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DESCRIPTIVE SUMMARIES OF THE RESEARCH DEVELOPMENT TEST & EVALUA--ETC(U)
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Army Appropriation FY 1982

Volume I.

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 1982 (U)

JANUARY 1981

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 1982 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 1982. Descriptive Summaries for projects within the program elements to be financed during FY 1982 for $5.0 million or more appear 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 $5.0 million during FY 1982. A Test and Evaluation Section is provided for all major weapon systems. 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 1980, FY 1981, FY 1982, and FY 1983 data in this Program Element Listing with data shown in the Program Element Listing dated January 1980 will reveal significant differences. Many of the differences are attributable to the following factors:

a. Restructuring of the FY 1980 and FY 1981 programs for comparability to the FY 1982 program structure.

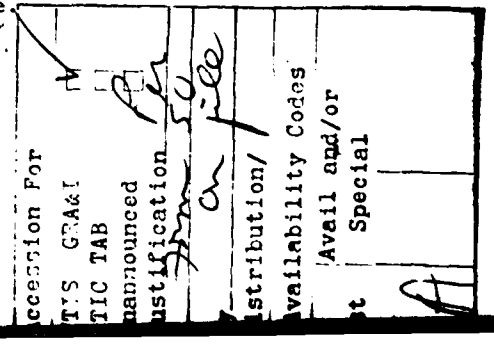
b. Reclassification to provide greater visibility and contribute to the effective management of the RDTE program such as the following:

(1) RDTE Headquarters Management.

(2) Further extension of the Single Program Element Funding Concept.

(3) Restructuring of Exploratory Development personnel RDTE programs.

The funding information used in these volumes corresponds to that contained in the President's Budget except for FY 1980. FY 1980 funds in the President's Budget are not restructured. The attached Descriptive Summaries have the FY 1980 column restructured to reflect more realistic historical information. Procurement data is shown where applicable for items in engineering or operational development. Military construction data is shown where applicable.



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FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.11.01.A
DOD Mission Area: #510 - Defense Research

Title: In-House Laboratory Independent Research (ILIR)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	17151	19669	21968	24368	Continuing	Not Applicable
A91	In-House Laboratory	17151	19669	21968	24368	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: 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, 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 the flexibility to respond quickly to new technical challenges, but also it serves as a wellspring for innovative and imaginative ideas, of which the more promising ones progress into development programs. There were 421 research and development tasks pursued in FY 1980.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: This request is based on the policy that this program is important to the Army laboratories and should be provided modest real growth. Funds are allocated directly to directors of participating laboratories by the Assistant Secretary of the Army (Research, Development, and Acquisition) and are not subject to reallocation by intervening echelons. This allocation is based on a review of the use of funds and of the accomplishments during the preceding fiscal year.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousnds)

RDTE	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
Funds (current requirements)	17151	19669	21968	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	17500	19600	21900	Continuing	Not Applicable

Program Element: #6.11.01.A
DOD Mission Area: #510 - Defense Research

Title: In-House Laboratory Independent Research (ILIR)
Budget Activity: #1 - Technology Base

The increase in funds for FY81 and FY82 will provide moderate real growth for this important program. The FY80 reduction reflects reprograming to other important technology base efforts.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.11.01.A
DOD Mission Area: #510 - Defense Research

Title: In-House Laboratory Independent Research (ILIR)
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This program promotes creativity, innovation, efficiency, improved morale, and recruitment/retention of scientists and engineers by providing funds to maintain or increase individual professional competence through original work relevant to assigned military missions. It also provides a vehicle whereby innovative, high-risk ideas with high potential payoff can be pursued to the benefit of the Army. This program is keyed to increasing innovative creativity and professional competence.

G. (U) RELATED ACTIVITIES: The Navy and Air Force have similar programs. Coordination is accomplished through scientific symposia, literature reviews, exchange of research and technology resumes, Department of Defense topical reviews, and the Defense Technical Information Center.

