Army Special Analysis of Wheeled Vehicles (WHEELS) study. Each project would include to the maximum extent possible, an integration of developments in component areas, both commercial and military, into the vehicle systems.

Budget Activity #2 - Advanced Technology Development

Program Element # 6.36.24.A Title Mobility

RELATED ACTIVITIES: This program is related to all of the Army's research and development programs connected with tactical and special purpose vehicles. Programs of primary interest are: Program Element (P.E.) 6.26.01.A, Tank and Automotive Technology; PE 6.11.02.A, Project AF22, Research in Vehicle Mobility; PE 6.21.05.A, Materials; PE 6.36.21.A, Vehicle Engine Development; and PE 6.26.06.A, Advanced Concepts Laboratory.

WORK PERFORMED BY: US Army Tank and Automotive Research and Development Command, Warren, Michigan, has the responsibility for implementation of this program. Major contractors that are expected to participate in the program are: FMC Corporation, San Jose, California; PACCAR Corporation, Renton, Washington; and Chrysler Corporation, Detroit, Michigan.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Not Applicable

2. FY 1977 Program: Not Applicable

3. FY 1978 Program: Not Applicable.

4. FY 1979 Planned Program: Initiate design and fabrication of military essential kits that can be added to currently available vehicles so that these vehicles will meet the required military characteristics for TOW Missile Carrier in the Light Infantry Support role. Additionally, an evaluation will be conducted of currently available heavy high mobility tactical vehicles, foreign and domestic, with two heavy high mobility tactical vehicle test rigs currently under fabrication. This evaluation will provide a cost-benefit analysis for various levels of mobility.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.37.02.A

Title Electric Power Sources

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	3,418	1,190	3,944	3,310	6,838	Continuing	Not Applicable
DG10	Electro-Chemical Power Sources	1,548	605	2,200	2,119	3,782	Continuing	Not Applicable
DG11	Electro-Mechanical Power Sources	1,870	585	1,744	1,191	3,056	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The objective of this program is to conduct advanced development on electric power sources and [illegible] devices for Army use. These electric power sources and devices include, but are not limited to, batteries, fuel cells, engine driven generators, power conditioners, power transmission devices, and power distribution devices.

BASIS FOR FY 1978 RDTE REQUEST: To continue advanced development of fuel cell power plants, lithium-organic electrolyte and vented nickel-cadmium batteries, thermoelectric generators, hybrid power sources for vehicle applications, and ceramic components for gas turbine engine generators.

[illegible] CHANGE IN FY 1978 OVER FY 1977: Funding [illegible] decrease is result [illegible] reduced efforts in fuel cells, evaluations of advanced gas turbines, and power controls and conditioners.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	[illegible]	[illegible]	80
(2) Contractor Employees	40	[illegible]	26
Total	66	0	106

NOT REPRODUCIBLE

Budget Activity 6.2 - Advanced Technology Development

Program Element 6.37.02.A Title Electric Power Sources

DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is to develop families of military electric power sources with power outputs from milliwatts to hundreds of kilowatts. Lower power requirements, as for portable electronic equipment, are met by batteries developed to have a high energy density, long storage life and operation over wide temperature ranges. Power ratings beyond batteries are met by engine generators with reliability, long life, reduced maintenance, and power quality capabilities exceeding those provided by commercially available systems. Fuel cells are under development to provide low and intermediate power for silent operation and other operational characteristics not met by existing power sources.

RELATED ACTIVITIES: The Power Sources Conference sponsored by the US Army Electronics Research and Development Command provides for exchange of information by government, academic and industrial researchers. The Army also maintains continuing coordination with the US Air Force; US Navy; Energy Research and Development Administration; National Aeronautics and Space Administration; Health, Education and Welfare Department; and Department of Transportation through the Interagency Advanced Power Group, the Power Information Center and the Department of Defense Project Manager for Mobile Electric Power. Advanced development items in this program element progress to engineering development in Program Element 6.47.14.A, Project D194, Engine Driven Generators, and Project D196, Silent Power Generating Sources. Related basic research is conducted in Program Element 6.11.02.A, Project AH47, Electronic Devices Research, and Project AH51, Combat Support Research. Exploratory development is conducted in Program Element 6.27.05.A, Project AH94, Electronics and Electronic Devices, and Program Element 6.27.33.A, Mobility Equipment Technology.

WORK PERFORMED BY: In-house work is performed by the US Army Mobility Equipment Research and Development Command, Fort Bevoir, VA; and the US Army Electronics Research and Development Command, Fort Monmouth, NJ. Contractors include Eagle-Pitcher, Joplin, MO (batteries); Gould Incorporated, St. Paul, MN (batteries); Mallory Battery Incorporated, Terrytown, NY (batteries); Potomac Research, McLean, VA (fuel cells); Yardley Electric, Pawcatuck, CT (batteries); 3-M Company, St. Paul, MN (thermoelectric power); Energy Research Corporation, Danbury, CT (fuel cell); Englehard Industries, Newark, NJ (fuel cells); Illinois Institute of Technology Research Institute, Chicago, IL (thermal cracker); Solar Division of International Harvester, San Diego, CA (turbine engine generators); Hercules Division, White Engines, Canton, OH (high speed, low horsepower (HP) diesels); and Delta Electronics Corporation, Costa Mesa, CA (inverters for fuel cells).

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Completed development of advanced compressor/turbine components for future 60 kilowatt (KW) generator sets. Completed initial evaluation of new concept for rotating vaned and vaneless diffusers for centrifugal compressors. Completed development of compliant-type gas bearings for 10 KW turbine engine. Completed in-house tests of fluidic fuel control on a gas turbine engine, and investigation of a 140,000 revolutions per minute bearing system for small gas turbines. Continued development of ceramic nozzle assembly for 10 KW gas turbine engine by extending silicone nitride vane effort to full silicon nitride nozzle assembly. Continued investigation of chemical vapor deposition of silicon carbide as candidate process for fabricating 10 kilowatt (KW) turbine rotor. Continued development of ceramic ball bearing systems for small gas turbines. Designed 15 KW general purpose power conditioner, demonstrated feasibility of step-wave inverter for high power conditioners, and designed and tested 1.5 KW inverter for fuel cell. Advanced development (AD) contracts for a 1.5 KW methanol fuel cell and an improved 1.5

Budget Activity: 6 - Advanced Technology Development

Program Element: [illegible]

Title: Electric Power Sources

KW thermal [illegible] logistic fuels were awarded. Validation In-Process Review on 1.5 KW methanol fuel cell was conducted. Performance characteristics of a lithium-organic sulphur dioxide (SO_2) electrolyte battery were confirmed. Advanced development (AD) of 100 watt and 500 watt thermoelectric generator design reconfigurations were completed. Design of an alternating current (AC) to direct current (DC) power processor was completed.

2. FY 1977 Program: The effort to apply ceramic nozzles and bearings to the 10 KW gas turbine engine will be extended to include [illegible] of all candidate items, and design selection and test of optimum configuration. Initiate work to optimize design of AD model of silenced 10 KW turbine generator set. Initiate evaluation of a 5 KW Stirling cycle generator set to determine performance and operational characteristics. Continue development and testing of 15 KW general purpose power conditioner and 1.5 KW fuel cell inverter. Initiate development of a 3 KW fuel cell inverter. Complete AD of 1.5 KW methanol fuel cell. Continue AD of 1.5 KW thermal cracker subsystem and expand to 3 KW. Initiate examination of alternates to the thermal cracker for utilizing logistic fuels for fuel cells. Complete AD effort on AC-DC power processor. Begin evaluation tests of 100 watt thermoelectric generator. Begin fabrication of 500 watt thermoelectric generator. Continue efforts to improve safety, reliability and life of lithium SO_2 batteries. Initiate AD of 3 KW methanol fuel cell.

3. FY 1978 Planned Program: Continue effort on advanced components for electric power sources. Complete development and test of ceramic nozzles for [illegible] KW gas turbine engine. Continue development of ceramic bearings for gas turbines. Complete evaluation of commercial 5 KW Stirling cycle generator set. Initiate development of an integrated power module inverter. Continue development of a 15 KW general purpose power conditioner and a 3 KW fuel cell inverter. Complete AD of 3 KW methanol fuel cell. Install improved hybrid power system in materials handling equipment and begin tests. Complete efforts on lithium SO_2 battery and prepare procurement data. Continue test of 100 watt and complete fabrication of 500 watt thermoelectric generator AD models. Initiate AD efforts on DC-DC converter/regulator for power processing. Funding decrease in FY 1978 over FY 1977 is net result of reduced efforts in fuel cells, evaluations of advanced gas turbines, and power conditioners, partially offset by increased battery efforts.

4. FY 1979 Planned Program: Continue evaluation of regenerative turbine, and other advanced cycle engine technology. Initiate development of low-cost, high reliability controls for diesel engines, and additional ceramic components for turbine engines. Initiate AD of 5 KW and 0.5 KW fuel cell inverters, 1.5 KW and 30 KW general purpose power conditioners and distribution modules to improve power distribution in the field. Initiate AD of 5 KW methanol fuel cell and 5 KW thermal cracker. Complete AD on optimized hybrid power system for materials handling equipment. Evaluate commercial fuel cell power plants from United Technology's target program. Continue efforts on 100 and 500 watt thermoelectric generators. Continue efforts on DC-DC converter/regulator for power processing. Increase in funds for FY 1979 over FY 1978 is required to begin AD effort on 5 KW fuel cell system, expand work on power control and conditioner devices, and pursue high pay-off ceramics technology for gas turbine generators.

5. Program to Completion: This is a continuing program.

NOT REPRODUCIBLE

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.37.02.A

Title Electric Power Sources

Project # DG10

Title Electro-Chemical Power Sources

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

DETAILED BACKGROUND AND DESCRIPTION: This project is designed to satisfy the Army's requirements in electro-chemical power sources (fuel cells and batteries). Many of these items are considered components of other systems and do not experience an engineering development program by themselves. The majority of the Army's batteries are fielded directly from this project. The effort in fuel cells is carried from exploratory development to engineering development in this project, with considerable effort expended in the fuel conditioning area. Objectives are to increase the energy and power densities, increase the temperature operating ranges, improve storage life and reduce the cost of electro-chemical power sources.

RELATED ACTIVITIES: The Power Sources Conference sponsored by the US Army Electronics Research and Development Command provides for exchange of information by government, academic and industrial researchers. In addition, the Army maintains continuing coordination with the US Air Force; US Navy; Energy Research and Development Administration; National Aeronautics and Space Administration; Health, Education and Welfare Department; and Department of Transportation through the Interagency Advanced Power Group, the Power Information Center and the Department of Defense Project Manager for Mobile Electric Power. Advanced development items in the project progress to engineering development in Program Element 6.47.14.A, Project D196, Silent Power Generating Sources. Related basic research is conducted in Program Element 6.11.02.A, Project AH47, Electronic Devices Research, and Project AH51, Combat Support Research. Exploratory development is conducted in Program Element 6.27.05.A, Project AH94, Electronics and Electronic Devices, and Program Element 6.27.33.A, Mobility Equipment Technology.

WORK PERFORMED BY: In-house laboratory work and contract monitoring is performed by the US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA; and the US Army Electronics Research and Development Command, Fort Monmouth, NJ. Contractors include Eagle-Pitcher, Joplin, MO (batteries); Gould Incorporated, St. Paul, MN (batteries); Mallory Battery Incorporated, Tarrytown, NY (batteries); Potomac Research, McLean, VA (fuel cells); Yardley Electric, Pawcatuck, CT (batteries); 3-M Company, St. Paul, MN (thermoelectric power); Energy Research Corporation, Danbury, CT (fuel cells); Englehard Industries, Newark, NJ (fuel cells); and Illinois Institute of Technology Research Institute, Chicago, IL (thermal cracker).

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Advanced development contracts for a 1.5 kilowatt methanol fuel cell and an improved 1.5 kilowatt thermal cracker for logistic fuels were awarded. In-house work continued on improving metal hydride fuel cells for low power remote applications and hybrid power source technology (fuel cell/battery) for materiel handling equipment (MHE) and other vehicle applications. A Validation In-Process Review on 1.5 kilowatt (KW) methanol fuel cell was conducted and will be reconvened during FY 1977 to resolve fuel and cost issues. Performance characteristics of lithium-organic electrolyte batteries

were confirmed through laboratory and field tests. An advanced development (AD) model configuration for a 500 watt thermoelectric generator was completed.

2. FY 1977 Program: Complete AD effort on 1.5 kilowatt (KW) methanol fuel cell. Continue AD effort on 1.5 KW thermal cracker subsystem and expand to 3 KW. Initiate studies of other technical approaches for use of logistic fuels for fuel cells. Continue development efforts on hybrid systems to improve controller, cell stack and methanol reformer. Initiate evaluation of ion exchange membrane technology for methanol fuel cells. Initiate AD on 3 KW methanol fuel cell. Continue improvement of fuel cell electrodes and advanced materials for fuel cell construction. Initiate AD efforts on a 60 watt metal hydride fuel cell. Begin fabrication of 500 watt thermoelectric generator models. Continue efforts on lithium-organic electrolyte batteries to improve safety and reliability.

3. FY 1978 Planned Program: Complete AD of 3 KW methanol fuel cell and conduct Validation In-Process Review. Install improved hybrid power system in materials handling lift truck and initiate tests. Complete AD on metal hydride fuel cell systems and initiate development of advanced electrolyte fuel cell stacks. Complete AD on thermal cracker subsystem for 1.5 KW Silent Lightweight Electric Energy Plant (SLEEP) fuel cell. Life-test low cost electrodes in fuel cell stacks using improved materials. Complete lithium-organic electrolyte battery effort and prepare procurement documentation. Characterization of 60 watt fuel cell will be completed. Initiate evaluation of 500 watt thermoelectric generator. Funding decrease in FY 1978 over FY 1977 is net result of reduced fuel efforts offset partially by increased battery effort.

4. FY 1979 Planned Program: Initiate AD of 5 KW methanol fuel cell and 5 KW thermal cracker. Evaluate commercial fuel cell power plants from United Technology's target program. Optimize advanced organic stack and develop alternate to thermal cracker for advanced fuel cell stacks. Complete AD on optimized battery/fuel cell hybrid power system for materials handling equipment. Complete evaluation of 500 watt thermoelectric generator AD models. Design advanced development models of uninterrupted power sources for use with communication/electronics equipment. Funding increase in FY 1979 over FY 1978 is primarily to start effort on 5 KW fuel cell system.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

		FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE:	Funds	1,548	605	2,200	2,119	3,782	Continuing	Not Applicable
	Quantities							

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.37.02.A

Title Electric Power Sources

Project # DG11

Title Electro-Mechanical Power Sources

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

DETAILED BACKGROUND AND DESCRIPTION: The objective of this project is to develop families of military electric power sources with power outputs from hundreds of watts to hundreds of kilowatts (KW). The electric power sources include spark ignition, compression ignition and turbine engine driven generator sets, electric power converters and unconventional electric power generators, e.g., Rankine and Stirling cycle engine driven generators. The component development for distribution of electric power is included in this Project. Objectives are improvement of engine efficiencies; extension of engine life; increased set reliability, availability, maintainability and dependability; reduction of initial cost and life-cycle cost; and reduction in weight of generator sets.

RELATED ACTIVITIES: The Power Sources Conference sponsored by the US Army Electronics Research and Development Command is the forum for exchange of information by Government, academic and industrial researchers. In addition, the Army maintains continuing coordination with the US Air Force, US Navy, US Energy Research and Development Administration, National Aeronautics and Space Administration, Health, Education and Welfare Department, and Department of Transportation through the Interagency Advanced Power Group, the Power Information Center and the Department of Defense Project Manager for Mobile Electric Power. Advanced development items in the project progress to engineering development under Program Element 6.47.14.A, Project D194, Engine Driven Generators, and Project D196, Silent Power Generating Sources. Related basic research is conducted in Program Element 6.11.02.A, Project AH47, Electronic Devices Research, and Project AH51, Combat Support Research. Exploratory development is conducted in Program Element 6.27.05.A, Project AH94, Electronics and Electronic Devices, and Program Element 6.27.33.A, Mobility Equipment Technology.

WORK PERFORMED BY: In-house laboratory work and contract monitoring is performed by the US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA, and the US Army Electronics Research and Development Command, Fort Monmouth, NJ. Contractors include Solar Division of International Harvester, San Diego, CA (turbine engine generators); Hercules Division, White Engines, Canton, OH (high speed, low horsepower (HP) diesels); and Delta Electronics Control Corporation, Costa Mesa, CA (inverters for fuel cells).

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: The development of advanced compressor/turbine components for future 60 KW generator sets was completed and goals met. The development test of an advance model 1.5 KW DC Rankine cycle power plant was completed and problem areas defined. Completed evaluation of the United Kingdom 1.5 KW low noise level Wankel engine generator set. Results indicated limited engine durability due to combustion chamber deposits. Completed initial evaluation of a new concept for rotating vaned and vaneless diffusers for centrifugal compressors. Completed development of compliant type gas bearings for the 10 KW turbine engine. Completed in-house testing of fluidic fuel control on a gas turbine engine and the investigation of a 140,000 revolutions per minute bearing system for small gas turbines. Continued development of ceramic nozzle assembly for the 10 KW gas

Budget .ty #2 - Advanced Technology Development

Program Element # 6.37.02.A Title Electric Power Sources

Project # DG11 Title Electro-Mechanical Power Sources

turbine engine by extending silicon nitride vane effort to full silicon nitride nozzle assembly. Continued the investigation of chemical vapor deposition of silicon carbide as candidate process for fabricating 10 kilowatt (KW) turbine rotor. Continued development of ceramic ball bearing systems for small gas turbines. Designed 15 KW general purpose power conditioner, demonstrated feasibility of step-wave inverter concepts for high power conditioners, and designed and tested 1.5 KW inverter for fuel cell. Design of a 100 watt man-portable thermoelectric generator was completed. Initiated advanced development (AD) of an AC-DC precision power processor for use with communication/electronics equipment.

2. FY 1977 Program: The development program to apply ceramic nozzles to the 10 KW gas turbine engine is being extended to include thermal proof testing of all candidate items, design selection and test of the optimum configuration. Complete the investigation of the technology for fabricating radial turbine rotors from silicon carbide by the chemical vapor deposition process. Initiate a program to optimize the design of the AD model of silenced 10 KW turbine generator set. Initiate the evaluation of a 5 KW Stirling cycle generator set to determine performance and operational characteristics. Evaluation of 10 horsepower (HP) and 20HP air cooled diesel engines is being continued to identify the design limitations for the engine when adapted to end item equipment. Continue in-house testing of selected advance industrial engines and controls. Continue development and testing of 15 KW general purpose power conditioner and 1.5 KW fuel cell inverter. Initiate development of 3 KW fuel cell inverters. Begin fabrication of 100 watt man-portable thermoelectric generator. Efforts on the AC-DC precision power processor will be completed and performance evaluated.

3. FY 1978 Planned Program: Continue AD effort on selected components to improve performance characteristics, reliability, maintainability, reduce fuel consumption, provide multi-fuel capability and improve cost and mission effectiveness for advanced power generating equipment using gas turbine, reciprocating and Stirling engines, and other advanced electro-mechanical sources. Complete the development of ceramic nozzles for the 10 KW gas turbine engine and conduct tests of 10 KW turbine engines with ceramic nozzles installed. Continue the development of ceramic bearings with the goal of having an all ceramic bearing turbine engine. Complete the evaluation of the commercial 5 KW Stirling cycle generator set and initiate engineering changes required to prove-out this technology for meeting military requirements. Continue in-house testing of selected gas turbine engines, including regenerative type, Stirling cycle and other advanced industrial engines, to determine adaptability for military use. Initiate development of integrated power module inverter. Continue development of 15 KW general purpose power conditioner and 5 KW fuel cell inverter. Complete fabrication of 100 watt thermoelectric generator. Initiate AD efforts on converter-regulator for precision power sources requirement. Funding decrease in FY 1978 over FY 1977 reflects reduced requirements for evaluating selected advanced gas turbines, and reduced thrust on power controls and conditioners.

4. FY 1979 Planned Program: Continue evaluation of Stirling, regenerative turbine, and other advanced engine technology. Initiate development and testing of low cost, high reliability controls for diesel engines. Develop, test and evaluate additional ceramic components for turbine engines. Continue AD of 15 KW power conditioner. Complete AD of 3 KW fuel cell inverter. Initiate

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Program Element # 6.37.02.A Title Electric Power Sources

Project # DG11 Title Electro-Mechanical Power Sources

development of 5 KW and 0.5 KW fuel cell inverters, 1.5 KW and 30 KW general purpose power conditioners, and distribution modules to improve field capability in power distribution. Begin test and evaluation of 100 watt thermoelectric generator. Continue advanced development efforts on a DC-DC converter/regulator for use with communication/electronics equipment. Increase in funds for FY 1979 over FY 1978 is necessary to increase thrust in potential high pay-off area of ceramics technology for gas turbine engine generators, and to expand efforts on power control and conditioner devices for generators and fuel cells.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

		FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE:	Funds	1,870	585	1,744	1,191	3,056	Continuing	Not Applicable
	Quantities							

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.03.A

Title Automatic Data Processing Equipment Development

Category Exploratory Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	1270	455	1703	4631	5984	Continuing	Not Applicable
D654	Automatic Data Processing Equipment Development	1270	455	1703	4631	5984	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program element supports advanced development and evaluations and demonstrations of new computer technologies with potential high pay offs for Army automated system developers. It includes the development of a framework for acquisition of a tri-service software-compatible family of militarized computers (Military Computer Family or MCF) with associated systems/support software; evaluation of tactical Automatic Data Processing systems, equipments, and processing techniques through use of the Teleprocessing Design Laboratory; the development of advanced tactical input/output terminals and peripheral devices; and development of improved techniques, standards, and tools for use in generating reliable and maintainable tactical systems software.

BASIS FOR FY 1978 RDTE REQUEST: The emphasis of the program is on completion of systems/software implementation plans and appropriate Army/Navy/Air Force management reviews of these plans for a software compatible Tactical Military Computer Family (MCF); application of the Teleprocessing Design Laboratory equipment for tactical computer system emulation and multiple system interoperability experimentation using actual Army tactical data system software, as well as emulation and evaluation of tactical systems for future incorporation into the Department of Defense inventory; further development and enhancement of software generation and maintenance tools as part of the Integrated Software Development System (ISDS); completion of advanced development models of the Programable Miniature Message Terminal (PROMT) and initial determination of its feasibility for application in support of multiple requirements; and preparation of guidance/directive documents to achieve a more uniform and progessive approach to tactical software engineering.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Major increases in FY 78 are required to support major management and technological thrusts initiated by the Department of Defense (DOD). The management thrusts as contained in DOD Directive 5000.29 are input supported by activities in this program. The technological thrusts concentrate on transferring to military developers and users the new tools for use in software life cycle. The program content has been fully coordinated by the Management Steering Committee for Embedded Computer Resources and forms an interlocking portion of the overall Defense software program. In addition, specific and unique Army activities include the transitioning of the Military Computer Family (MCF) program from 6.2 (Exploratory

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.03.A Title Automatic Data Processing Equipment Development

Development) into 6.3 (Advanced Development) with the completion of its supporting systems and software implementation plans; and the similar transition of the Integrated Software Development System (ESDS) to 6.3 (Advanced Development) and the acquisition of the first priority increment of tactical software development tools under this program.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement) is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	18	0	18
(2) Contractor Employees	21	0	21
Total	39	0	39

DETAILED BACKGROUND AND DESCRIPTION: This program element supports the US Army Material Development and Readiness Command (DARCOM) Center for Tactical Computer Sciences (CENTACS) advanced development program in tactical computer hardware and software technology, and tactical systems design tools and techniques. The project encompasses the development of standards and a framework for the acquisition of a tri-service Military Computer Family (MCF) for use by project managers developing tactical computer-based systems; an Integrated Software Development System (ISDS) used for developing tactical computer-based systems; preparation of guidance documents (supporting Army implementation of Department of Defense Directive 5000.29) for use by US Army Material Development and Readiness Command and other system developers; the Teleprocessing Design Laboratory's continued development of a library of computer system emulations with the objects of (1) improving individual systems software and hardware performance and (2) enhancing the capability of the laboratory to perform simultaneous tactical system emulations for interoperability experimentations; and development of a compatible family of new, significantly improved tactical input/output terminals and peripheral devices. Products of individual tasks complement one another and the entire project represents a coordinated effort as solving current problems of tactical computer-based system development.

RELATED ACTIVITIES: Efforts in this program element have application to developments in Program Element (PE) 6.37.22.A (Tactical Operations System) PE 2.37.26.A (Tactical Fire Direction System), PE 6.37.23.A (Integration of Army Tactical Data Systems (ARTADS), and PE 6.27.01 AH92 (Communications-Electronics). In FY 1973, this program element was a project within PE 6.37.23.A (Command and Control). In FY 1972 and prior, this program was identified as PE 6.37.03.A (Automatic Data Systems for the Army in the Field). An Army/Navy Memorandum of Agreement for the cooperative development of a software compatible Military Computer Family (MCF) of tactical computers and associated systems software has been established, and has recently become the basis for tri-service cooperation.

Budget Activity #2 - Advanced Technology Development

Program Element *6.37.03.A Title Automatic Data Processing Equipment Development

WORK PERFORMED BY: The advanced development of tactical computer equipment and support software is performed by the Center for Tactical Computer Sciences (CENTACS), US Army Electronics Research and Development Command, Fort Monmouth, NJ. Contractors include: Westinghouse Corporation, Baltimore, MD; Control Data Corporation, Minneapolis, MI; Softech Incorporated, Boston, MA; McDonald Douglas, Huntington Beach, CA; HOS Incorporated, Cambridge, MA; Systems Development Corporation, Santa Monica, CA; Advanced Technology Division, ITEX, Sunnyvale, CA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: The Teleprocessing Design Center (TDC), an engineering design and test facility used for evaluation of candidate Army Tactical Data Systems equipment and systems for the conduct of inter-Army and inter-service interoperability experiments, was developed and installed. The Tactical Fire Direction System (TACFIRE) battalion system emulation has been completed and is fully operational and executable. Development of emulations of the TACFIRE Division Artillery software system and the Tactical Operating System Operable Segment (TOS^2) have been initiated. Basic emulators for the AN/UYK-19 and AN/UYK-15 processors have been completed and are available to serve as a basis for emulation of tactical systems employing these processors. An Automated Verification System (AVS) software package, designed to evaluate testing and performance of programs written in the Army Higher Order Tactical Procedure Oriented Language (TACPOL) is installed, tested, and operational in the TDC. The compatible Military Computer Family (MCF) project (now a tri-service program) for development of a framework for acquisition of tactical computers, has reached a point where a joint selection committee has recommended adoption of a specific objective architecture. The Center for Tactical Computer Science Requirements Advisory Group (CRAG) was formed and continues to provide advice, assistance, and guidance regarding the needs of Army Project Managers and related activities represented by the membership. The Integrated Software Development System (ISDS) is identified as a significant requirement in support of Army tactical data system developments and its development has been initiated within this program element. The ISDS provides both a blueprint and the necessary tools for development of reliable, maintainable tactical computer-based systems software. The Block Oriented Random Access Memory (BORAM), a jointly funded (Army/Navy) cooperative program has produced equipment for test by Army/Navy engineers.

2. FY 1977 Program: The TDC emulation of the TACFIRE battalion system will be modified to represent the most current version of TACFIRE to be used for development/operational testing. The TACFIRE Division level system will be emulated to permit exercises of interoperable systems using actual tactical software (i.e. TACFIRE Division and Battalion). The TDC emulation of the Tactical Operations Support System (TOS^2) will give the facility a capability to demonstrate interoperability of two significant Army systems within a single installation without the necessity of physically implanting the military versions of the hardware on site. Based on Department of Defense Directive 5000.29, more intensified effort will be allocated to development of directive and guidance documents for use by tactical data systems developers. The MCF architecture recommended by the service/industry

evaluation committee will be approved and work on the System Implementation Plan and Support Software System Implementation Plan will be initiated. A software testing tool similar to that used for testing the Tactical Procedure Oriented Language (TACPOL) will be developed for the Litton 3050 assembly language, and will be used to evaluate the reliability of computer programs written in assembly language. Contracts will be issued for advanced development models of a miniature message entry terminal. These models will subsequently be utilized to determine the feasibility of employing a common device for multiple system requirements. Major effort in the Integrated Software Development System will be initiated in close coordination with representatives of Project Managers and other system developers. Detailed specifications for highest priority tools will be developed. This is a multi-year project to provide new methodologies, implementing tools and related guidance for the developers of tactical data systems.

3. FY 1978 Planned Program: The Teleprocessing Design Center (TDC) will have the capability to emulate a variety of Army systems to include the AN/GYK-12 (Litton 3050 processor) used in TACFIRE the Air Defense Control and Coordination System, AN/TSQ-73, and the Tactical Operations System Operable Segment (TOS^2) test bed. Additionally, emulations of the AN/UYK-19, AN/UYK-15 tactical computers, and the AN/UYK-20 computer system used by the Navy and the Position Location Reporting System (joint Army/Marines project) will be available. This extensive capability will serve as a foundation for the TDC to support the Ground Amphibious Military Operations (GAMO) interoperability program with as many as three systems running concurrently providing for all data interchanges among systems. Implementation planning and support software for the Military Computer Family (MCF) will be completed and reviewed by Army/Navy/Air Force management. Preparation for acquisition of representative MCF equipment will be iniciated. Work on the Integrated Software Development System (ISDS) formal methodology for software development will commence and will be aimed at covering all phases of embedded real time tactical system software development and post deployment maintenance. Generation of additional guidance documents for tactical data system developers will continue together with supplemental orientation and training for users of the documents. Preliminary work will be accomplished to adapt PROMT devices to candidate system applications and plan for appropriate testing. Increase in funding level over FY 1977 is required to support the Department of Defense Higher Order Language program and to initiate efforts to establish a Tactical Procedure Oriented Languate (TACPOL) language control facility and associated software tools. This effort is a major thrust of the Department of Defense and is a significant first step towards providing a standard set of Higher Order Languages for use by automated system developers.

4. FY 1979 Planned Program: The TDC will be engaged in extensive support of the GAMO program and will also be testing emulators for additional Army and other service systems prior to further interoperability experiments. Prototype software tools based on the Integrated Software Development System formal tactical software development methodology will be introduced throughout the US Army Materiel Development and Readiness Command with attendant orientation and training for using personnel and managers. An Integrated Software Development System design analyzer will be completed which will be capable of automatically checking for the validity of specification language descriptions. A structuring executive will also be completed to organize, in real time, functions performed within the control processes of a tactical system. New and revised directive and guidance documents relating to disciplined software development will be generated and completed material will be distributed throughout the US Army. Work on

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.03.A Title Automatic Data Processing Equipment Development

development of a high resolution Interactive Intelligent Graphics Terminal (I^2 GT) will begin both as a replacement for more cumbersome existing equipment and to provide significantly improved graphical performance capabilities. Increase in funding level over FY 1978 is required to continue support of the Department of Defense Higher Order Language program and to continue efforts to create a Tactical Procedure Oriented Language Control facility initiated in FY 1978.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.06.A

Title Identification Friend or Foe (IFF) Developments

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	200	53	1400	581	1500	Continuing	Not Applicable
D-243-02	IFF Developments, Air-by-Ground	0	0	700	381	1200	Continuing	Not Applicable
D-243-03	IFF Developments, Ground-by-Ground	200	53	700	200	300	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This advanced development effort is being performed to establish the feasibility of Identification of Friend or Foe, IFF techniques and equipments that can be used to satisfy Army requirements for both battlefield and air defense IFF systems. The potential applications include ground-by-ground (tank-by-tank), air-by-ground (air defense), and ground-by-air (tank-by-aircraft). The IFF system is to provide for positive and automatic recognition and identification. Several technical approaches will be pursued to provide a tradeoff range between performance and cost. The initial effort supports a cooperative system which requires an interrogator on the one hand and a transponder on the other in order to complete the identification. The goal is to work toward a non-cooperative system where positive identification can be made without the unknown having respond to an interrogator.

BASIS FOR FY 1978 RDTE REQUEST: The development of the laser/radio, microwave/Very High Frequency IFF systems initiated in FY 1976 will be completed for a side by side developmental test to determine which system or combination of components from the two systems meets best the requirements for tank-by-tank IFF. The non-cooperative effort will be continued for the identification of aircraft by Army Air Defense missile batteries. A technique developed by the Navy and Air Force will be modified to be compatible with Army quick reaction air defense requirements. A computer simulation of performance, including vulnerability to deception will be completed and evaluated prior to any fabrication of hardware (planned for FY 1979). Army support of a tri-service development of improvements to MARK XII air defense IFF will continue.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: FY 1978 funding is decreased, based on expected completion and evaluation of development models in FY 1977 for tank-by-tank test in FY 1978. Hence, FY 1978 funds for this project will be limited to support test and analysis of test results.

Budget Activity #4 - Advanced Technology Development

Program Element #6.37.06.A Title: Identification Friend or Foe (IFF) Developments

PERSONNEL IMPACT: The average number of employees supported with requested FY 1978 funds (RDTE and Procurement) is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	6	0	6
(2) Contractor Employees	5	0	5
Total	11	0	11

DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is to establish the technical and operational feasibility of a system of equipments that can be used by ground weapons systems to identify ground targets they acquire and might attack. Some of the equipments that will be developed may also have application to ground-by-air and air-by-ground Identification of Friend or Foe (IFF) operations. Programs of the next several years will concentrate on laser and microwave interrogator/transponder approaches to tank-to-tank IFF systems. This effort will provide baseline information to permit advanced development of IFF devices having more universal application, as for example, IFF for direct fire weapons other than those on tanks and IFF for a variety of surveillance sensors including radar and night viewing types. The microwave/Very High Frequency (VHF) system relies on the traditional interrogation/response technique. A narrow-beam microwave interrogation is directed at the transponder, which receives the interrogation through an omnidirectional antenna, validates that the interrogation is authentic, and replies with an omnidirectional VHF transmission. The VHF response is received and decoded back at the interrogator, and a "friend" presentation is then displayed. The laser interrogator will follow the same general steps as outlined above in the microwave interrogator. The goal of the program is to determine which single system, or which combination of techniques from both systems, offers the best solution to the BIFF (battlefield identification friend or foe) problem. The non-cooperative solution is a long range goal which looks promising for the air defense role.

RELATED ACTIVITIES: The Navy and Air Force have the principal developments in the non-cooperative IFF which are being applied for use in the air defense role. Talks have been initiated with the Federal Republic of Germany for a data exchange agreement (DEA) on the developmental efforts underway and possibly some cooperative R&D effort in the future on BIFF. Development of improvements to MARK XII by the Navy and Air Force have application to Army systems and warrant Army participation to assure compatibility with Army operations.

WORK PERFORMED BY: In-house work is being performed by the US Army Electronics Research and Development Command, Fort Monmouth, New Jersey. Contractors that are expected to actively participate in the battlefield IFF development are Hazeltine Corporation, Greenlawn, New York; General Electric Company, Syracuse, New York; Teledyne Electronics, San Diego, California; Motorola, Inc., Scottsdale, Arizona; American Electronics Laboratory, Bluebell, Pennsylvania; Texas Instruments, Dallas, Texas; Airborne Instruments Laboratory, Long Island, New York; RCA Corporation, Camden, New Jersey; and Stanford Research Institute, Menlo Park, California.

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.06.A Title: Identification Friend or Foe (IFF) Developments

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Fabrication of two different forms of Battlefield Identification Friend or Foe (BIFF) equipment were started in FY 1976 and continued in FY 197T for the purpose of demonstration in tank-to-tank Identification Friend or Foe (IFF) application. The equipment will serve as test vehicles which can be examined from both operational and technical viewpoints to determine which single system, or which combination of basic components from between the two equipments, can be utilized to provide a basic or first generation ground-to-ground IFF system. Two sets of each equipments are being developed so that the microwave/Very High Frequency (VHF) and the laser/radio BIFF will be able to be compared in a side by side demonstration.

2. FY 1977 Program: Complete fabrication of BIFF equipments started in FY 1976 and perform a study on integration thereof on the battlefield. Participate in tri-service development of improvements to MARK XII air defense IFF as part of the United Kingdom/ United States and NATO cooperative IFF programs. Initiate computer simulation of non-cooperative IFF techniques (developed by Navy and Air Force) applied to Army air defense missile batteries.

3. FY 1978 Planned Program: Participate in side by side field development test of the two types of BIFF equipments and analyze test results for subsequent FY 1979 engineering development of an optimum configuration under program 6.47.09.A, IFF Equipment/ AIMS. Complete computer simulation of the non-cooperative technique applied to Army air defense batteries and prepare procurement data for FY 1979 procurement of development models. Continue participation in tri-service development of improvements to MARK XII air defense IFF. The FY 1978 funding is decreased from FY 1977 since during this year the results of field tests will be evaluated.

4. FY 1979 Planned Program: Increase in FY 1979 funds over FY 1978 due primarily to plans to procure advanced development models of non-cooperative air defense IFF based on the FY 1978 results of the computer simulation. Continue participation in tri-service development of improvements to MARK XII air defense IFF. Certain improvements should enter engineering development under program 6.47.09.A, IFF Equipment/AIMS.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element 6.37.10.A

Title Night Vision Advanced Development

Category Advanced Development

Budget Activity 02 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	12,000	2600	13430	12951	16289	Continuing	Not Applicable
DK 70	Night Vision Systems	12,000	2600	13430	12951	16289	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: The objective of this program element is to conduct the advanced development of night vision techniques, components and devices, which will provide the Army an improved capability to operate during periods of darkness or reduced visibility. The program bridges the gap between research of advanced night vision concepts, and the Full Scale Development of night vision equipments, by demonstrating the application of these concepts in models of proposed systems. Prior to FY 1978, this program was project DK70 under program element 6.37.19.A, Surveillance, Target Acquisition and Night Observation (STANO).