H. (U) WORK PERFORMED BY: In-house Laboratory Independent Research is performed in thirty-seven Army RDTE activities.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: The following is a sample of accomplishments obtained during FY80 from among the ILIR tasks conducted.

a. (U) The Army Materials and Mechanics Research Center has proven the feasibility of making variable cross-section profiles of component parts using long, continuous, fiber-reinforced composites. The applicability of these composite materials to military systems such as missiles and helicopters is increasing rapidly due to their low cost and high strength-to-weight ratios. The limitations of constructing only constant cross-section parts has been overcome by an adjustable die developed in this program. Another accomplishment with related application was the development of a method for winding long filament composites into complex shapes using a new concept in making the mandrels upon which the composite fibers are wound.

b. (U) The Ballistic Research Laboratory has developed a method of gaining large amounts of information on the rates and mechanism of ignition and combustion processes in gun propellants using the technique of holography. This technique yields a three-dimensional image of the combustion event with very high resolution and depth-of-field. This work is expected to impact current efforts to develop improved propellant materials and packaging configurations for munitions.

c. (U) The Chemical systems Laboratory conducted several work units related to novel techniques in the production and application of new battlefield smokes, effective over a wide range of wavelengths, and to understanding their physical and optical properties. It is expected that as this work is carried into the 6.2 area it will impact upon the operational concepts of fighting under limited visibility conditions.

Program Element: #6.11.01.A
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Title: In-House Laboratory Independent Research (ILIR)
Budget Activity: #1 - Technology Base

d. (U) At the Large Caliber Weapon Systems Laboratory fundamental investigations were carried out on a new concpet in projectile propulsion involving acceleration by electromagnetic fields. Basic theory was investigated which lead to the development of a computer code capable of mapping the pertinent fields and currents, thus enabling work to proceed on design studies.

e. (U) The Fire Control and Small Caliber Weapon Systems Laboratory devised an effective countermeasure to protect the optical components in sighting instruments from damage by frequency-doubled Nd:YAG lasers. Using thin film techniques, high reflectivity metal mirrors having extremely high and narrow band absorption characteristics were fabricated which removed effectively all of the laser radiation in question from the optical train while hardly attentuating the light transmitted from the target.

f. (U) The Aviation Research and Development Command demonstrated the feasibility of modifying an existing air traffic control radar to transmit air traffic control and/or command and control data to an aircraft, which is converted into verbal instructions by a digital voice synthesizer.

g. (U) The Atmospheric Sciences Laboratory has completed the groundwork for particle beam weapon propagation tests to be held in the next several years by identifying atmospheric parameters which are expected to affect beam stability.

h. (U) The Electronics Technology and Devices Laboratory demonstrated a new concept in high frequency tube sources operating in the millimeter/near-millimeter wavelength regions. The new tubes depend on the "multipactor" phenomenon in which the required electron bunching can be obtained by secondary electron resonance instead of using relatively heavy magnets. Kilowatt level peak powers are achievable with weights in the range of only 1-2 kilograms and volumes of only 150-300 cubic centimeters thus making possible mini-RPV radar system applications.

i. (U) The Harry Diamond Laboratories completed the initial steps to address a major Army need for pulsed, high-voltage, high-power electrical sources. The sources are required at the terawatt (quatrillion watt) peak power level for particle beams, high-power radar jammers, radar systems, and nuclear effects simulators. However, such sources must also be portable, rugged, and reliable. A newly initiated devices program seeks to achieve these goals based on a rotary flux compressor machine originally developed at the University of Texas. One device was successfully modeled on the computer, dielectric flashover studies were completed, and the general system design concept defined.

j. (U) The Night Vision and Electro-optics Laboratory continued the design process and began fabricating a prototype of a new concept in miniature cryogenic coolers for infrared detectors. The mean time between failure (MTBF) of most thermal

imaging systems is directly dependent upon the MTRF of the detector's cooler. This new cooler, based on a linear drive magnetic suspension system, virtually eliminates all the problems associated with mechanical coolers and holds the prospect of a 50-percent weight reduction, 60-percent cost reduction, 10-decibel noise reduction, plus a 50-percent improvement in cooling power. These coolers are used in missile seekers, tank thermal sights, and other Army systems.

k. (U) The Mobility Equipment Research and Development Command, using advanced mathematical pattern recognition techniques, developed and validated an "inverse" computer model which can demonstrate weaknesses in our camouflage techniques and help to redirect our programs in this area.

l. (U) The Missile Command investigated the application of infrared holographic optical elements for use in missile seekers. Such applications can provide significant reductions in size, weight, and cost of the seeker subsystem. Photographic processes were developed which improve the efficiency of these holographic components by a factor of seventeen.

m. (U) The Tank-Automotive Research and Development Command applied the recently developed surface and near surface nondestructive evaluation technique of photoacoustic spectroscopy to examine ceramic engine components for microflaws. The ability to screen ceramic components will permit the development of advanced diesel engines which take advantage of the ceramic materials (high temperature, weight, corrosion resistance) and their substitution for selected metal parts.