BASIS FOR FY 1978 RDTE REQUEST: Specific tasks within the program element include development of standard infrared common modules and third generation image intensification (I^2) devices. The common module program will achieve cost reduction through standardization of design, and encouragement of competition in the market place. In addition, improved infrared components will be configured for direct replacement of existing modules, minimizing the costs of implementing improved technologies. Third generation I^2 tube technology will extend the night airborne capability from quarter moon to starlight, an increase of 25% over present capability. The net effect of I^2 improvements in ground applications will be an extension of target detection ranges by a factor of two to three times present capability, thereby closely matching daylight performance.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The decrease in resources for FY 1978 from those for FY 1977 is due to completion of the baseline design verification effort on the standard far infrared common modules. Efforts continue to improve the characteristics of these modules for high-performance system applications and reduce their cost.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

Budget Activity 02 - Advanced Technology Development

Program Element *6.37.10.A Title Night Vision Advanced Development

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	81	0	81
(2) Contractor Employees	318	0	318
Total	399	0	399

DETAILED BACKGROUND AND DESCRIPTION: The emphasis of this program is to improve the Army's capability to fight at night and under limited visibility conditions, and reduce life-cycle costs to the US Government. In the past, when developing a night vision system design in response to military requirements, a common approach was to develop a system with custom configured components. This approach forced the cost of systems upwards since each requirement involved similar, but unique development and relatively small procurements (as in all other high technologies, custom equipment implies high cost). An approach to reducing overall system costs in the infrared area is the development of sets of infrared common modules which will be procured in volume, and produced on a competitive basis. Improvements to image intensifier (I^2) devices are similarly programmed to minimize life-cycle cost impact to the government. Third generation I^2 technology will be designed to provide a 100% improvement in intensifier tube performance, and provide a direct replacement for existing tubes. Other areas of emphasis include the development of radiation sources, advanced systems concepts and counter-countermeasure (CCM) techniques.

RELATED ACTIVITIES: A Joint Logistics Commanders' decision gave the Army prime responsibility for the development of standardized thermal system components. Currently the Army and other defense services are sharing in the development of thermal devices. For example, the Army is co-developing an electronic multiplexer with the Air Force, and an infrared detector/charge coupled devices (CCD) with the Navy.

WORK PERFORMED BY: In-house work is performed by the US Army Night Vision Laboratories, Fort Belvoir, Virginia. Representative contractors are: Honeywell, Inc., Minneapolis, Minnesota; Borg-Warner Thermoelectrics, Des Plaines, Illinois; Fairchild Camera and Instrument Corporation, Syosset, New York; Texas Instruments, Inc., Dallas, Texas; Martin-Marietta Corp., Orlando, Florida; Magnavox, Mahwah, New Jersey; International Telephone and Telegraph Corporation, Roanoke, Virginia.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977 and FY 1976 and Prior Accomplishments:

a. FY 1975 and Prior. A major effort to reduce the cost of thermal imaging systems resulted in the development of a modular approach. During FY 1975, these common modules were evaluated for interoperability. Tests of common module weapon sights demonstrated both their ability to meet long range weapon system requirements, and their applicability to the Advanced Attack

Helicopter. Third generation image intensification (I^2) tubes fabricated in FY 1975 demonstrated increased sensitivity, relative to second generation devices. This I^2 program is directed to develop tubes which will be interchangeable with second generation tubes, so that complete system replacement is not necessary.

b. FY 197T and FY 1976: In prototype evaluations, manportable and high performance thermal common module imagers, and the armored searchlight met all Army performance requirements. For both manportable applications (Heavy (TOW) and Medium (DRAGON) Anti-Tank Weapons, Ground Laser Locator-Designator, Night Observation Device Long Range (NODLR)), and high performance applications (night sights for tanks and helicopters) the approach utilizes the Army developed common thermal imaging modules. The common modules continued in development, with the emphasis on cost reduction techniques. In the I^2 area third generation tubes, improved microchannel plates, lower cost microchannel plate glass, and improved phosphor screens were successfully demonstrated. Advanced development systems initiated during this period include; the Tank Infrared Elbow (TIRE) to improve detection capability of tanks in the field, and a one-tube night vision goggle to reduce system weight and cost.

2. FY 1977 Program: Preliminary production planning for the infrared common modules will be completed. The Tank Infrared Elbow (TIRE) will be evaluated, potential vehicle applications identified, and the TIRE released for engineering development. Development of third generation I^2 tubes continues with the introduction of high performance microchannel plates and phosphor screens. Further development will continue on low cost glass material for microchannel plates. A new task will be initiated to develop a low cost, lightweight thermal imaging system for use as a rifle sight.

3. FY 1978 Planned Program: Work on the common thermal imaging system modules will continue with emphasis on incorporation of advanced technology, while maintaining compatibility. Such improvements are: (1) Video electronics modules improved by implementation of hybrid circuitry, automatic low frequency signal suppression, automatic gain control; (2) Cryogenic coolers improved by reducing weight, acoustic noise and input power. An advanced multiplexing technique, utilizing charged coupled devices (CCD) will be initiated. Feasibility systems utilizing third generation I^2 technology will be fabricated and evaluated. Prototype lightweight thermal imaging rifle sights will be procured, and in-house testing begun. The reduction in FY 1978 funding from FY 1977 is due mainly to the completing of the design verification of the standard infrared common modules in FY 1977.

4. FY 1979 Planned Program: An advanced development model of an IR rifle sight will be procured. Improvement efforts will continue on the common modules, with major emphasis being placed on producibility changes. New technologies such as intermediate and room temperature detectors, thermoelectric coolers, charged coupled device (CCD) multiplexers, and full DC restoration circuitry will be investigated for integration into existing thermal systems. The increase in funding in FY 1979 from FY 1978 is to allow for completion of the testing and evaluation of the light-weight, high performance thermal rifle.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.19.A

Title Special Purpose Detectors

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES/PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	0	1500	1355	1400	Continuing	Not Applicable
DK 71	Low Energy Laser Devices	0	0	0	300	400	Continuing	Not Applicable
DK 75	Optical	0	0	1500	1055	1000	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program element conducts the advanced development of surveillance, target acquisition devices. The objective is to provide the Army with an improved capability to locate and engage targets during all weather conditions. This program in FY 77 is completing Advanced Development (AD) of an Artillery Launched Television Target Location System and is initiating effort on an optical augmentation system.

BASIS FOR FY 1978 RDTE REQUEST: DK 75 funding in FY 1978 will provide for the continuation of the Advanced Development (AD) Scanning Optical Augmentation Locator (SOAL) equipment, and initiation of an AD Flash Detection System (FDS). DK 71 funding will provide for AD models of a modularized design of the mini-rangefinder, for use at platoon level.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Slight decrease due to completion of AD on Artillery Launched Television Target Location System. Continuation of effort on SOAL. Initiate AD effort on FDS, and mini-rangefinder.

PERSONNEL IMPACT: The average number of employees supported with requested FY 1978 funds (RDTE & Procurement) is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	10	0	10
(2) Contractor	21	0	21
Total	31	0	31

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.19.A

Title Special Purpose Detectors

DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is to establish the operational/tactical feasibility of a system of equipments which can provide the Army with a greatly improved and new capability in surveillance, target acquisition and vehicle defense. Technical feasibility of optical augmentation has been established by field experiments, and in FY 1978 Advanced Development (AD) models of a Scanning Optical Augmentation Locator (SOAL) sensor will be integrated into the periscope sight of a tactical vehicle for Developmental Test/Operational Test I (DT/OT I). Flash detection has been demonstrated at ranges in excess of the maximum weapon range and an AD system capable of real-time weapon location will be developed for evaluation. Miniaturized laser technology has been developed to the point where a low cost, accurate and reliable mini-rangefinder can be provided at the platoon level to increase the probability of first round hit by intermediate direct fire weapons.

RELATED ACTIVITIES: P.E. 6.27.03.A, Combat Surveillance, Target Acquisition and Identification; P.E. 6.27.09.A, Night Vision Technology; P.E. 6.27.26.A, DARPA/HOWLS (Army Support); P.E. 6.27.15.A, Optical ESM/ECM.

WORK PERFORMED BY: In-house work is being performed by the US Army Electronics Research and Development Command, Fort Monmouth, NJ. Contractors who are expected to actively participate in the Surveillance and Target Acquisition Developments are Texas Instrument, Dallas, Texas; EOS-KEROS, Pasadena, California; RCA, Camden, NJ; Honeywell, Boston, Massachusetts; Hughes Aircraft Corporation, Culver City, California.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976 and Prior Accomplishments: A feasibility demonstration model of a 360° scanning optical augmentation sensor was completed in FY 1974 and subsequent field experiments demonstrated the validity of the concept. A Letter of Agreement (LOA) for application of this type of sensor in a tactical vehicle has been coordinated. Flash detection of US and foreign artillery, in suppressed and unsuppressed modes, has been demonstrated at ranges considered useful for military applications. Coverages of 360° x 7° have been achieved; however, current requirements call for a much more restricted capability. An LOA is being coordinated. First phase of development for the mini-rangefinder has been completed.

2. FY 1977 Program: An Advanced Development (AD) Scanning Optical Augmentation Locator (SOAL) sensor will be fabricated under contract for tank application; the AD phase of the Artillery Launched TV Target Locator System will be completed. Funding for these projects was obtained by authorized reprograming actions.

3. FY 1978 Planned Program: Continuation of contractual effort on SOAL. Initiation of Flash Detection System (FDS) and mini-rangefinder advanced development, to include contractural efforts. The decrease in FY 1978 funding is due to completion of AD on Artillery Launched Television Target Locator System.

4. FY 1979 Planned Program: Completion of AD models of SOAL and FDS; Development Test I/Operational Test I (DT I/OT I) for both systems. Completion of AD models of mini-rangefinder and DT I/OT I.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.20.A

Title Biological Defense Materiel Concepts

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	0	0	457	1678	Continuing	Not Applicable
	Quantities							Not Applicable
D165	Biological Detection & Warning Materiel	0	0	0	457	1678	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This element provides for the advanced development of promising new material and items and apparatus for special application for Army use in improving its capability to defend against attacks of biological agents.

BASIS FOR FY 1978 RDTE REQUEST: A review of the Biological Defense Program established the requirement for a Biological Fixed Installation Alarm development when realizing the vulnerability of fixed installations to biological agent attack. The current Biological Detection and Warning System does not meet the performance parameter requirements for a fixed installation alarm and this item's development will be a first in the field of biological detection.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: This task will be initiated in FY 1978.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	4	0	4
(2) Contractor Employees	0	0	0
Total	4	0	4

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.20.A Title Biological Defense Materiel Concepts

DETAILED BACKGROUND AND DESCRIPTION: The objective of this program will be to design, fabricate and evaluate promising new materiel and items and apparatus to warn of the presence of and to protect against a biological agent. A first generation Biological Fixed Installation Alarm concept will be investigated to develop a biological agent detection and warning system suitable for critical compact military installations.

RELATED ACTIVITIES: Precursor work is reported under Program Element 6.27.06.A, CB Defense and General Investigations. Coordination is maintained with the other Services to assure provision for the adoption of joint-Service requirements where practicable, and preclude duplicative efforts.

WORK PERFORMED BY: US Army Armament Research and Development Command, Edgewood, Maryland.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Not applicable.

2. FY 1977 Program: Not applicable.

3. FY 1978 Planned Program: Design studies for the Biological Fixed Installation Alarm will be conducted in-house and by contract to establish the most feasible approach for use in critical compact installations. The Pattern Acquisition and Correlation Technique (PACT) and other promising approaches will be extensively tested and design parameters identified. The PACT is felt to be the most suitable technique for the task objective. This task is an FY 1978 starter. All necessary experimental work has been performed and the proposed system is ready for full scale development.

4. FY 1979 Planned Program: Design studies for the Biological Fixed Installation Alarm will be continued in-house and by contract to establish the most feasible approach for use in critical installations. Additionally, the PACT and other promising approaches will continue to be extensively tested and design parameters identified. The in-house and contract effort will be increased in FY 1979.

5. Program to Completion: Complete Advanced Development and prepare to enter Full-Scale Development during FY 1981.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.21.A

Title Chemical Defensive Materiel Concepts

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	3840	720	5060	5652	9953	Continuing	Not Applicable
	Quantities							Not Applicable
DE80	Individual Cml Protection Materiel	3120	375	1739	0	0	Continuing	Not Applicable
DE81	Cml Decontamination Materiel	291	345	1075	1550	1869	Continuing	Not Applicable
D601	Cml Detection & Warning Materiel	280	0	2246	4102	5254	Continuing	Not Applicable
D604	Collective Cml Protection Materiel	149	0	0	0	2830	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This element provides for the advanced development (AD) of concepts of defense of personnel and equipment against chemical attack.

BASIS FOR FY 1978 RDTE REQUEST: This program will permit efforts to continue on the development of the Advanced Point Sampling Alarm, the Automatic Liquid Agent Detector (ALAD), Personal Decontaminating Kit and a large scale equipment decontaminating apparatus.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: AD contracts for ALAD and the Detector Kit for chemical agents in water will be awarded in FY 78 and a Product Improvement Program to improve the capability of the M19 Sampling and Analyzing Kit will begin.

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.21.A Title Chemical Defensive Materiel Concepts

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	61	0	61
(2) Contractor Employees	40	0	40
Total	101	0	101

DETAILED BACKGROUND AND DESCRIPTION: The objective of this element is to develop rapid detection and warning systems, and protective materials and equipment to warn of the presence of and to protect against chemical attack. This element covers defensive systems and equipment to protect individuals from chemical agents by providing: protection for the respiratory system and all body surfaces; manual and automatic detection and warning devices that respond to toxic agents on all surfaces, in the atmosphere, and in food and water; and means to decontaminate skin, clothing, equipment, terrain, food, and water. This element also provides for the development of collective protection shelters for certain headquarters and communications functions, for rest and relief and for certain vehicle crews to relieve the stresses and restrictions inherent in individual protective equipment.

RELATED ACTIVITIES: Conversion of the Army approved Required Operational Capability (ROC) for the New Protective Mask to a Joint Service Operational Requirement is being staffed. Approval of a Memorandum of Understanding between the United States and Canada for cooperative Research and Development of the New Protective Mask is also anticipated.

WORK PERFORMED BY: US Army Armament Research and Development Command (ARRADCOM), Edgewood, MD; Arctic Test Center, Fort Greeley, AL; Tropic Test Center, Panama. Contractors are Sierra Engineering Company, Sierra Madre, CA; Ayo Company, North Bayshore, Long Island, NY; Gentry Corporation, Carbondale, PA; and Utility Research Company, Montclair, NJ.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Hardware for Passive Remote Detector was refurbished for comparative tests with Forward Looking Infrared (FLIR) approach. The New Protective Mask entered Advanced Development (AD) in FY 1975. Coatings for elastomer used in mask faceblank have been developed. A mold was designed and built to produce a facepiece in which the lens is an integral part and in which the major components are molded to the facepiece. Test results indicate new mask potentially fills the ROC requirements. Evaluation of a five-gallon commercial spray equipment for use as a Decontamination Apparatus for Vehicles reached AD in March 1976.

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.21.A Title Chemical Defensive Materiel Concepts

2. FY 1977 Program: Development Test I (DT I) of New Mask will be conducted and the Validation In-Process Review (IPR) will be held on 31 March 1977. Advanced Development (AD) of the New Mask will be completed and planning for full scale Producibility Engineering and Planning (PEP) effort will be accomplished. AD will be initiated for the ionization detector and intermediate size decontamination apparatus.

3. FY 1978 Planned Program: AD of the Passive Remote Detector and Advance Point Detector continue. The New Mask will undergo Engineering Development (ED). The most promising concepts and prototype hardware for a Personnel Decontaminating System, Field Decontaminating System, Detector Kit for Chemical Agents in water and a product improvement program for the M19 Sampling Kit will progress into AD. These four new starts will increase funding requirements for FY 1978.

4. FY 1979 Planned Program: ED of the Passive Remote Detector will be initiated. The New Mask will be type classified in fourth quarter FY 1979. The most promising concepts and prototype hardware for the Residual Gas Life Indicator, Simplified Collective Protection for Field Shelters and Advanced Collective Protection will move into AD. These four new AD starts will require an increase in funding in FY 1979.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.21.A

Title Chemical Defense Materiel Concepts

Project #D601

Title Chemical Detection and Warning Materiel

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

DETAILED BACKGROUND AND DESCRIPTION: The objective of this project is to evolve new principles and concepts for use in improved kits, individual detectors, field laboratories and contamination surveillance techniques. Specifically, this project conducts advanced development (AD) on chemical agent detection and warning systems for field use; chemical agent detection systems for rapid survey of contamination of terrain and other surfaces; chemical agent detector kits, and chemical field laboratories.

RELATED ACTIVITIES: Foreign state-of-the-art trends and potential threats to present materiel or systems have been considered throughout the research and development cycle. Air Force and Navy requirements for Advanced Point Detector Alarm are being considered to permit joint use of the developed item.

WORK PERFORMED BY: US Army Armament Research and Development Command (ARRADCOM), Edgewood, MD; Dugway Proving Ground, UT; Block Engineering Company, Cambridge, MA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Hardware for Remote Sensing Alarm was developed and refurbished in FY 1976 for comparative tests with Forward Looking Infrared (FLIR) system. AD for the XM256 Detector Kit was completed in FY 74 and the Liquid Agent Detector was completed in FY 75.

2. FY 1977 Program: AD of a Automatic Liquid Agent Detector (ALAD) will begin with extensive evaluation of detector configuration and design of electronics. The Advanced Point Detector will enter AD with the modification of the Air Force Ionization Detector to provide Army field application. The primary approach to AD of the Detector Kit for Chemical Agents in Water will be an attempt to modify existing shelf-available detectors or to create new detectors using concepts of the XM256 Chemical Agent Detector Kit.

3. FY 1978 Planned Program: Field testing of the Remote Sensing Alarm will be conducted. AD hardware for the ALAD will be fabricated with intent of later incorporating design as part of a point sampling vapor alarm device. The Advanced Point Detector Task will emphasize testing and modifying prototypes with aim of Limited Procurement for Army upon completion of Development and Operational Tests. The concept feasibility package for the Detector Kit for Chemical Agents in Water will be completed. A Product Improvement Program to improve the capability of the M19 Sampling and Analyzing Kit will begin. Contracts for ALAD hardware and the initation of AD for these two programs will increase funding for FY 1978.

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.21.A Title Chemical Defense Materiel Concepts

Project #DM01 Title Chemical Detection and Warning Materiel

4. FY 1979 Planned Program: Advanced Development of the Remote Sensing Alarm and the Automatic Liquid Agent Detector will be completed. The Product Improvement Program for the M19 Sampling and Analyzing Kit will be completed.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	280	0	2246	4102	5254	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.23.A

Title Command and Control

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	8363	2030	7397	6437	10500	Continuing	Not Applicable
D898	Land Navigation and Control Equipment	30	0	0	0	0	0	1474
D101	Integration of Army Tactical Data Systems (ARTADS)	8333	2030	7397	6437	10500	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: In FY 76 and prior, this program element consisted of two projects, D898 and D101. D898 was involved in advanced development of airtraffic control and location/navigation equipments and subsystems. Army efforts within this project were terminated in FY 76 and are being continued under USAF direction. Project D101 provides for a systems approach toward insuring interoperability and integration of Army tactical data systems in a coherent total program to enhance the capability of the ground force commander for tactical command and control.

BASIS FOR FY 1978 RDTE REQUEST: The FY 1978 request is to continue the development and testing of integrated militarized peripherals of Army tactical data systems and to insure their secure operation in the field.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The change is essentially due to differences in the funding flow for on-going contracts.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	69	0	69
(2) Contractor Employees	70	0	70
Total	139	0	139

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.23.A Title Command and Control

DETAILED BACKGROUND AND DESCRIPTION: This project ensures integration of Army Tactical Data Systems (ARTADS) by taking a systems approach in developing state-of-the-art peripherals for use within the Army family of tactical data systems (Tactical Operations System (TOS), Tactical Fire Direction System (TACFIRE), Position Location and Reporting System (PLRS), Joint Tactical Information Distribution System (JTIDS), and the Missile Minder (AN/TSQ-73). Concurrently, studies are in progress on interoperability of tactical data systems and concepts for security and encryption techniques. This project accelerates development and fielding of secure, responsive and effective automatic data processing equipment which satisfy the needs of several systems to support the ground force commander within the context of the Tactical Command and Control Program.

RELATED ACTIVITIES: The project is related to TOS and TACFIRE, program elements 6.37.22.A and 2.37.26.A, respectively, and to the AN/TSQ-73, program element 6.43.02.A. Project D101 also has application to 6.37.03.A (Automatic Data Processing, Field Army).

WORK PERFORMED BY: Activities under project D101 are the responsibilities of the Project Manager, Army Tactical Data Systems, Fort Monmouth, New Jersey. The project manager is under the US Army Electronics Research and Development Command (ERADCOM), Fort Monmouth, New Jersey. Human factors tasks are performed by the Army Research Institute, Washington, DC and the Human Engineering Laboratory (HEL), Aberdeen, MD. Contractors performing work under this project include: Systems Development Corporation, West Long Branch, NJ; Singer Librascope, Glendale, CA; Litton Industries, Inc., Van Nuys, CA; Magnavox, Fort Wayne, IN; Scope Electronics, Reston, VA; Control Data Corporation, Minneapolis, MN; and Hughes Aircraft, Fullerton, CA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: This project was established in FY 1972, initiating a variety of ARTADS development, support, and integration activities. Advanced development was started on application of new technologies to tactical computer systems. In FY 1973, a contract was started on application of new technologies to tactical computer systems. In FY 1973, a contract was awarded for a microprogrammable multi-processor for the ARTADS Teleprocessing Design Center, an in-house laboratory test bed facility capable of emulating computers for purposes of experimentation. The system was delivered in FY 1976 and successfully put into operation. Competitive contracts were awarded in FY 1973 for design and fabrication of advanced development models of a Digital Message Device (DMD). These models were successfully tested with TACFIRE in FY 1974 and the DMD is now in engineering development as part of the TACFIRE system. Phase I competitive design contracts, awarded for the Query Control Station (QCS) in FY 1973, were completed in FY 1974. Phase II fabrication of the advanced development prototypes, begun in FY 1975 as a 28-month effort, continues through FY 197T. A two-year contract for an advanced development prototype of the Word Recognition System (WRS) awarded in FY 1975 continues through FY 197T. Phase I competitive advanced development contracts for design of the Interactive Computer Presentation Panel (ICPP) awarded in FY 1975, were completed in FY 1976. Phase II fabrication of the ICPP prototypes started at the beginning of FY 197T are continuing through FY 197T. R&D costs for the ICPP are being shared equally with the Federal Republic of Germany. In FY 1976, the first contract in a series was awarded under the ARTADS Surety Master Plan. As approved by the Vice Chief of Staff, Army, the plan provides for a six-year program to develop the necessary policies, procedures, and techniques to insure that ARTAD systems are fielded with adequate security.

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.23.A Title Command and Control

2. FY 1977 Program: The Query Control Station (QCS) prototype will be completed, tested in-plant, and then at Fort Hood, Texas. The Word Recognition System (WRS) will also be tested in-plant and then at Fort Hood, Texas. The ICPP contracts will continue through the fiscal year. The Army Tactical Data System (ARTADS) Surety Program will also continue through the year. A contract will be awarded for fabrication of prototypes of the Battlefield Interoperability Terminal for interoperability testing over a three-year period with the Joint Tactical Information Distribution System, Packet Radio, TACFIRE, and the Single Channel Ground and Airborne Radio Subsystem. Also to be awarded is a 27-month contract to design, fabricate, test, and support a fourth generation computer which can emulate the Litton GYK-12 computer used in TACFIRE. This would allow future competition not only for the TACFIRE computer, but for the Missile Minder, the TRITAC TTC-39 Switch, and other systems.

3. FY 1978 Planned Program: Upon completion of testing the advanced development prototype of the QCS, it will be reviewed together with the Tactical Operations System (TOS) at an Army Systems Acquisition Review Council/Defense Systems Acquisition Review Council (ASARC/DSARC) scheduled for November/December 1977. Advanced development will continue for the WRS with emphasis on reduction of physical size and weight, increased modularity, full militarization, and design interfaces with TACFIRE and TOS. Advanced development prototypes of the ICPP will be delivered and tested. The ARTADS Surety Program, the Battlefield Interoperability Terminal Program, and the GYK-12 Emulation Program will continue through the fiscal year. The basis for increase in funding from FY 1977 to FY 1978 is essentially due to differences in the funding flow for on-going contracts.

4. FY 1979 Planned Program: Following an in-process review of the ICPP, Phase III front end specification work will begin the transition to engineering development. A contract will be awarded to develop user language interpretation capability for the TACFIRE procedure oriented language. This will ultimately ensure the standardization of computer language among Army tactical data systems. The ARTADS Surety Program, the Battlefield Interoperability Terminal Program, and the GYK-12 Emulation Program will continue through the year. An advanced development contract will be awarded to integrate speech recognition with interactive console displays aimed at improving man/machine interface. The basis for increase in funding from FY 1978 to FY 1979 is essentially due to differences in the funding flow of on-going contracts, the new contracts for User Language and Speech Recognition, increases due to rising overhead costs, and organizational increases resulting from realignment of US Army Materiel Development and Readiness Command (DARCOM) R&D laboratories.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.25.A

Title Remotely Piloted Vehicles (RPVs)/Drones

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	11,975	2,090	5,692	9,611	7,600	Continuing	Not Applicable
DK61	Remotely Piloted Vehicles	11,975	2,090	5,692	9,611	7,600	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Develop small, low cost, easily operated Remotely Piloted Vehicles (RPV's) which are deployable in forward tactical areas to extend the eyes of the Brigade and Division commanders and increase the effectiveness of their direct support firepower. These RPV's will complement the larger and more sophisticated Air Force RPV systems. Top priority is the Aquila mini-RPV System Demonstrator. Other activities address known deficiencies in RPV technology. The development of a RPV with a small warhead (Kamikaze) has been cancelled.

BASIS FOR FY 1978 RDTE REQUEST: Priority will be given to efforts necessary to field a mini-RPV system. Complete Aquila project. Complete preparation for entrance into Engineering Development under P.E. 6.47.30.A, preparing to award contracts beginning in FY 79. The anti-jam Integrated Communication and Navigation System (ICNS) data link will be flight tested in the Aquila RPV. The ICNS will be converted from the test G band frequency to the J band which is required for deployment. Efforts will continue in propulsion, sensors, launch and recovery and other areas deemed to be high risk in order to determine methods to reduce cost and risk and to improve reliability.

BASIS FOR CHANGE IN FY 1978 OVER 1977: Primary increase is due to Aquila schedule slippages which caused program to extend into FY 78. Also additional RPV's are required for subsystem testing, the ICNS data link will be tested and converted to J Band, reduction of a millimeter radar to 35 pounds for an adverse weather capability and as a weapons illuminator for radar guided weapon seekers will be initiated, and an investigation initiated using the mini-RPV as a communication relay and for radiation survey missions.

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.25.A Title Remotely Piloted Vehicles (RPVs)/Drones

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	38	0	38
(2) Contractor Employees	75	0	75
Total	113	0	113

TERMINATION COST: ($ in Thousands)

	FY 1977 and Prior	FY 1978	Total
(1) Estimated Government Liability Financed with RDTE only:	$24,874	$2000	$26,874

DETAILED BACKGROUND AND DESCRIPTION: The objective of the Army RPV program is to field a mini-RPV system that has high reliability and is cost effective for reconnaissance, surveillance, target acquisition and target designation missions. The major activity is the Aquila System Technology Demonstrator which will provide the means to determine organizational and operational concepts utilizing mini-RPV's as well as to determine those subsystems that need further R&D. The demonstration includes 30 RPV's, 4 ground control stations, 4 launchers and recovery systems. There are interchangeable sensors varying from unstabilized daylight TV's to stabilized daylight TV's with autotrack capability and laser range finders and designators. The RPV has a 12 foot wing span, a 6 foot fuselage, a gross weight of 138 pounds, is powered by a 12 horsepower McCulloch engine, cruises at speeds between 75 and 100 knots, and is recovered in a net assembly. An important contribution of the Aquila has been to demonstrate that the RPV is not simply a large model airplane with a sensor. The integration of all the requirements of a military RPV into a realistic system is a challenge which requires careful design and detailed engineering. The Army has found some unexpected pitfalls involving simple mistakes. Many of the problems uncovered during the testing to date have resulted in the initiation of technology programs in order to determine the solutions prior to Engineering Development. In parallel efforts higher risk elements are being investigated to insure a proper technology base prior to Engineering Development. An anti-jam data link is required to counter the high electronic warfare threat. A task to improve the survivability and vulnerability of the RPV system is underway. A engine fabrication program will provide more horsepower, lower costs and improve engine reliability. Various recovery techniques are being studied. Design studies have been contracted to reduce the weight and cost of the sensors which may constitute 50% of the total RPV cost. Contracts to develop light weight night sensors have been issued. A program to demonstrate a millimeter wave radar using off-the-shelf components is in process which will provide an adverse weather capability and may also act as an illuminator for millimeter guided weapons as they are developed. Light weight, higher power lasers for designators are also under contract. A program to demonstrate tactical communication jamming is underway. Smaller projects investigating low cost actuators, alternators and propellers are also in process. Hardware developed under these tasks will be incorporated into the Aquila RPV as applicable and then directed into Engineering Development and production systems as the technology permits.

Budget Activity 6 - Advanced Technology Development

Program Element #6.37.25.A Title Remotely Piloted Vehicles (RPVs)/Drones

RELATED ACTIVITIES: The US Air Force has an advanced development program directed at a larger class of vehicles called the advanced Remotely Piloted Vehicles (RPV) in P.E. 6.37.39.F, a high altitude program in P.E. 6.37.32.F, and a harassment program in P.E. 6.47.46.F, which are being monitored to utilize any applicable technology and equipment developments. During FY 76, a joint Defense Advanced Research Projects Agency (DARPA)/Army) development of an integrated anti-jam command, control and communications and Navigation system (ICNS) was initiated over which the Army has since taken control. The US Navy has a mini-RPV program, P.E. 6.32.65.N, Remotely Piloted Vehicles, which is being coordinated closely to obtain related data which can be used in the Army program. To preclude duplication of effort a quarterly Joint Technical Coordinating Group (JTCG) meeting is held. As a result of these meetings joint service efforts are being coordinated in engine development (Army), steerable fabric wing (Navy), recovery technology and a study to determine if a common airframe is feasible (Air Force). A Memorandum of Understanding with the United Kingdom will initiate data exchanges on RPVs. At the current time there is no duplication of effort in mini-RPV's within the Services.

WORK PERFORMED BY: The US Army Electronics Research and Development Command, Fort Monmouth, NJ; US Army Missile Research and Development Command, Huntsville, AL; Air Mobility Research and Development Laboratories-Ames Research Center, CA, Ft. Eustis Directorate, Ft. Eustis, VA and US Mobility Equipment Research and Development Command Fort Belvoir, VA. Contractors actively participating in the RPV development are Lockheed Missiles and Space Company, Inc, Sunnyvale, CA; Aeronutronic-Ford, Newport Beach, CA; E-systems Inc, Melpar Divsion, Falls Church, VA; Teledyne Ryan, San Diego, CA; Texas Instruments, Dallas, Texas; Honeywell, Minneapolis, MN; Harris Intertype Corp, Melborne, FL; and Norden, Norwalk, CT: All American Engineering, Wilmington, DE; Developmental Sciences, Inc, Industry, CA. There are six other contractors that have approximately $600,000 worth of contracts.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: In FY 73 and FY 74 the Remotely Piloted Aerial Observer/Designator System (RPAODS) program yielded parametric data in such areas as detectability, survivability, target search and acquisition, target tracking and designation and imagery transmission links. In late FY 74, the Aquila program was established to utilize data obtained from RPAODS, incorporate general requirements established by the user and develop a program to demonstrate the technology, determine the cost-effectiveness of the system, and establish the operational and organizational concepts necessary to operate mini-RPV's in the field. The contract was a cost plus incentive fee for $7.65 million. The Army was scheduled to commence testing in October 1975 with completion of the contract in December 1976. Design and some fabrication took place in FY 75. In FY 1976 the Aeronutronic-Ford (formerly Philco-Ford) FRAERE II RPV successfully lased a target tank and a laser seeking Cannon Launched Guided Projectile (CLGP) scored a direct hit on the target tank. An initial effort of integrating a small, lightweight jammer into a mini-RPV was started. A contract was let for an anti-jam data link to provide hardware to be integrated into 2 Aquila RPV's and one ground control station. Contractor flight testing of Aquila was initiated in December 1975 in California (5 months late). By April 1976 13 flights had been conducted. Eight of these flights resulted in damage to the RPV's. Problems were related

to a premature engineering freeze to meet schedule and infant mortality of parts. Fabrication of the remainder of the RPV's was stopped and an Army review team formed for a reliability review. Over 30 changes were made to include extended ground testing and adding a backup parachute.

2. FY 1977 Program: Successful automatic launch, flight and recovery with way point navigation has now been demonstrated. The Aquila Contract is expected to conclude in December 1977 at a total cost of $15.0 million. Many of the identified problem areas have resulted in parallel programs to develop better hardware and different solutions. The objectives of the program are now being met. Operational testing at Ft. Sill, OK will be conducted under simulated field conditions in order to determine the Remotely Piloted Vehicles (RPV's) place in the force structure and how it should be integrated into command, control and targeting systems. Development will be continued in propulsion, launch, and recovery techniques, actuators, servos, manufacturing, and improved design concepts. Development of an integrated anti-jam command, control and communication and navigation system (ICNS) will continue. The millimeter surveillance radar will be tower tested. Emphasis will be placed on technology which will lead to lower cost for infrared imagers. Sensors and sensor subsystem components will be tested using a manual aircraft as a test bed. Development of a laser designator/rangefinder for RPV's will be conducted to provide a low cost, producible modular system, based on an outgrowth of an in-house Electronics Research and Development Command mission funded program. A tunable jammer and a barrage jammer will be tested.

3. FY 1978 Planned Program: The program funds will increase in FY 78 in order to complete the Aquila demonstration and to conduct efforts directed toward entering the Engineering Development phase under P.E. 6.47.30.A, Remotely Piloted Vehicles. The hardware developed and fabricated under the technology programs will be demonstrated. These efforts include the anti-jam data link, forward looking infrared (FLIR), milimeter radar, and other launch and/or recovery methods. Those items successfully demonstrated will be included in the specifications for the Engineering Development Phase. Developmental efforts already started in the areas of lasers, engines, and an anti-jam data link in the J Band will continue. Work in the RPV vulnerability/survivability area must be continued to improve survivability on the battlefield. The effectiveness of a small communication jammer on a RPV will be expected based on the results of the testing in FY 77.

4. FY 1979 Planned Program: The data link, laser and radar will be the major thrust of this program. Work will continue in testing low cost sensors, data link's and in those areas where short comings are found during the testing of the Aquila. Work in RPV relays and Electronic Warfare will be expanded. Funds required are less than FY 78 because Aquila contracts will have been completed and contracts for Engineering Development under P.E. 6.47.30.A will begin.

5. Program to Completion: The critical technology efforts and jammer programs will be continued and demonstrated. The technology effort is aimed toward reducing the risk and cost associated with fielding a mini-RPV and providing a day/night all weather capability in the future.

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.25.A Title Remotely Piloted Vehicles (RPVs)/Drones

6. Major Milestones:

		Date	Estimated RDTE Cost to Reach Events (Cumulative)
a.	Contract start	20 Dec 74	.620
b.	1st Remotely Piloted Vehicle flight	Dec 75	10.160
c.	1st Equip turned over to Army	Jan 77	19.585
d.	Training and Doctrine Command Demo begins	Jun 77	24.874
e.	Complete Aquila Technological Demonstration	Dec 77	26.874
f.	Approved Required Operational Capability for Engineering Development	Feb 78	

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.25.A Title Remotely Piloted Vehicles (RPV's)/Drones

TEST AND EVALUATION DATA:

1. Development Test and Evaluation: The test program for the Aquila demonstration RPV system is composed of ground and flight tests by the contractor (Lockheed Missiles and Space Company, Inc.) and by Test and Evaluation Command (TECOM). All hardware is subjected to check out and acceptance testing at the component level, at the integrated subsystem level and again after integration as a complete system. Contractor tests up to this point have uncovered numerous problems which are being resolved by extending the ground testing at system level. Ninety percent of the total system has been successfully flight demonstrated. TECOM testing will be conducted at Fort Huachuca, Arizona starting 3Q FY 77, and will obtain additional data for expansion of the flight envelope to insure safety when operated by Army personnel. The sensor payload will also be tested employing a manned aircraft. The system currently being tested is a demonstration system intended to be used to refine and accurately describe the initial Army requirements for RPV's.