n. (U) White Sands Missile Range investigated the problem of detecting targets in scenes where there was no grey level difference between a target and its background. A theoretical study of the problem yielded two candidate solutions based on computer-generated color vector fields and artificial textures.

o. (U) The Army has a responsibility for protecting the aquatic environment from damage resulting from the disposal of wastes generated by Army pest control programs. The Army Medical Bioengineering Research and Development Laboratory has devised a simple kit for performing thin layer chromatography in the field and successfully detected seven different containment pesticides. Previous to this, no simple reliable and sufficiently sensitive method was available for field testing of water.

p. (U) Work at the Army Medical Institute of Infectious Diseases was directed towards the rapid separation and identification of immune complexes of infectious diseases of unique military importance. A new technique enabled the separation of the major host protein in only 15 to 30 minutes.

q. (U) The Letterman Army Institute of Research has developed a technique whereby a blood fraction containing a high

concentration of hematopoietic stem cells (HSC) can be rapidly separated and cryopreserved for long periods. The HSC can then be used as an adjunct to chemotherapy or radiotherapy for individuals intentionally or accidently exposed to radioactive or toxic materials capable of inducing bone marrow damage.

r. (U) The Walter Reed Army Institute of Research investigated a new method of treating leishmaniasis, a serious parasitic infection endemic to the tropical and subtroptical areas of the world. The treatment consists of combining antileishmanial drugs with specially prepared liposomes which are then targeted to the specific type of cells that are invaded by the parasite.

s. (U) The Construction Engineering Research Laboratory has developed a polymeric foam capable of suppressing 90% of the infrared radiation from a piece of Army material. This foam may be used as a lightweight camouflage of equipment from view by enemy infrared detectors.

t. (U) The Combat Surveillance and Target Acquisition Laboratory successfully demonstrated an electrically scanned antenna for operation at millimeter wavelengths. Operation in this portion of the spectrum is a major area of emphasis for the support of military operations in limited visibility conditions. Components such as a scanned antenna are not generally available in this wavelength regime. The development of this antenna is a major contribution to the radar community.

u. (U) The Electronic Warfare Laboratory has developed a decoding concept which will enable EW units in the field to intercept and interpret exotic communications and noncommunications signals and then direct jamming signals against them. The decoding can be accomplished rapidly and inexpensively without the need for large computers and run times; thus automatic jamming of weapons will be possible once this new concept has been reduced to a hardware configuration.

2. (U) FY 1981 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 subsequent fiscal year. Directors of individual laboratories or activities then assign funds to both new and continuing promising work efforts. The freedom from a rigidly structed program and the resulting autonomy at activity level permits the Directors to effectively utilize thier in-house laboratory independent research funds.

3. (U) FY 1982 Planned Program: This highly successful program will continue with the current high technology 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 for FY 1982 will provide a modest increase for this innovative program.

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DOD Mission Area: #510 - Defense Research

Title: In-House Laboratory Independent Research (ILIR)
Budget Activity: #1 - Technology Base

4. (U) FY 1983 Planned Program: The program will be continued with the same management policies and objectives.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.11.02.A
DOD Mission Area: #510 - Defense Research

Title: Defense Research Sciences
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	113550	124016	172311	187635	Continuing	Not Applicable
AF22	Research in Vehicular Mobility	600	670	925	1200	Continuing	Not Applicable
AH42	Research in Materials and Mechanics	2217	2165	2816	3500	Continuing	Not Applicable
AH43	*Research in Ballistics	6757	6663	7170	9300	Continuing	Not Applicable
AH44	Research in Fluidics, Nuclear Effects, and ISTA Electronics	2747	2403	2456	2935	Continuing	Not Applicable
AH45	*Air Mobility Research	5595	5849	7039	8100	Continuing	Not Applicable
AH46	Research in Combat Surveillance and Target Acquisition	250	194	70	350	Continuing	Not Applicable
AH47	Electronic Devices Research	2950	2359	2388	3500	Continuing	Not Applicable
AH48	Electromagnetic Propagation and Antenna Research	1300	1258	1679	2000	Continuing	Not Applicable
AH49	Missile and High Energy Laser Research	2150	2739	3499	4800	Continuing	Not Applicable
AH51	Combat Support Research	1000	920	1676	2200	Continuing	Not Applicable
AH52	Research in Support of Equipment for Individual Soldier	1872	2305	2666	3200	Continuing	Not Applicable