2. Operational Test and Evaluation: The systems will be delivered to the Training and Doctrine Command (TRADOC) for hands on evaluation at Fort Sill, Oklahoma during 4Q FY 77 and 1Q FY 78. The TRADOC, Project Seeker, evaluation will be conducted under simulated field conditions to the extent that it can be with developmental hardware which has not been militarized. The supporting technology programs are test programs in themselves to demonstrate additional technology or to resolve areas of high risk and cost. The TRADOC Combined Arms Test Activity (TCATA) has conducted a field test of a representative RPV sensor system. The TCATA and Project Seeker data will be merged into the Concept Formulation Package which will provide the basis for a decision whether to proceed with further development. The system is presently in the initial development effort and has not progressed to the point where any Test and Evaluation data is available.

3. SYSTEM CHARACTERISTICS:

	OBJECTIVE	DEMONSTRATED (Contractor Testing)
Gross Weight	120 lbs	136 lbs
Payload	30 lbs	37 lbs
Cruise Speed	75-120 kts	49-103 kts
Endurance	1.5 hrs	1.5 hrs
Service Ceiling	12000 ft.	11000 ft.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.31.A

Title Military Personnel Performance Development and Assessment

Category Advanced Development

Budget Activity # 2 - Advanced Technology Development

RESOURCES/PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	2,336	759	3,531	2,624	5,500	Continuing	NA
A768	Manpower Accessions and Retention Systems	1,088	254	1,081	1,074	1,200	Continuing	NA
A770	Performance-Oriented Individual Skill Development & Evaluation	1,243	472	1,450	1,450	3,500	Continuing	NA
A776	Role of Women in Army	5	33	1,000	100	80	Continuing	NA

BRIEF DESCRIPTION OF ELEMENT: Attain highest possible combat readiness within units through individual skill development and training. Establish procedures for feedback system and training management in units. Fully define Army jobs which are within performance capability of women. Improve manpower quality in officer and enlisted accession and retention through better personnel screening, classification and training systems. Methods and materials to successfully implement Officer and Enlisted Personnel Management System (OPMS & EPMS) through cost effective, equitable, and realistic performance-based evaluation.

BASIS FOR FY 1978 RDTE REQUEST: Progress in improved selection, classification, skill development, and training procedures in high-density combat arms specialties will be applied to low density and technical specialties in active, Reserve and National Guard units as developed. Continue advanced development to improve Army manpower accession, utilization and retention systems for active Army and Reserve Components and to carefully and systematically examine the role of women in the Army. Continue development of procedures and materials needed for Army implementation of performance-based skill development and evaluation, particularly in active units.

BASIS FOR CHANGE IN FY 1978 OVER 1977: N/A

PERSONNEL IMPACT: The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	74	0	74
(2) Contractor Employees	17	0	17
Total	91	0	91

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.31.A Title Military Personnel Performance Development and Assessment

DETAILED BACKGROUND AND DESCRIPTION: Combat readiness in a smaller Army requires maximum efficiency in management and utilization of personnel. To achieve this, the Army is rapidly implementing a new Enlisted Personnel Management System (EPMS) and a new Officer Personnel Manager System (OPMS). These systems require objective analysis of duties and job functions, systematic and consistent job description aggregation of jobs into suitable career fields, performance assessment and realistic plans for career progression and promotion, and improved individual skill training. These facets must be integrated into systematic personnel management processes meeting the requirements of a combat ready officer and enlisted force supporting ongoing implementation of the new EPMS and OPMS. Research is being conducted on problems related to utilization of women in Army jobs. Valid techniques have been developed for (a) personnel management decisions at key points in officer advanced training and (b) differential leadership assessment and training techniques. Research on the enlisted force has examined the role of the recruiter, reenlistment potential, a new joint services qualification and classification test battery and a predictor of military adjustment. The Army is beginning to use performance based tests for measuring individual readiness in military jobs. Decentralizing training by moving it closer to the job requires development and cost effectiveness evaluation of new training techniques, feedback and management methods.

RELATED ACTIVITIES: Through Department of Defense this work is coordinated with related work in Navy (Program Elements 6.27.63N Navy Personnel Support Technology and 6.37.07N Manpower Control Systems) and Air Force (Program Element 6.27.03F Personnel Utilization Technology).

WORK PERFORMED BY: Applied Sciences Assoc., Valencia, PA; Data Design Labs, Cucamonga, CA; Human Resources Research Organization, Alexandria, VA; American Institutes for Research, Pittsburgh, PA; Systems Development Corporation, Santa Monica, CA; Litton-Mellonics, Sunnyvale, CA; Kinton, Alexandria, VA. There will be approximately eight additional contractors for a total dollar value of $600,000. In-house research is performed by the US Army Research Institute, Arlington, VA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Development of new Army enlisted selection and classification measures. New validated measures of leadership and career potential standardized for introduction into Reserve Officer Training Corps (ROTC) and Officer Candidate School. Peer rating techniques validated for ROTC cadets and junior officers. New forms of the Armed Services Vocational Aptitude Battery/Armed Forces Qualification Test partially developed. Completed examination of current enlistment motivations and decision-to-enlist processes. Efforts to implement and evaluate performance-based training at Army Training Centers completed. Performance objectives developed for combat arms jobs are being converted to performance test items for inclusion in Skill Qualification Tests (SQT) to measure job proficiency. Prototype Skill Qualification Tests developed and validated for Military Occupational Specialties (MOS). A comprehensive performance-based training and evaluation system initiated for the infantryman's job. Development and evaluation of nonresident instructional programs begun. Began development of methodology to assess new types of job and training literature. Developed and implemented new joint services qualification and classification test battery. developed biographical questionnaire and performance tests for predicting Basic Combat Training failure; developed ROTC and regular officer career progression system; developed new instruments for OCS and ROTC selection and Regular Army commissioning; examined

Budget Activity: 3 - Advanced Technology Development

Program Element: 63731A Title: Military Personnel Performance Development and Assessment

sex and ethnic differences in cadet and officer evaluation techniques; continue research on measures of task criticality and utilization of women. Analysis of refresher training requirements begun to facilitate policy guidance for maintaining combat readiness.

3. FY 77 Program: Research will continue on efforts to develop Officer Personnel Management System and Enlisted Personnel Management System career management and progression system components, ways of managing performance based training, economic and effective simulation techniques and job aids, and determine how much training is necessary to assure retention and transfer to the job. Research will be initiated to evaluate predictors of military aptitude and provide field validation of other measures; determine the optimum mix of instruments and procedures in ROTC programs; identify incentives for enlistment and reenlistment; identify important selection and training factor for NCO's; initiate on-the-job training and evaluation systems for air-defense, armor and artillery soldiers; develop performance measures that provide diagnostic information for evaluating training and job performance; provide in-depth assessment of the relationship between number of enlisted women in a combat support unit and ability of that unit to perform the mission; determine effects of female officer on Army organization processes and performance; examine effects of the male/female mix on unit esprit, job satisfaction, and intention to stay in the Army; determine how women are being used in traditional male jobs; provide data on factors associated with the utilization of women in uniquely military roles; and identify physical fitness requirements for selected Army jobs.

4. FY 78 Planned Program: Research will continue on ways of integrating training and evaluation resources into the job environment, using performance-based training and testing materials in the field, development of effective simulations and job aids, training for retention and transfer of skills, expansion of on-the-job training and evaluation systems to other Military Occupational Specialities, improved retention and classification tests, and utilization of women.

5. FY 79 Planned Program: Research will continue in the following areas: analyze selection factors in Reserve Officers Training Corps(ROTC), compare performance of ROTC, Officer Candidate School(OCS), and United States Military Academy(USMA) graduates, and validate and apply career commitment model; determine the function of changing perceptions of the Army's societal role; develop models for evaluating training programs; develop a framework identifying unit processes that contribute to organizational effectiveness; develop procedures for selecting recruiters; develop improved content for Military Occupational Specialities classification testing; identify reenlistment requirements and motivations of enlisted personnel; extend current research on individual performance-based training and testing to the more technical occupational specialties; identify factors in the management of unit training resources, the development of existing materials and methods, and the effective allocation of training to schools and on the job; provide answers to questions concerning the utilization of women in units; determine the extent of male/female differences in leadership, the effect of male/female "fraternization" in units, and the possibilities for job engineering to increase the effectiveness of women soldiers. Substantial increase in funds is necessary to achieve performance-based training and evaluation at duty stations and to expand the effort to meet the unique requirements of Armor, Artillery, and Air Defense.

6. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.37.31.A

Title Military Personnel Performance Development and Assessment

Project #A770

Title Performance-Oriented Individual Skill Development and Evaluation

Category Advanced Development

Budget Activity # 2 - Advanced Technology Development

DETAILED BACKGROUND AND DESCRIPTION: Highest efficiency and economy in individual enlisted training, evaluation, and utilization is essential to achieve and maintain maximum combat readiness of the Army. Implementation of the Enlisted Personnel Management System (EPMS) to help attain maximum combat readiness requires research, development, and guidance in the form of (a) individual performance-based training methods, materials and programs for soldiers in schools and at duty stations; (b) performance-based, job-referenced evaluation techniques and materials for individual training and personnel management (Skill Qualification Tests); (c) feedback information systems to capture and use field data on the effectiveness, cost and benefits of training in producing individual job proficiency and combat readiness; (d) administrative and technical means to coordinate training and evaluation resources toward optimal development and maintenance of individual proficiency in unit duty assignments.

RELATED ACTIVITIES: Through Department of Defense this work is coordinated with related work in Navy (Program Elements 6.27.65N, Energy and Environmental Protection and 6.37.07N, Manpower Control Systems) and Air Force (Program Element 6.27.03F, Personnel Utilization Technology). Related Army Program Element is 6.22.17A, Army Personnel and Manpower Technology and Projects 6.37.31.A768, Manpower Accessions & Retention System and 6.37.31A776, Role of Women in Army.

WORK PERFORMED BY: Contractors: Applied Science Associates, Valencia, CA; Data Design Laboratories, Cucamonga, CA; Human Resources Research Organization, Alexandria, VA; Kinton, Alexandria, VA; Litton Mellonics, Sunnyvale, CA. There will be approximately three additional contractors for a total value of $250,000. In-house organization responsible for program is U.S. Army Research Institute for the Behavorial and Social Sciences, Arlington, VA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: Major innovations based on modern instructional technology were instituted in training programs conducted at Army Training Centers. A literacy training program based on specific job reading requirements was implemented at Army Training Centers. A comprehensive set of performance objectives, which lists conditions, behaviors, and standards of performance, was developed for critical tasks in combat arms jobs. Efforts were initiated in developing performance-based training programs in support of Individual Extension Training System for selected combat arms specialties. Preliminary efforts to establish a longitudinal data base with potential utility to training and personnel management were undertaken. Skill Qualification Tests were developed and validated for eight Military Occupational Specialties.

2. FY 1977 Program: Efforts to improve individual performance-based training methods, materials and programs are: effects of refresher training on job skill retention and transfer; cost-effectiveness evaluation of Training Extension Course lessons; effectiveness of training for noncommissioned officers; self-paced and modularized training systems; and new simulation devices

and task scoring tables for Armor crew training; evaluation of new generation technical manuals and job aids used as an initial effort to determine whether minimums for safe Nape-Of-The-Earth designed for the user; and performance-based nonresident instructional program for combat arms duty positions. Efforts to obtain fair, feasible, and valid performance-based measures of job proficiency are: self-instructional materials on the construction and validation of Skill Qualification Tests; methods for developing simulated/synthetic performance tests; differential selection and assignment for combat arms specialties or duty positions; and evaluation of task performance by individuals working as part of a team. Research on training feedback information systems covers task criticality and dimensions pertinent to a training feedback system, relationship between individual characteristics, types of training and subsequent performance, with special focus on basic electronics skills and knowledges, and development of prediction indices for success in critical specialties. Extensive efforts are underway to manage training resources toward optimal development and maintenance of individual proficiency in unit duty assignments: management and record keeping systems for Individual Extension Training System, job and training packages for Reserve and National Guard units, and integrated task training modules and criterion referenced tests.

3. FY 1978 Planned Program: Projected research efforts in FY 1978 are to extend the four major thrusts in (a) performance-based training, (b) evaluation of job proficiency and training courses, (c) training feedback systems, and (d) training resource management. The cost-effectiveness of management systems for conducting performance-based nonresident training and testing programs, in both Active Army and Reserve Components, will be evaluated. Refined scoring procedures of job-proficiency tests will be developed to reflect realistic job requirements. Training feedback systems based on meaningful clusters of tasks will be ready for large scale tryout and evaluation. The cost-effectiveness of implementation strategies for managing, conducting and evaluating the Individual Extension Training System for infantry jobs will be determined. Preliminary work on developing comprehensive training and testing systems for the other combat arm branches (Armor, Air Defense, and Field Artillery) will be initiated.

4. FY 1979 Planned Program: A major expansion of efforts to develop and validate training and testing programs in support of Individual Extension Training System for Armor, Air Defense, and Field Artillery will be undertaken. Pilot evaluations are planned for US Army Forces Command and US Army Europe units. The earlier research efforts conducted for infantry jobs will provide the basis for adapting and extending the results to meet unique requirements of the other combat arms. Included in the effort are performance-based training and evaluation at duty stations, job performance aids, cost-effectiveness analysis of training, and training regimens for optimal skill retention. Refined techniques will also be developed to determine what and how to train in units, effective use of resources in unit training, scheduling of personnel and resources, and use of training profiles to access the training status of individual soldiers and their units. In addition, other research will continue in developing performance-based training and testing programs for technical specialties, such as maintenance, adminstrative, and intelligence jobs. Training feedback systems will be prepared for implementation. Prototype criterion-referenced tests of performance on complex job tasks will be prepared for large scale use.

5. Program to Completion: This is a continuing project.

Budget Activity # 2 - Advanced Technology Development

Program Element # 6.37.31.A

Title Military Personnel Performance Development and Assessment

Project #A770

Title Performance-Oriented Individual Skill Development and Evaluation

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	1243	472	1450	1450	3500	Continuing	NA

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.32.A

Title Combat Medical Materiel

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	81	20	88	94	106	Continuing	Not Applicable
A836	Combat Medical Materiel	81	20	88	94	106	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: A reliable and efficient casualty treatment system during wartime is vital to maintaining the combat strength. The need for tactical flexibility in modern warfare and new weapon developments has increased the problems and complexity of diagnosing and treating large numbers of devastating combat injuries. This requires an agressive research effort to develop new and improved medical field equipment in areas such as clinical laboratory determinations, dental operating sets, sterilization of medical supplies, whole body x-rav, purified water production, eye examination, insect detection and control, field sanitation, and patient handling.

BASIS FOR FY 1978 RDTE REQUEST: To conduct short and long range advanced development of field medical equipment to meet approved DA materiel requirements needed to support improved medical treatment of the combat wounded soldier.

BASIS FOR INCREASE IN FY 1978 OVER FY 1977: The requested increase promotes necessary growth in the level of effort to insure accomplishment of project objectives, namely, advancing and improving field medical treatment, and considers inflationary trends.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	5	0	5
(2) Contractor Employees	0	0	0
Total	5	0	5

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.32.A Title Combat Medical Materiel

DETAILED BACKGROUND AND DESCRIPTION: Research is conducted in this program element to develop medical, dental and veterinary materiel required to support the health care delivery systems in the field. The approach is through design, fabrication and testing of advanced development prototype equipment. The products of more fundamental exploratory development studies are analyzed, redesigned, and reduced for prototypes suitable for user testing. Critical data required for assessing suitability for progression into engineering development is provided.

RELATED ACTIVITIES: Related studies are performed under Program Elements/DA Projects 6.27.78.A/A838, Combat Medical Materiel, and 6.47.17.A/D832, Combat Medical Materiel. All three Program Elements are under the immediate supervision of the same responsible individual to avoid any duplication of effort.

WORK PERFORMED BY: All work is performed in-house at the US Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: This DA Project was initiated in FY 77 along with the Army Medical Department's reorganization of its research program to conform with a single program element funding concept. Funding in FY 76 and FY 77 are shown to reflect dollar comparability. Research was formerly performed under Program Element/DA Projects 6.27.78.A/A838, Combat Medical Materiel and 6.47.17.A/D832, Combat Medical Materiel. Accomplishments can be found in descriptive summaries for these programs.

2. FY 1977 Program: Prototypes of the Army-Life Support Power Source System for environmental control of the Casualty Holding and Evacuation Bags will be fabricated and tested. This effort is intended to develop a device which will automatically, economically, and safely provide a means of heating casualty evacuation bags. The Department of the Navy is interested in this work and has transferred $20,000 to the US Army Medical Research and Development Command for a partial support of this task. Preliminary work on a Flying Spot X-Ray device will begin in advanced engineering during the second half of FY 1977.

3. FY 1978 Planned Program: Advanced prototypes of the new emergency sterilizers will be fabricated. A hardened prototype of the Flying Spot X-Ray will be built and made available for operational testing. Contingent upon satisfactory test results, this effort will continue into engineering development the following year. The program increase is requested to partially offset inflation which has outpaced program increases in the past.

4. FY 1979 Planned Program: The CO_2 system for detection of hidden insects infestations will move into advanced engineering. Prototypes of the Ultra-Low-Volume Nozzle system developed for tailoring the use of insecticides to control selected insect populations will be operationally tested. Advanced prototypes of new medical field shelters will be fabricated and tested.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.38.A

Title Non-Systems Training Devices Development (NSTD)

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	1,999	25	2,888	5,160	4,500	Continuing	Not Applicable
A115	NSTD Infantry	1,000	25	2,888	1,094	1,700	Continuing	Not Applicable
A224	NSTD Armor/Anti-Armor	999	0	0	4,066	1,925	Continuing	Not Applicable
A225	NSTD Arty/AD/Engr	0	0	0	0	375	Continuing	Not Applicable
A226	NSTD Comb Arms	0	0	0	0	500	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Program provides for the orderly transition of non-systems training devices from the exploratory development phase into the advanced development phase. The program will provide the necessary prototype hardware/software to ascertain the feasibility of proceeding into engineering development.

BASIS FOR FY 1978 RDTE REQUEST: Complete Advanced Development of the Infantry Remoted Target System (IRETS) and the Marksmanship Gunnery Laser Devices (MAGLAD I) to support infantry training. Initiate development of more realistic three dimensional targets, both stationary and moving, for tank gunnery ranges. Conduct advanced development of the Armor Remoted Target System (ARETS), Marksmanship Laser Gunnery Device (MAGLAD) for armor/anti-armor training. Develop an Armor Full Crew Interaction Simulator research facility. These programs will result in realistic and cost effective training at both the individual and unit levels.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The significant increase reflects the Army's major initiative to develop more realistic, cost and operationally effective training devices. The program provides for developer to specify proven components during preparation of engineering specifications for initiation of Advanced Development (AD) effort on the Armor Remoted Target System (ARETS) and the Marksmanship Gunnery Laser Devices (MAGLAD II) to support armor/anti-armor training to resolve one of the Army's major training deficiencies-tank crew training. Development of an Armor Full Crew Interaction Simulator (AFCIS) laboratory facility for the purpose of evaluating the application of simulation to tank crew training will also be initiated. The programs listed above are considered high priority because of the great potential they provide in satisfying the Army's training challenges; ammunition costs, range/training area availability, realistic training devices and environment, and training time in a cost effective manner.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.38.A Title Non-Systems Training Devices Development (NSTD)

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	7	0	7
(2) Contractor Employees	50	0	50
Total	57	0	57

DETAILED BACKGROUND AND DESCRIPTION: The Army's Non-Systems Training Devices development programs have traditionally been financed exclusively with Category 6.4 funds (Engineering Development). Such a system was sufficient to support a training philosophy which embraced the use of simulation in institutions and the use of operational equipment as the unit's training support mechanism by using state-of-the-art technology. Escalating resource costs and diminishing training budgets combine to mitigate a change in that philosophy. The Army has, therefore, embarked on a major initiative to introduce simulation devices into the unit environment. The heart of that initiative is a comprehensive Advanced Development program which allows for logical progression from Exploratory Development into Engineering Development. Program provides for fabrication and testing of experimental prototype (breadboard) training devices which provide the necessary information and risk assurance prior to entry into Engineering Design phase.

RELATED ACTIVITIES: The program of development is closely coordinated with the other services, joint use of resources at the Naval Training Equipment Center, and worldwide staffing of training equipment/devices requirements. Related program elements are P.E. 6.27.27.A, Non-Systems Training Devices Technology; 6.27.22.A, Army Training Technology; 6.47.15.A, Non-Systems Training Devices Engineering; 6.37.51.F, Innovation in Education and Training; 6.32.27.F, Advanced Simulation Technology; 6.37.20.N, Education and Training. Starting in FY 1978, this program element will be restructured along more functional areas as shown in project listing above.

WORK PERFORMED BY: Primary contractor: International Laser Systems Incorporated, Orlando, FL. All other programs are currently scheduled to be released on a competitive basis. Potential or anticipated bidders include: Singer Co., Silver Springs, MD; BDM Corp., Monterey, CA; Xerox Electro-Optical Systems, Inc., Pasadena, CA; ITT Corp., Nutley, NY; Boeing Vertol, Philadephia, PA; Bell Helicopter, Fort Worth, TX; Joannell Labs., Newark, NJ; Detroit Bullet Trap, Detroit, MI; ABA Electro-Mechanical Systems Corp., Pinellas Park, FL; American Airlines, Fort Worth, TX; Hughes Aircraft co., Fullerton, CA; General Electric Co., Pittsfield, MA; and AAI Corp., Baltimore, MD. The above list does not represent a complete list of contractors that may bid for approximately $7.0M. In-house developing organizations responsible for the program, the Naval Training Equipment Center, Orlando, FL, and Project Manager for Training Devices (PM TRADE), Orlando, FL.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Completed development effort on various components of the Multiple Integrated Laser Engagement System (MILES) which proceeded into major Engineering Development during FY 1976. Initiated development of the Infantry Remoted Target System (IRETS) and the Marksmanship Gunnery Laser Devices (MAGLAD I) for infantry training.

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.38.A Title Non-Systems Training Devices Development (NSTD)

2. FY 1977 Program: Complete Advanced Development effort on the Marksmanship Gunnery Laser Devices (MAGLAD I) for infantry type weapons. Development Test I/Operational Test I (DT I/OT I) tests are scheduled for 4Q77. No major difficulties are anticipated and program should proceed into Engineering Development during FY 1978. Continue major development effort on the Infantry Remoted Target System (IRETS). DT I/OT I tests currently scheduled for 1Q78. This program is also scheduled to proceed into Engineering Development during FY 1978.

3. FY 1978 Planned Program: Complete DT I/OT I tests on the Infantry Remoted Target System (IRETS). Initiate Advanced Development effort on the Armor Remoted Target System (ARETS) and the Marksmanship Gunnery Laser Devices (MAGLAD II) to support armor/anti-armor training. Programs include fabrication of prototypes of the various target subsystems as well as laser firing devices for armor/anti-armor weapon systems. Develop a device which permits rapid diagnosis of shooting malpractices and very inexpensive indoor marksmanship practice without the use of live ammunition. Initiate development of an Armor Full Crew Interaction Simulator (AFCIS) laboratory facility for the purpose of evaluating the application of simulation to tank crew training; capability which will allow training of each crew member individually or in combination with other crew members, as well as concurrent collection of data to support training developments; capability which will provide for selective cancellation of basic system functions and cues to assist in the evaluation of technology training value and effectiveness.

4. FY 1979 Planned Program: Complete Advanced Development on the Armor Remoted Target System (ARETS) and the Marksmanship Gunnery Laser Devices (MAGLAD II) for armor/anti-armor training, DT I/OT I scheduled for 4Q79. Continue development of the Diagnostic Rifle Marksmanship Simulator (DRIMS). Continue major development effort on the Armor Full Crew Interaction Simulator (AFCIS) initiated during FY 1978.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.38.A Title Non-Systems Training Devices (NSTD)

Project #A224 Title Non-Systems Training Devices Armor/Anti-Armor

Category Advanced Development Budget Activity #2 - Advanced Technology Development

DETAILED BACKGROUND AND DESCRIPTION: Most of the current gunnery training targets and ranges are old, difficult to maintain, and marginally effective. The overall objective of this program is to provide the Army with a system of gunnery trainers/simulators, targets and crew trainers that will realistically support training for the various armor/anti-armor weapons systems. The tank target equipment to be developed will provide the Army with a standard system for tank and anti-tank gunnery which previously was nonexistent. Additionally, the Army currently has no way of effectively training tank crews, other than the use of operational equipment. A full crew training simulator is critically needed to support tank crew training to achieve and maintain high combat effectiveness.

RELATED ACTIVITIES: The program is closely coordinated with the other Services, joint use of the Naval Training Equipment Center (NTEC), and worldwide staffing of training equipment requirements. Related elements are P.E. 6.27.27.A, Non-Systems Training Devices Technology; 6.47.15.A, Non-Systems Training Devices Engineering; 6.37.51.F, Innovation in Education and Training; 6.32.27.F, Advanced Simulator Technology; 6.37.20.N, Education and Training. This is a new project element starting with FY 1978. All development effort was accomplished in project #A115, P.E. 6.37.38.A, Non-Systems Training Devices Development, prior to FY 1978.

WORK PERFORMED BY: All programs are currently scheduled to be released on a competitive basis. Potential or anticipated bidders include: Singer Simulation Products Co., Silver Springs, MD; American Airlines, Fort Worth, TX; Hughes Aircraft Co., Fullerton, CA; Grumman Aerospace Corp., Bethpage, NY; General Electric Co., Pittsfield, MA; Boeing Vertol, Philadelphia, PA; Bell Helicopter, Fort Worth, TX; ABA Electro-Mechanical Systems Corp., Pinellas Park, FL; Joannell Labs., Newark, NJ; Detroit Bullet Trap, Detroit, MI. The above list does not represent a complete list of contractors that may bid competitively for approximately $6.0M. In-house developing organizations responsible for the program: the Naval Training Equipment Center and Project Manager for Training Devices (PM TRADE), Orlando, FL.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: Not Applicable.

2. FY 1977 Program: Not Applicable.

3. FY 1978 Planned Program: Significant increase in funding reflects the Army's initiative to develop and field cost and operationally effective training devices. Initiate major Advanced Development Effort (AD) on armor/anti-armor training devices and simulators to assist in resolving one of the Army's major training deficiencies - tank crew training. Develop the Armor Remoted

Budget Activity #2 - Advanced Technolcgy Development

Program Element # 6.37.38.A Title Non-Systems Training Devices (NSTD)

Project # A224 Title Non-Systems Training Devices Armor/Anti-Armor

Target System (ARETS) and the Marksmanship Gunnery Laser Devices (MAGLAD II) for armor/anti-armor training. Initiate development of the Armor Full Crew Interaction Simulator (AFCIS) research facility to assist the Armor Community in evaluating the application of simulation to tank crew training, provide capability to support training developments and in the evaluation of technology training value and effectiveness. These programs are designed to assist the Army in satisfying existing training deficiencies for armor/anti-armor weapon systems.

4. FY 1979 Planned Program: Continue major development effort of the Armor Remoted Target System (ARETS) and Marksmanship Gunnery Laser Devices (MAGLAD II) and Tank Full-Crew Interaction Simulator (TFCIS) programs. Development Test I/Operational Test I (DT I/OD I) for ARETS and MAGLAD II are scheduled for 4Q79. No new starts are projected for FY 1979.

5. Program to Completion: This is a continuing program.

RESOURCES: ($ in Thousands)

	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
RDTE: Funds	999	0	0	4,066	1,925	Continuing	Not Applicable

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.41.A

Title Meteorological Equipments

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	0	1257	1137	2145	Continuing	Not Applicable
	Quantities	0	0	0	0	0	Not Applicable	Not Applicable
D533-01	Field Artillery Meteorological Acquisition System (FAMAS)	0	0	1257	0	0	Continuing	Not Applicable
D533-02	Determination of Temperature and Wind Based on Meteorological Satellite Data (SATFAL)	0	0	0	0	1295	Continuing	Not Applicable
D533-03	Automatic Meteorological System (AMS)	0	0	0	0	500	Continuing	Not Applicable
D158-01	Field Artillery Meteorological Acquisition System (FAMAS)	0	0	0	1137	350	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Conduct advanced development on meteorological equipment required by the Field Army.

BASIS FOR FY 1978 RDTE REQUEST: The advanced development of the Field Artillery Meteorological Acquisition System (FAMAS) will be continued to provide the Field Artillery with a lightweight, highly mobile meteorological data acquisition system for support of forward area artillery.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Funding in FY 1978 is decreased by $120,000 since only $1,137,000 is required to start a new 6.3B project D158, Meteorological Equipment Development, to continue advanced development of the FAMAS.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	5	0	5
(2) Contractor Employees	9	0	9
Total	14	0	14

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.41.A

Title Meteorological Equipments

DETAILED BACKGROUND AND DESCRIPTION: The objective of this new program element is to establish an Atmospheric Sciences Advanced Development program. Items currently included in this program area: The Field Artillery Meteorological Acquisition System (FAMAS) required by the Artillery Center and School, US Army Training and Doctrine Command (TRADOC) and identified in the Battle King Study; the Remote Atmospheric Weather Station (RAWS), required by the Intelligence School and Center, TRADOC and identified as a high priority in the official TRADOC publication, Tactical Environmental Support System (TESS) Study, which lists Army meteorological requirements in the short and mid-term time frames as identified by 21 users; the Automatic Meteorological System (Artillery) required by the Artillery; and Determination of Temperature and Wind Based on Meteorological Satellite Data (SATFAL), the use of meteorological satellite data for nuclear fallout prediction required by Ordnance and Artillery. All items have approved Letters of Agreements (LOA's), or LOA's being staffed by the Training and Doctrine Command-Materiel Development and Readiness Command (TRADOC-DARCOM). Only the FAMAS is funded in FY 1977. This will be a continuing effort with other items currently in the (6.2) Exploratory Development effort moving into (6.3) Advanced Development in later years as LOAs are approved. The 6.3 development of the FAMAS will be initiated in FY 1977 to provide forward area Army Artillery Battalions with timely and accurate meteorological data. The FAMAS will be highly mobile, lightweight, automated data processing and unmanned meteorological data acquisition system to increase the accuracy of Artillery fire in the divisional forward area. The FAMAS is being developed with the capability of being deployed utilizing Navigation Aid (NAVAID) and/or Radio Direction Finding (RDF) antennas with the data processing and communications being common to both antenna systems. The (6.3) Advanced Development of the SATFAL will be initiated in FY 1978. Army requirements for meteorological data, other than nuclear fallout prediction, exist only to 14 kilometers. Meteorological Satellites can provide the 14-30 kilometer altitude wind and temperature data for any Army battlefield, and thus achieve a substantial reduction in the manhours, equipment, complexity and operations on the battlefield. Advanced development will be initiated on the Automatic Meteorological Acquisition System (AMS-Artillery) in FY 1979. The AMS-Artillery will be a software system which will significantly improve the accuracy in the computer meteorology message for Artillery Ballistics. It will optimize the utilization of tactical communications and computer systems already in the field to significantly improve meteorological firing data.

RELATED ACTIVITIES: Program Elements 6.11.02.A, B53A, Atmospheric Sciences; 6.21.11.A, AH71, Atmospheric Investigations; and 6.47.26.A, Meteorological Equipment Systems. Coordination of requirements with Army-Air Weather Service Meteorological Equipment Coordination Committee. As a result of Committee Coordination, equipments are being developed to meet Army and Air Force requirements. Coordination on Meteorological equipment development with NATO allies is accomplished through participation in Panel XII (Meteorology), NATO Army Armaments Group. Several NATO nations have expressed an interest in purchasing items of US equipment currently under development. Coordination with the National Weather Service and non-military organizations developing meteorological equipment for civilian use is accomplished through the Office of the Director of Defense, Research and Engineering (ODDR&E) participation on the Interdepartmental Committee for Applied Meteorological Research (ICAMR), and through the Annual Symposium on Meteorological Observations and Instrumentation, sponsored by the American Meteorological Society.

WORK PERFORMED BY: Approximately 75 percent of the work is accomplished in-house by the Atmospheric Sciences Laboratory (ASL), White Sands Missile Range, New Mexico and Fort Monmouth, New Jersey. Contracts totaling approximately $350,000 will be placed with successful bidders.

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.41.A Title Meteorological Equipments

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: None, this is a new program element starting in FY 1977.

2. FY 1977 Program: This is a new project (D533) Meteorological Equipment Development (6.3a), Advanced Development (AD) in FY 1977. Initiate Advanced Development on the Field Artillery Meteorological Acquisition System (FAMAS). User tests will be conducted. A test Integration Work Group (TWIG) will be held. Specifications and procurement data package will be prepared for the AD Model. A contract will be awarded for procurement of an AD Model of FAMAS.

3. FY 1978 Planned Program: A new project (D158) Meteorological Equipment Development, (6.3B) Advanced Development will be initiated with funding of $1.17M for development of the FAMAS. Procurement of the AD Model of FAMAS will be completed and acceptance tests initiated. Funding in FY 1978 is decreased by $120,000 since only $1,137,000 is required to continue advanced development of the FAMAS.

4. FY 1979 Planned Program: Advanced development of FAMAS will be completed. Advanced development of SATFAL will be initiated. Advanced development will be initiated on the Determination of Temperature and Wind Based on Meteorological Satellite Data (SATFAL) for which a Letter of Agreement (LOA) was approved. The ground terminal design for the AD phase will be finalized. Specifications for ground terminal will be prepared. The design of the sensors and spacecraft transmitter systems will be completed in conjunction Advanced development will be initiated on the Automatic Meteorological System, Artillery. The meteorological model to be used will be completed and the computer software program will be initiated. Funding increase in FY 1979 over FY 1978 is to initiate AD on the Automatic Meteorological System - Artillery (AMS-A) required to increase the accuracy of Artillery.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.42.A Title Advanced Electronic Devices

Category Advanced Development Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	0	0	1,227	2,000	Continuing	Not Applicable
DF3201	Beam, Plasma, Display and Transmitter Devices and Subsystems	0	0	0	666	840	Continuing	Not Applicable
DF3202	Semiconductor Devices and Integrated Circuits	0	0	0	561	740	Continuing	Not Applicable
DF3203	Signal Processing Devices	0	0	0	0	420	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program is needed to help transition electron devices and components into military systems. An exploratory development, usually only feasibility is demonstrated, which is insufficient to allow systems applications. Premature transition to systems has resulted in poor reliability and schedule slippages. This program provides the needed technology advances to insure successful application, including increasing reliability and lowering life cycle costs.

BASIS FOR FY 1978 RDTE REQUEST: Traveling wave tubes must be designed and built incorporating a technique for reducing arcing and using an air-cooled collector. This method is much simpler than the present vapor phase cooled tube thereby providing a reliable, arc free, cost effective transmitter tube for the Mortar Locating Radar, AN/TPQ-36. The high power traveling wave tube amplifier used in the Artillery Locating Radar, AN/TPQ-37, must be ruggedized and have electronic characteristics optimized for this phased array system. The final tube design is to obtain an operational life of 5000 hours. The floating deck modulator presently used in the Artillery Locating Radar, AN/TPQ-37, will be modified by bringing the modulator and interface assembly to ground potential thereby allowing for simpler trouble-shooting and maintenance. Use of low cost analog charge coupled devices to replace high speed digital computers will be pursued in developing low cost, small, low power, signal processors for portable radars, sensors, secure communications and electronic warfare (EW). Low cost, C-Band, transistorized 10 watt power amplifier modules must be developed and used to allow for the improvement of the operational reliability of the AN/GRC-143, Tactical Troposcatter System, and increase in range capability and propagation reliability of the AN/GRC-144. Tactical Radio Relay Equipment. Advanced technology and packaging techniques will be developed specifically aimed at improving the reliability levels of current plastic encapsulated complementary metal-oxide-semiconductor microcircuits.

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.42.A Title Advanced Electronic Devices

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: This is a new start in FY 1978.

PERSONNEL IMPACT:

The average number of employees support with requested FY 1978 funds (RDTE and Procurements) is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civilian Employees	4	0	4
(2) Contractor Employees	22	0	22
Total	26	0	26

DETAILED BACKGROUND AND DESCRIPTION: The objective is to provide advanced development models of electronic components, assemblies and subsystems for application in military systems. Proven device feasibility will be directed to specific system applications based on user needs. The approach will include the development of sufficient numbers of models/modules to determine reliability, performance, reproducibility with major emphasis on greater commonality of application and lower life cycle costs. This program is critical to the improvement in fielded EW, Radar and Communications Systems.

RELATED ACTIVITIES: Coordination is achieved with other Government agencies through participation in the activities of the Department of Defense Advisory Group on Electron Devices (AGED). Inter-service coordination and program cooperation are also directly derived from joint preparation of the Technology Coordinating Paper on Electron Devices which assess the technical program, goals and potential pay-off from the Tri-Service total investment of electronics technology base funds.

WORK PERFORMED BY: USA Electronics Research and Development Command (ERADCOM), Fort Monmouth, New Jersey. ERADCOM will utilize approximately 14 percent of the program funds in-house. Six contracts worth approximately $1.1 million will be awarded under this program..

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments:

   Not Applicable.

2. FY 1977 Program:

   Not Applicable.