Program Element: #6.11.02.A
DOD Mission Area: #510 - Defense Research

Title: Defense Research Sciences
Budget Activity: #1 - Technology Base

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
BH57	*Research in Scientific Problems with Military Applications	38092	46508	62295	74000	Continuing	Not Applicable
AH60	*Research in Large Caliber Armaments	5365	5319	6274	7200	Continuing	Not Applicable
AH61	Research in Fire Control and Small Caliber Armament	982	1177	1422	1800	Continuing	Not Applicable
AH63	Research in Electronic Warfare	200	279	395	500	Continuing	Not Applicable
AH68	Processes in Pollution Abatement Technology	218	188	363	410	Continuing	Not Applicable
BS04	Identification and Health Effects of Military Pollutants	450	445	481	640	Continuing	Not Applicable
BS10	*Research on Military Diseases, Injury and Health Hazards	21102	22273	39922	32600	Continuing	Not Applicable
AT22	Research in Soil and Rock Mechanics	569	560	794	1030	Continuing	Not Applicable
AT23	Basic Research in Military Construction	558	590	691	755	Continuing	Not Applicable
AT24	Research in Snow, Ice, and Frozen Ground	1528	1580	1963	2400	Continuing	Not Applicable
A31B	*Night Vision and Electro-optics Research	6894	6767	7938	9500	Continuing	Not Applicable

Program Element: #6.11.02.A
DOD Mission Area: #510 - Defense Research

Title: Defense Research Sciences
Budget Activity: #1 - Technology Base

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
B52C	Research in Geodetic, Geographic, and Mapping Sciences	1383	1460	1716	1815	Continuing	Not Applicable
B53A	Research in Atmospheric Sciences	3694	3822	4154	5300	Continuing	Not Applicable
A71A	*Research in Defensive Systems for CW/BW	1500	1948	7422	3100	Continuing	Not Applicable
B74A	Research in Human Engineering	1467	1555	1742	2500	Continuing	Not Applicable
B74F	Basic Research in Behavioral and Social Sciences	2110	2020	2355	3000	Continuing	Not Applicable

* These projects are covered by separate Congressional Descriptive Summaries.

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Research performed under this program in the physical, biological-medical, engineering, environmental, and behavioral-social sciences initiates new developments leading to improved Army capabilities and provides solutions to identified Army problems. Each project is associated with a particular Army mission. Flexibility exists to take advantage of scientific and technological opportunities. This research program responds to high-priority capability requirements as stated in the Army Science and Technology Objectives Guide.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: New and continuing research will provide the Army with improved and advanced weapons and with improved care and support of the individual soldier, and will be responsive to new objectives defined by the Army user. An increase of $22.0 million for FY82 is requested to support new concepts in chemical/biological warfare defense development. Additional needs have been identified by top-level physical, biological, and medical scientists in DOD to expand and accelerate FY82 critical tasks essential to the development of an adequate defense against the biological and chemical warfare threat. The Army's Chemical Warfare and Chemical Biological Warfare Defense Technology Base Enhancement Program calls for exploiting new concepts in chemical warfare agent detection and warning, individual and collective protection, decontamination, casualty prevention, and medical treatment. Recognizing that an inadequate technology base exists upon which the Army must build an improved materiel capability, the Chemical Systems Laboratory (A71A), the Army Medical R&D

Program Element: #6.11.02.A
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Command (BS10), and the Army Research Office (BH57) will support research in-house, at universities and industry for work in new concepts already identified which will support and enhance our CW/BW defense posture. The critical, urgent need to strengthen our CW/BW defense has been pointed out by a number of important threat studies. A reduction of $4.294 million in the overall program element for FY82 is in response to OSD direction for improved efficiency.

D. COMPARISON WITH FY 1981 RDTE REQUEST ($ in thousands):

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	113550	124016	172311	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	113652	137311	164452	Continuing	Not Applicable

The FY80 reduction reflects minor reprograming in the research program. The lower value, $124,016, for FY81 reflects a Congressional reduction of $12,311, a $43 reduction for Senior Executive Service (SES) bonuses, a $49 reduction in accordance with a Congressional request for curtailment of studies and analyses and an $892 reduction for improved efficiency. The increase in FY82 funds requested above as shown in the FY 1981 submission is to support new work in chemical/biological warfare defense.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.11.02.A
DOD Mission Area: #510 - Defense Research