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.42.A Title Advanced Electronic Devices

3. FY 1978 Planned Program:

Traveling Wave Tubes (TWTs) will be designed and built incorporating a "beam scraper" for reducing arcing and an air cooled collector which is much simpler than the present vapor phase cooled tube thereby providing a reliable, arc free, cost effective transmitter tube for the Mortar Locating Radar, AN/TPQ-36. The high power final output TWT used in the Artillery Locating Radar, AN/TPQ-37, will be ruggedized for use in a tactical environment and have its phase and amplitude control characteristics optimized to the degree necessary for this phased array system. Interim model tubes will be constructed for performance evaluation and the data used to finalize the tube design to obtain an operational life of 5000 hours while meeting system electrical and environmental requirements. The reliability and maintainability of the modulator for the Artillery Locating Radar, AN/TPQ-37, will be increased by a modification which removes the modulator and interface assembly from floating dock to ground and inserting an isolation pulse transformer to couple the basic grid pulse to the RF amplifier. Trouble-shooting and maintaining the basic modulator and interface circuit will be simpler since they will be at ground potential. Basic modulator units will be designed, built and evaluated in the AN/TPQ-37 transmitter. A program will be started to use low cost analog charge coupled devices (CCD) to replace high speed digital computers in performing real time signal analysis for low cost, small, low power, signal processors for portable radars, sensors, secure communications and electronic warfare (EW). A program will be initiated to develop high reliability 10 watt, solid-state power amplifier modules for operation over the 4.4 to 5.0 GHz frequency band by utilizing microwave integrated circuit techniques with matched power transistors to realized a low cost reliable module. Amplifier modules will be used to improve the operational reliability of the AN/GRC-143, Tactical Troposcatter System and to increase the range capability and propagation reliability of the AN/GRC-144, Tactical Radio Relay Equipment. A program will be started to develop advanced technology and packaging techniques specifically aimed at improving the reliability levels of current plastic incapsulated complementary metal-oxide-semiconductor (CMOS) microcircuits. The increase in FY 1978 over FY 1977 funds is due to the program being started in FY 1978.

4. FY 1979 Planned Program:

The Traveling Wave Tube (TWT) program for the Mortar Locating Radar, AN/TPQ-36, will emphasize the engineering assessment of the beam scraper and air cooled depressed collector incorporated in the tube design, as well as a refinement of techniques to produce a cost-effective, reliable tube. The Traveling Wave Tube program for the Artillery Locating Radar, AN/TPQ-37 will devote itself to the detailed electrical, mechanical, and environmental tests required to insure reliable operation of the system in the field. Representative tubes will be life tested to obtain meaningful and reliable data concerning the 500 hour operational life objective. Development and testing of advanced low cost analog charge coupled device (CCD) signal processors in military environments will be completed. Performance and reliability will be tabulated. Design parameters will be finalized and complete system interface compatibility tests completed. Optimization of input and output matching circuitry for the 10 watt, solid state power amplifier over the 4.4 to 5.0 GHz operation will be finalized. Transistor power levels will be improved to reduce the number of devices required to achieve 100 watts. Devices will be fabricated to determine reliability and producibility of high power modules. The reliability evaluation of plastic encapsulated microcircuits will be continued by developing those

technologies required to eliminate failures. A sufficient number of these devices will be tested to determine reliability levels and adequacy of the techniques in meeting overall goals of performance and long life at reasonable cost. Extremely small, low power, highly stable reference oscillators, producible in large quantities at low cost are required for Global Positioning System (GPS)/Navigation by Stationary Relay (NAVSTAR) manpack receiver equipments. Advanced development of a 1 cubic inch crystal oscillator, having a 2×10^{-8}/year overall stability and less than 250 milliwatt power consumption, will be undertaken to finalize the thermal and mechanical design and potimize the oscillator circuit design. Advanced development models of fiber optic cable assemblies will be undertaken to replace conventional metallic cables to improve the tactical mobility and reduce the vulnerability of Pulse Code Modulation and Time Division Multiplex cable trunking systems within Army command posts. Compact individualized pulsers using marx, spiral, and line type modulators, will be applied to laser systems. Trade-off analyses considering power supply circuits, pulse circuits, switches and cooling techniques will be conducted. Models will be built for testing with specific equipments emphasizing reliability, compactness, ruggedness, and ease of maintenance. A program will be started to use charge coupled linear imaging devices in photosensor arrays to replace mechanical scanning in page readers and having wider dynamic range and lower light level operating capability. Advanced development models of temperature compensated surface acoustic wave delay lines will be fabricated using a previously demonstrated fused silica/lithium tantalate composite. The composite approach will be more cost effective by using a chemical vapor deposition process for producing fused silica thin films. Modules equivalent to the current Patriot missile delay line will be fabricated to determine whether equivalent performance can be achieved with significant savings in cost, weight and power requirements. The increase in FY 1979 funds over FY 1978 is due to increased contractual effort to support the FY 1979 planned program.

5. Program to Completion:

This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.43.A

Title Training and Utilization in Military Systems

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES/PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	4169	987	5504	8420	9951	Continuing	Not Applicable
A771	Systems Embedded Training Development	536	127	900	963	1200	Continuing	Not Applicable
A772	Aircrew Performance in Tac Environ	1165	189	1400	1453	2000	Continuing	Not Applicable
A773	Combat Unit Training	1173	318	1504	2033	2200	Continuing	Not Applicable
A774	Man-Machine Integrated Battlefield Sys	778	199	900	968	1000	Continuing	Not Applicable
A775	Human Performance in Field Assessment	517	154	800	1065	1200	Continuing	Not Applicable
A780	Trng Dev for Battlefield Effectiveness	0	0	0	1453	1651	Continuing	Not Applicable
A783	On the Job Indiv Training Technology	0	0	0	485	700	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Advanced development for application of automated and simulation training and training device technology in the unit setting; application of training technology for helicopter crew development; improved readiness posture through individual and unit training development for active and reserve combat and combat support units; man-machine interface and interaction in integrated battlefield systems; field assessment of human performance in executing military tasks; transfer of unit training technology to operational commanders.

BASIS FOR FY 1978 RDTE REQUEST: Continue advanced development for more cost-effective training and utilization of personnel in military systems, for more valid performance evaluation criteria and measurement methodology, for improved unit/team training techniques and training management procedures, for enhanced operational performance in combat systems, and for transitioning between prototype advanced training technology and field unit command users.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The Director of Defense Research and Engineering convened a special Defense Science Board Task Force on Training Technology to (1) advise on the effectiveness of defense programs and management of defense technology R&D; (2) provide recommendations for increasing the effectiveness and efficiency of defense training; and (3) consider alternative management approaches. The specific increases requested in the FY 78 budget represent Army actions to improve training programs as recommended by the special Task Force. Major thrust centers on developing valid Cost Training Effectiveness Analyses (CTEA) in support of training devices and simulators with special emphasis on new flight simulators because of

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.43.A Title Training and Utilization in Military Systems

their high cost and potential impact on aviation training. Also, part of the requested increase will fund work on urgent requirements from the Commanding General, US Army Training and Doctrine Command (TRADOC), to develop more cost effective training at the Army service schools while implementing improvements in training technology in deployed US Army field commands. These FY 78 funding levels represent hard core requirements needed to increase research and development to improve implementation and evaluation of individual, crew, group, team, and unit training Army-wide. This technology will be applicable to Reserve and National Guard units as well as the active Army. The requested increases will fund the two new programs entitled Training Development for Battlefield Effectiveness and On-the-Job Individual Training Technology.

PERSONNEL IMPACT: The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	130	0	130
(2) Contractor Employees	121	0	121
Total	251	0	251

DETAILED BACKGROUND AND DESCRIPTION: Systems embedded training development provides cost-effective training packages using actual system hardware of complex computerized tactical systems to self-instruct users in system operation, e.g., the Missile Minder (AN/TSQ73). Aircrew performance in tactical environment addresses training for helicopter flight crews in topics of nap-of-the-earth flying, navigation, and night flying, emphasizing development of procedures to minimize error and determination of training needs to maintain flight proficiency in operational units. Combat unit training integrates realistic two-sided tactical engagement simulation training into Army Training and Evaluation Program (ARTEP), and develops cost effective methods for tank and other combat arms unit training; man-machine integrated battlefield systems concerns development of improved command and control capability through enhanced transformation and organization of battlefield information; staff aids to battle management, human factors in continuous operations. Human performance in field operations addresses development of methods for human factors evaluations of weapons systems, and field assessment of new training, doctrine and combat developments growing out of the new engagement simulation techniques. Training development for battlefield effectiveness and on-the-job individual training technology provide implementation methodology and guidance for transitioning new training developments to field units and individuals.

RELATED ACTIVITIES: 6.37.51.F, Training and Education Innovations; 6.37.20.N, Education and Training; 6.27.22.A, Army Training Technology; 6.37.38.A, Non-systems Training Devices Development. Interservice coordination is effected through annual and monthly tri-service technical coordination reviews.

WORK PERFORMED BY: Litton-Mellonics, Sunnyvale, CA; Perceptronics, Inc., Woodland Hills, CA; Computer Based Education Research Lab, Urbana, IL; Northwest Regional Education Institute, Portland, OR; Human Sciences Research, Inc., McLean, VA; American Institutes for Research, Pittsburgh, PA; Kinton, Inc., Alexandria, VA; Human Resources Research Organization, Alexandria, VA; HRB-Singer, Inc., State College, PA; Systems Development Corp., Santa Monica, CA. There will be approximately ten additional contractors for a total dollar value of $900,000. US Army Research Institute for the Behavioral and Social Sciences (in-house).

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.43.A Title Training and Utilization in Military Systems

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976, and Prior Accomplishments: A technique to specify training device requirements in the early phases of weapons system development was completed. Evaluation of instructional graphics for computer assisted instruction (CAI) completed. A computer model for generating field test exercise control system specifications developed. Completed a diagnostic study on night terrain flight navigation skills and on the feasibility of the Army's Synthetic Flight Trainer System (SFTS) as a night flying trainer and as a device for determining aviation learning aptitude. A realistic combat engagement simulation technique developed for small infantry units. Potential cost reduction in gunnery training through simulation verified. Work on spacing of unattended ground sensors provided techniques for greatly improved operator performance. Developed method for allocating combat intelligence collection resources more efficiently. Requirements for training tank crews in closed-hatch operations identified. Improved air-to-ground target handoff techniques developed.

2. FY 1977 Program: Extend and improve model to specify training device requirements in the early phases of weapons system development. Evaluate helicopter aerial defense tactics. Extend tactical engagement simulation training for combined arms tactical training to include air defense simulation. Develop guidelines to aid Army Training Evaluation Program evaluators. Determine unique training requirements for three Army tanks (M60A1AOS, M60A3 and XMI). Develop home station tank gunnery training program. Define a training development requirement reflecting battalion command and control performance demands and training strategies. Develop processor aided storage and retrieval techniques for tactical combat intelligence information processing. Determine performance effects of improved portrayal of terrain relief and vegetation on maps. Devise measures of effectiveness for evaluating tank crew performance in world-wide tank training programs. Conduct field tryout of multiple-integrated laser engagement team training program and evaluation model.

3. FY 197& Planned Program: Publish handbook to assist users in acquiring simulation and training device requirements data during various phases of weapon system development. Complete evaluation of media alternatives for training general and specialized infantry skills. Develop recommended program of instruction for teaching minimum weather operations and use of tactical instruments in nap-of-the-earth flight. Determine the best training medium for various learning objectives of helicopter crews. Develop new aviator selection and differential assignment processes to reduce costly attrition. Validate engagement simulation training/evaluation model for combined arms units. Complete M60A1AOS tank weapons system training effectiveness analysis. Develop training design and evaluation system for brigade. Develop & evaluate coding techniques for more effective communication of topographic information. Validate automated aids for movement analysis of tactical forces. Increased funds will support completion of prototype engagement simulation training program and the infantry and combined arms leader training techniques; completion of the first phase of an adaptive computerized training system and an improved general educational development high school equivalency program. Concentrate effort on field test and cost-effectiveness evaluation of individual on-the-job training systems.

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.43.A Title Training and Utilization in Military Systems

4. FY 1979 Planned Program: Conduct cost and training effectiveness evaluation of computer-aided instruction for the Army general education development program. Determine optimum training system (simulators, aircraft, and course work) to maintain pilot proficiency. Assess and quantify training value of high fidelity aircraft simulation systems. Develop techniques for integrating air-defense and Army air operations into engagement simulation training. Develop improved techniques for acquiring diagnostic information from Army Training Evaluation Program evaluators. Validate decision support modules for the battlefield staff and specify system requirements. Specify human capabilities in supporting continuity of operations in manual, manual back-up and automated modes of battlefield performance. Develop techniques for assessing human factors in command and control effectiveness. Develop implementation packages for foreign language training program, for on-line authoring aids, and for integrated technical documentation and training.

5. Program to Completion: This is a continuing program.

FY 1978 DESCRIPTIVE SUMMARY

Program Element # 6.37.44.A Title Army Contemporary Issue Development

Category Advanced Development Budget Activity #2 - Advanced Technology Development

RESOURCES/PROJECT LISTING: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	485	62	300	485	500	Continuing	Not Applicable
A769	Army Contemporary Issue Development	485	62	300	485	500	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program element provides for advanced development research in two major categories: (1) improving the morale and combat readiness of troops through development, evaluation and assessment of experimental programs designed to impact directly on improving race and ethnic relations in the Army, and (2) developing assessment and diagnostic instruments for use by the chain-of-command in assessing esprit de corps, motivation, readiness and problems associated with poor discipline and delinquency.

BASIS FOR 1978 RDTE REQUEST: Implementation and validation of programs and processes developed within the context of both Army-wide and Division-size test beds so as to realize both the Department of Defense and Department of Army goals of affirmative action, harmonious race relations and the institutionalization of programs that produce individually and organizationally effective military personnel.

BASIS FOR INCREASE IN FY 1978 OVER 1977: The level of funding requested for this Program Element in FY 77 was reduced by 40%. Without the minimal support being sought, advanced development research efforts geared toward operational implementation of programs within Department of Army will not be possible. It should be noted that during FY 77, over one-third of the research requirements generated by active duty Army field units were directly related to this Program Element. From the vantage point of active Army commanders, issues and problems associated with this area of personnel and human resources research continue to be major areas of critical concern.

PERSONNEL IMPACT: The average number of employees supported with requested FY 1977 funds (RDTE and Procurement) is as follows:

	RDTE	Procurement	Total
(1) Federal Civilian Employees	2	0	2
(2) Contractor Employees	6	0	6
Total	8	0	8

Budget Activity #2 - Advanced Technology Development

Program Element # 6.37.44.A Title Army Contemporary Issue Development

DETAILED BACKGROUND AND DESCRIPTION: Research on Contemporary Issues within the Army supports and extends the technology base efforts and methodological developments carried out under programs concerned with increasing soldier productivity. The specific areas of inquiry addressed under the Contemporary Issues element are designed to provide for direct implementation of programs at the field unit level concerning human relations and human resources problems identified by the chain-of-command as impacting directly on the effectiveness and readiness of their units. As such, research being carried out under this program provides the sole vehicle for validation and implementation of Department of Army sponsored programs in the areas of race and ethnic relations, human resources utilization and evaluation of the Army's equal opportunity programs.

RELATED ACTIVITIES: None

WORK PERFORMED BY: Human Sciences research, Inc., and two other contractors to be selected. In-house organization responsible for executing the program is the U.S. Army Research Institute for the Behavioral and Social Sciences, Arlington, VA.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 197T, FY 1976 and Prior Accomplishments: The Report on Measuring Changes in Institutional Racial Discrimination in the Army was cited by the Secretary of the Army as a basis for the 1975 Army Affirmative Action Plan. At the request of the White House a report evaluating the President's Clemency Program was issued and incorporated into the broader Department of Defense evaluation of the program. On the basis of continuing evaluations of the Army's Race Relations and Equal Opportunity Program and Training Programs for Race Relations and Equal Opportunity personnel, a revision of the basic Department of Army Pamphlet 600-21 is being made. A technical report containing information and documentation on a series of diagnostic instruments for use by the chain-of-command in assessing human resources problems was issued. Initial feedback from installation commanders indicates strong support for the information and a requirement to validate the diagnostic instruments against performance-based indicators of soldier effectiveness.

2. FY 1977 Program: An Army wide evaluation of the Race Relations Program is currently underway. Preliminary results indicate that the operational implementation of this program at both the School and Unit level is highly variable. The lack of formal involvement of trained Race Relations personnel in the conduct of training programs emerges as a major drawback to the effectiveness of the program. The lack of a "crises" environment as manifested by racial upheavals also emerges as a factor in the program's reduced emphasis. However, there is growing evidence of institutional discrimination and of the differential administration of the judicial system as applied to racial and ethnic minorities which strongly suggest that the program requires renewed emphasis as as to preclude major disturbances. This is particularly true given the dramatic increase in non-white enlistments in the Army during recent months.

3. FY 1978 Planned Program: A series of diagnostic and assessment instruments possessing high degrees of reliability and tapping a wide range of human resources problems and issues will be validated against performance-based measures of individual soldier effectiveness and unit readiness with a Division level. Development of standardized feedback mechanisms for use by the chain-of-command in monitoring human resources issues to provide for an "early warning system" in combating problems and issues prior to

their reaching crisis proportions. Development of a series of Human Relations Training Programs for use at the Battalion and Company level as a mechanism for combating racial and ethnic discrimination and prejudice. Developing a taxonomy reflecting the administration of justice within the Army with particular emphasis to racial and ethnic minorities as well as women.

4. FY 1979 Planned Program: In FY 1979 a methodology for the implementation of the system for measuring Institutional Racial Discrimination (IRD) will be validated against individual and unit measures of performance effectiveness. Further, research designed to address intervention strategies for use at the Company level for dealing with disciplinary problems among racial and ethnic minorities will be field tested. The establishment of a series of institutional reporting systems -- personnel and organizational -- for use in forecasting personnel problems will be field tested and the feasibility and costs associated with operationally implementing such a system developed.

5. Program to Completion: This is a continuing program.

6. Major Milestones:

(a) The prototype system for measuring Institutional Racial Discrimination (FY 1978)

(b) Validated system for monitoring equal opportunity programs (FY 1979)

(c) Report on the extent of racial polarization (FY 1979)

(d) Report on factors impacting on the socialization of the American Soldier (FY 1978)

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element # 6.37.47.A

Title Soldier Support/Survivability

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	1,276	291	1,241	1,990	3,932	Continuing	Not Applicable
D610	Food Advance Development	197	174	725	1,162	2,190	Continuing	Not Applicable
D669	Clothing and Equipment	1,079	117	516	828	1,742	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This is a new program element, which contains two soldier support projects previously carried in 6.37.26.A, Combat Support Equipment. The two projects in this element support developments in the Department of Defense Food Research Development Technology and Engineering program and Army requirements relative to clothing and life support equipment to increase the combat efficiency of the individual soldier.

BASIS FOR FY 1978 RDTE REQUEST: Initiate advanced develpment (AD) of flashblindness protection equipment for Army aviators, development of heated handwear to meet Environmental Protection Agency/Occupational Safety and Health Administration/National Institute of Occupational Safety and Health (EPA/OSHA/NIOSH) standards. Continue AD on design studies for cold-dry weather uniforms; transportable helicopter enclosures; a relocatable maintenance hanger; field food service sanitation equipment, and the continuous flow field bakery system. Initiate continue AD efforts on approximately fifteen service requirements previously carried in 6.27.24.A, AH99, Food Technology.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The significant increases in this project are the result of the transfer of funds and requirements previously carried in the exploratory development element of the Department of Defense Food Research Development Technology and Engineering program (6.27.24.A. Food Technology) and initiation of advance development of the heated handwear, flashblindness protection to meet EPA/OSHA/NIOSH standards.

PERSONNEL IMPACT:

Budget Activity #2 - Advanced Technology Development

Program Element # 6.37.47.A Title Soldier Support/Survivability

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	34	0	34
(2) Contractor Employees	7	0	7
Total	41	0	41

DETAILED BACKGROUND AND DESCRIPTION: In keeping with the overall food program objectives of improving quality and customer acceptance while reducing costs and labor, the efforts to develop a new bakery system for the Army/Marine Corps in the field are conducted in this program element. The new, highly productive system will utilize modern bread baking technology and produce a product acceptable to service personnel, while using fewer personnel to operate it. The food service sanitation system efforts are being undertaken to improve overall sanitation standards, while reducing labor requirements. A major restructuring of the Department of Defense (DOD) Food RDT&Eng program, transferred numerous service requirements previously carried in the 6.2 exploratory development level of effort, which is intended to make the program more responsive to the Services' needs. Better clothing, individual equipment, shelters and field service equipment are required for protection of the soldier and to improve his performance.

RELATED ACTIVITIES: A portion of the work conducted in this element is part of the DOD Food Research Development Technology and Engineering program. Other elements and projects within this program are 6.11.02.A, AH52, Research in Support of Equipment for the Individual Soldier; 6.27.24.A, AH99, Food Technology; 6.47.13.A, DL47, Wholesomeness Testing of Irradiated Foods; and D548, Military Subsistence Systems. The other portion of this element is related to the Army's Clothing and Life Support Equipment Program. Other elements/projects are 6.27.23.A, AH98, Clothing, Equipment and Packaging Technology; 6.47.13.A, DL40, Clothing and Equipment and DL42, Personnel Armor Systems. Close coordination is conducted with the other Services to insure there are no duplications of effort in the clothing and life support equipment areas.

WORK PERFORMED BY: In-house work in this element is performed by the US Army Natick Research and Development Command, Natick, Massachusetts. Contractors include the Food Machinery Corporation, Santa Clara, California; Alpha Industries, Knoxville, Tennessee; Comfort Products Company, Aspen, Colorado; Tanners Council Research Laboratory, University of Cincinnati, Cincinnati, Ohio; IIT Research Institute, Chicago, Illinois; Footwear Research, Haverhill, Massachusetts; and Sandia Laboratories, Albuquerque, New Mexico.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976 and Prior Accomplishments: Within the food program portion of this element, work was conducted in 6.27.24.A, Food Technology and 6.47.13.A, D548, Military Subsistance Systems during years prior to FY 1976. Design studies have progressed

towards establishing a basis for simplifying baking operations in the field. A make-up/mixing section for a continuous flow system has been fabricated and a contract has been awarded for the proofing/baking section of this system. Design studies have also progressed on a field sanitizing unit for the Army/Marine Corps. A personnel armor system for ground troops and in-house design of a relocatable maintenance hanger were completed. Developed a parka and trousers, cold weather reversible which is 1.36 kilograms lighter than standard items. A contract was awarded for development of combat boots incorporating water-resistant uppers and vibram design outsole. A study of the US, UK and Canadian chemical protective clothing was completed.

2. FY 1977 Program: Continue development of a field sanitation system for the Army/Marine Corps, and the contract for the proofer/oven system. Initiate a contract for the design and development of a dispensing and cooling unit and shelters and auxillary equipment for the field bakery. Continue to support new subsistence items for the Department of Defense. Procure high-pressure arches and low pressure tubes for the relocatable maintenance hanger and begin evaluation. Fabricate cold-dry weather uniforms. Select materials for fabrication of infantry combat boot; design and develop molds in four sizes only. Complete evaluation of vapor permeable/water impermeable rainwear.

3. FY 1978 Planned Program: Complete advance development (AD) evaluations of mixer/depositor and proofer/oven units, receive and evaluate depanner/cooler unit, slicer and other auxillary equipment of the continuous flow field bakery. Complete evaluation of field sanitizing equipment. Continue to support new subsistence items for the Department of Defense (DOD). A portion of the funding increase in this element is the result of the transfer of service requirements from 6.2 exploratory development. Fabricate prototype relocatable hanger. Evaluate cold-dry weather uniform in Alaska. Fabricate prototype heated handwear and construct prototype flash protective device for aircrewman utilizing electro-optical shutter ceramic material. Investigate the Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), and National Institute of Occupational Safety and Health (NIOSH) standards and define problem areas as they apply to the material manufacturing operations in the clothing and flexible areas. The balance of the funding increase in this element is to fund the increased clothing AD efforts.

4. FY 1979 Planned Program: Continue to support new subsistence items for the DOD. Complete evaluation of an automated system for menu planning, and prepare test plans; complete evaluation of canteen cup stand; and evaluation of prototype lightweight combat assault ration. Funding increases reflect the continuation of transfers of service requirements and funding previously planned for the 6.2 exploratory development element of the food program. Initiate effort to develop lightweight cooling/heating device for protective clothing systems. Conduct physiological testing of prototype heated handwear. Determine durability and fabrication characteristics of candidate novel materials for shelter systems; develop engineering criteria and shelter objectives. Complete prototype construction of simplified electro-optical device for flashblindness protection for Army aircrewmen. Initiate AD of combat vehicle crewmen's (CVC) helmet by studying human factor compatibility; develop communication concepts; and initial helmet design and establishment of medical constraints. Funding increase caused by the new initiative in utilization of novel shelter systems, application of molding techniques for equipment, development of molded clothing, CVC helmet and footwear and application of micro-climatology to clothing.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.48.A

Title Automatic Test Equipment

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	2470	880	1193	2734	4602	Continuing	Not Applicable
	Quantities						Not Applicable	Not Applicable
AJ29	Automatic Test Support System	1650	780	674	2401	2355	Continuing	Not Applicable
D203	Vehicle Diagnostics	50	0	100	0	100	Continuing	Not Applicable
D244	Communications Electronics Automatic Test System	570	100	319	236	547	Continuing	Not Applicable
D633	ATE Advanced Tech	0	0	0	0	1500	Continuing	Not Applicable
D651	Calibration	200	0	100	97	100	Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: Accomplishment of advanced development of automated test, measurement and diagnostic equipment in several disciplines to support the maintenance of tactical combat and combat support systems used by the Army in the field.

BASIS FOR FY 1978 RDTE REQUEST: Continue development of a compiler for acceptance of multiple object codes and generation of test procedures. Continue feasibility study of automatically monitoring diesel engine operations. Continue advanced technology investigations into direct execution of high level language structures; initiate development of a Contact and Repair Test Equipment (CARTE) system. Initiate development of standards and calibration means for electro-optical communication systems; continue development of laser calibration standards.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: The FY 1978 increase in funding level over that of FY 1977 results from initiation of advanced development work in three areas. First, several contractual efforts will be established to investigate the feasibility of new integrated, automatic test equipment system approaches and the feasibility of applying the Operational Performance Analysis Language (OPAL) to the next generation of Army Automatic Test Equipment (ATE). Second, non-system oriented advanced development work will be initiated to develop software and hardware for directly executing Higher Level Language structures in ATE. Third, a development will be initiated for the design and fabrication of a CARTE system.

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.48.A Title Automatic Test Equipment

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	24	0	24
(2) Contractor Employees	37	0	37
Total	61	0	61

DETAILED BACKGROUND AND DESCRIPTION: This program is aimed at providing Army-wide common automatic test equipment for the test, measurement, and diagnosis of electronic, electrical, optical, mechanical, and hydraulic systems. The approach will establish an integrated family of multi-purpose automatic, semi-automatic, and ancillary manual test systems applicable to all items of Army materiel at all maintenance echelons. Specific tasks are concerned with overall systems architectures, system configurations and associated software concepts, including the development of a standard Army programming language, for common Army-wide automatic test equipment.

RELATED ACTIVITIES: 6.27.79.A, Test, Measurement, and Diagnostic Equipment Technology and 6.47.46.A, Engineering Development - Automatic Test Equipment support exploratory and engineering development, respectively. Funds shown in FY 1976 and FY 1977 are in Program Elements 6.36.22.A, Test, Measurement, and Diagnostic Equipment; and 6.37.07.A, Communications Development.

WORK PERFORMED BY: US Army Communications Research and Development Command, Fort Monmouth, New Jersey. Contractors include: Massachusetts Computer Associates, Wakefield, Massachusetts; Opto-Logic Corporation, Los Angeles, California; Rockwell International, Anaheim, California; University of Pennsylvania, University Park, Pennsylvania; and North Carolina State University, Raleigh, North Carolina. The US Army Missile Research and Development Command, Redstone Arsenal, Alabama, is responsible for the Calibration Program. Major contractors include: Hewlett-Packard Corporation, Palo Alto, California; John Fluke Manufacturing Company, Seattle, Washington; Eon Incorporated, Brooklyn, New York; and the US National Bureau of Standards. The vehicle diagnostic work is done by the US Army Tank-Automotive Research and Development Command, Warren, Michigan, and by contract with Wayne State University, Detroit, Michigan.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: A test procedure computer language was formulated along with design specifications for a compiler to accept it and generate an object language. Two mobile calibration systems were procured and modified for testing; advanced development of an assemblage of simplified test equipment for internal combustion engines was completed and

transitioned into engineering development. Completed evaluation of common test adapters for diagnostic equipment; initiated work on instrumentation to measure the operational temperatures of critical weapons system components; development of an initial definition of the Operational Performance Analysis Language (OPAL) was completed.

2. FY 1977 Program: Initiate fabrication of an OPAL compiler; evaluate concepts for software simulation of hardware and higher level language microprocessors; write and debug applicable programs; conduct feasibility investigations for the application of AN/USM-410 Automatic Test Support System to several developmental combat support systems; evaluate a commercial portable calibration system for oscilloscopes; complete feasibility studies of a high energy laser measurement system and conduct field trials with a prototype system.

3. FY 1978 Planned Program: Continue development of a compiler for acceptance of multiple object codes and generation of test procedures. Continue feasibility study of automatically monitoring diesel engine operations. Initiate advanced technology investigations into direct execution of high level language structures; initiate development of a Contact and Repair Test Equipment (CARTE) system. Initiate development of standards and calibration means for electro-optical communications systems; continue development of laser calibration standards. The increase in FY 1978 funds over FY 1977 is due to initiation of development of a CARTE system, direct execution of high level language structures and several calibration standards.

4. FY 1979 Planned Program: Continue the OPAL compiler work initiated previously, as well as the feasibility studies on integrated automatic test equipment system approaches; design and fabricate stimuli modules for the CARTE system; develop software routines to aid in test program preparation and debugging; develop methods to automatically generate fault isolation tests for analog circuits; initiate a feasibility study on multiple work station approaches, using the AN/USM-410 as a test bed; continue development of electro-optical and laser calibration standards. The increase in FY 1979 funding over FY 1978 is due to incremental funding increases for the Operational Performance Analysis Language (OPAL) compiler and the Contact and Repair Test Equipment (CARTE) and to initiation of AN/USM-410 Multiple Work Station Feasibility Study.

5. Program to Completion: This is a continuing program.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.37.53.A

Title Deep Basing Technology

Category Advanced Development

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING: ($ in Thousands)

Project Number	Title	FY 1976	FY 197T	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	0	0	3389	7000	12411	22800
AT43-01	Geotechnical Research and Development	0	0	0	813	725	375	1913
AT43-02	Geotechnical Site Characterization	0	0	0	925	1950	3208	6083
AT43-03	Drilling/Excavation Technology	0	0	0	755	1775	3828	6358
AT43-04	Construction Technology	0	0	0	896	1334	2118	4348
AT43-05	Prototype Efforts	0	0	0	0	975	2600	3575
AT43-06	Development Test and Excavation Plan	0	0	0	0	241	282	523

BRIEF DESCRIPTION OF ELEMENT: Research and development necessary to provide economical excavation and facilities construction technology for deep underground command, control and communication bases.

BASIS FOR FY 1978 RDTE REQUEST: FY 1978 funding is required to initiate research in four major technical areas to support the Department of Defense (DOD) directed work in support of the World Wide Military Command and Control System (WWMCCS) Deep Basing Program.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: This is a new program for FY 1978.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
1) Federal Civilian Employees	86	0	86
2) Contractor Employees	9	0	9
Total	95	0	95

Budget Activity #2 - Advanced Technology Development

Program Element #6.37.53.A Title Deep Basing Technology

DETAILED BACKGROUND AND DESCRIPTION: Recent re-evaluation of US planning on survivability of command, control and communications (C^3) systems has been dictated by a national "Flexible Response" policy which demands great survivability, a secure nuclear reserve which requires post-conflict command and control, and the vulnerability of current airborne C^3 facilities to modern Soviet arms. Department of Defense has determined that alternative methods of providing survivable C^3 facilities should be investigated. One such concept is Deep Basing, combining a super-hard deep underground command center and extremely low frequency communications system. Since excavation costs are estimated at 60 percent of the total deep base cost, research and development of new excavation/construction techniques is expected to provide a large return on investment if deep bases are built. The deep basing excavation/construction research and development program was assigned by the World Wide Military Command and Control System (WWMCCS) Council to Army for funding and execution (Corps of Engineers) based on experience on other underground facility construction.

RELATED ACTIVITIES: Other portions of the deep basing program are being initiated in FY 1978 by Defense Nuclear Agency (site excavation/characterization; nuclear effects/hardening), Defense Communications Agency (communications system design/development; communications technology/survivability). Close coordination of effort by all program participants will insure unity of effort.

WORK PERFORMED BY: Approximately 90 percent of first year's work will be performed in-house, primarily at US Army Engineer Waterways Experiment Station, with coordinated effort at Construction Engineering Research Laboratory, Cold Regions Research and Engineering Laboratory, and Huntsville Division, Corps of Engineers. Contractor involvement will increase to 40 percent in later years.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1971, FY 1976, and Prior Accomplishments: Not applicable.

2. FY 1977 Program: Coordinated planning only has been initiated.

3. FY 1978 Planned Program: Coordinated planning will continue with associated deep basing agencies. Initial programs will be initiated in geotechnical research and development (rock stress measurement, bore hold drilling); geotechnical site characterization (geotechnical review and field survey); drilling/excavation technology (technology interface, continuous excavation design, conventional excavation technology, new excavation technology, and muck removal); and construction technology (high-strength concrete, rock support, material handling, human factors, personnel transportation, and heat sink optimization). This is a new start in FY 1978.

4. FY 1979 Planned Program: Work will continue on areas initiated in FY 1978 and new work will be initiated in prototype efforts and development test and evaluation plan to utilize results of FY 1978 work.

5. Program to Completion: Work will continue on established programs through FY 1982.

FY 1978 RDTE DESCRIPTIVE SUMMARY

Program Element #6.57.10.A

Title Joint Chemical/Biological Contact Point and Test

Category Testing

Budget Activity #2 - Advanced Technology Development

RESOURCES /PROJECT LISTING/: ($ in Thousands)

Project Number	Title	FY 1976	FY 1977	FY 1977	FY 1978	FY 1979	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT						Continuing	Not Applicable
0049	Joint CB Contact Point and Test						Continuing	Not Applicable

BRIEF DESCRIPTION OF ELEMENT: This program supports joint operational tests, investigations and/or studies for unified and specified commanders and the services. Joint Contact Point includes the publication and maintenance of Chemical and Biological (CB) Technical Data Source Books and provides data evaluation in support of CB data inquiries.

BASIS FOR FY 1978 RDTE REQUEST: Efforts scheduled include two operational tests, four operations research studies and CB Technical Data Source Books. These will be in progress and/or completed in FY 1978.

BASIS FOR CHANGE IN FY 1978 OVER FY 1977: Decrease in funds represents lower testing activity in FY 1978.

PERSONNEL IMPACT:

The average number of employees supported with requested FY 1978 funds (RDTE and Procurement), is as follows:

	RDTE	PROCUREMENT	TOTAL
(1) Federal Civ. Employees	25	0	25
(2) Contractor Employees	0	0	0
Total	25	0	25

Budget Activity #2 - Advanced Technology Development

Program Element #6.57.10.A Title Joint Chemical/Biological Contact Point and Test

DETAILED BACKGROUND AND DESCRIPTION: This program was formed in FY 1975 as a result of the disestablishment of Deseret Test Center (DTC) as a joint activity. The program provides for performing those joint tasks that remained after the responsibilities formerly performed by DTC were returned to Service control. The objective of this program is to plan, conduct, evaluate, and report on Joint Operational Tests, technical investigations and/or operations research studies in response to requirements from the commanders of the unified and specified commands and the Services and to serve as the Department of Defense Joint Contact Point for chemical and biological defense tests and technical data. Tests and studies provide essential data on chemical weapons systems and chemical biological defense material and aid in determining whether items and/or systems meet the military and technical characteristics required by the users. The Joint Contact Point is responsible for the publication and maintenance of chemical and biological data source books to provide data evaluation and studies in support of the chemical warfare and biological defense program.

RELATED ACTIVITIES: No comparable work is done by the other Services since this program was developed to respond to chemical biological tests and/or study requirements posed by the commanders of the unified and specified commands and the Services. Work was reported previously as a part of Program Element 6.57.0A.A, Deseret Test Center.

WORK PERFORMED BY: Dugway Proving Ground, Dugway, Utah.

PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1977, FY 1976, and Prior Accomplishments: In FY 1976 and FY 1977, four Chemical/Biological (CB) Technical Data Source Books, an evaluation of U.S. Marine Corps vehicles to withstand massive chemical attack, a report for literature survey on thickened chemical agents, an evaluation of all chemical agent delivery assessment techniques and a report on hazards evaluation of chemical agents were published and distributed to appropriate activities. Congressional action for FY 1975 withheld funding for this program.

2. FY 1977 Program: CB Technical Data Source Books will be published and distributed to Service activities. Five operations research studies and five operations research tests/investigations will be in progress and/or completed as requested by commanders of unified and specified commands (CINCS) and the Services.

3. FY 1978 Planned Program: Five operations research studies and two operations research tests will be in progress and/or completed as requested by the CINCS and Services.

Budget Activity #2 - Advanced Technology Development

Program Element #6.57.10.A Title Joint Chemical/Biological Contact Point and Test | Chemical/

Biological Technical Data Source Books will be published and distributed to Service activities.

4. FY 1979 Planned Program: Two operations research studies and five operations research tests will be in progress and/or completed. | Chemical/Biological Technical Data Source Books will be published and distributed to Service activities.

5. Program to Completion: This is a continuing program.