Title: Defense Research Sciences
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This program element is the total Army's investment in basic science and engineering. Experience has shown that virtually all major advances in military capability can be traced to the exploitation of scientific knowledge; for example, nuclear weapons, radar, and synthetic rubbers. The objective of this program is to explore new scientific opportunities primarily through the Army's in-house research community and under contract with leading researchers in academia and industry. About 35% of the Defense Research Sciences program is managed by the Army Research Office, whose program is organized by scientific discipline; for example, physics, chemistry, mathematics, materials, and engineering sciences. This portion of the program is totally dedicated to contract support of leading national scientists. In addition to addressing specific Army needs for scientific information, this program element provides a mechanism for stimulating interest of the at-large scientific community in Army problems. There is an intimate relationship fostered between in-house and contractor laboratories to focus effort in areas of greatest payoff. In addition to the organization of the program element by generic laboratory missions and scientific disciplines, a significant effort is directed to "Areas of Emphasis." These are topics which have a high potential payoff in new combat capabilities and receive high-level attention at the Army Headquarters level. At the present time there are seven of these topics; namely, millimeter waves; gun propulsion; fire control; mobility and installation energy; command, control, communications and intelligence system engineering; microelectronics; and chemical warfare and chemical/biological warfare defense. These Areas of Emphasis typically involve the participation of several in-house laboratories and the Army Research Office contract program, and are coordinated through the Office of the Director of Army Research. This program consists of a very large number of scientific tasks. Many of the objectives deal with persistent problems as, for example, that of increasing the ability to penetrate armor. Changes in the program are much more apparent in the approaches to the objective rather than in the objective itself. For example, research on electromagnetic acceleration of hypervelocity particles is an alternate approach to armor penetration, the practical application of which hinges on the resolution of several specific scientific issues. Increases in funding in the 6.1 program have been applied in two directions; the first, to offset past serious erosion in the capability of this program to accelerate areas of scientific strength such as missiles and electronics, and the second, to develop technical objectives of opportunity such as the Areas of Emphasis described above.

G. (U) 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 the Interior; Department of Energy; National Bureau of Standards; Department of Health and Human Services; other Government agencies; Government agencies of allied nations; and the industrial and academic community all sponsor related research in some areas of this program. Coordination to eliminate duplication is accomplished by tri-Service

Program Element: #6.11.02.A
Title: Defense Research Sciences
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topical reviews; exchange of progress reports 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; review of the scientific literature; and publications of current research. The Army's Defense Research Sciences Program is included in the Tri-Service Technology Coordinating Papers. Additional details on related activities are provided in individual project descriptive summaries.

H. (U) WORK PERFORMED BY: The research supported under this program is performed by in-house laboratories and activities and by academic institutions, not-for-profit organizations, and industrial laboratories through contracts. Specific contractors are listed in the project and scientific areas descriptive summaries. The laboratories/activities responsible for research under this program are the following, listed by major Army developing agencies.

US Army Materiel Development and 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 Technology Laboratories Moffett Field, California
Combat Surveillance and Target Acquisition Laboratory, Fort Monmouth, New Jersey
Electronics Technology and Devices Laboratory, Fort Monmouth, New Jersey
Communications Research and Development Command, Fort Monmouth, New Jersey
Electronic Warfare Laboratory, Fort Monmouth, New Jersey
Missile Command, Redstone Arsenal, Alabama

US 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

US Army Medical Research and Development Command:

Walter Reed Army Institute of Research, Washingon, DC
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, DC
Aeromedical Research Laboratory, Fort Rucker, Alabama

Program Element: #6.11.02.A
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Title: Defense Research Sciences
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US Army Materiel Development and Readiness Command:
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
Fire Control and Small Caliber Weapon Systems Laboratory, Dover, New Jersey
Army Research Office, Research Triangle Park, North Carolinia
Night Vision and Electro-Optics Laboratories, Fort Belvoir, Virginia
Atmospheric Sciences Laboratory, White Sands Missile Range, New Mexico
Chemical Systems Laboratory, Aberdeen Proving Ground, Maryland
Human Engineering Laboratory, Aberdeen Proving Ground, Maryland

Office of the Deputy Chief of Staff for Personnel:
Research Institute of Environmental Medicine, Natick, Massachusetts
Biomedical Laboratory, Aberdeen Proving Ground, Maryland
US Army Research Institute for the Behavioral and Social Sciences, Arlington, Virginia

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Several recent accomplishments have the potential of significantly increasing future Army capabilities. These include the ability to detect targets and guide weapons as a result of the development of new, higher frequency microwave and millimeter wave components. Progress that has been made in the integration of detection and image processing on the same electronic chip is the start of "smart" night vision devices for improving operations in limited visibility conditions, target-cueing capability, and counter-countermeasures. In the area of armaments, research has shown that certain chemical compounds may contain as much as 50% greater explosive energy than the standard explosives. A new form of ductile chrome has been developed which has a fivefold increase in gun barrel erosion life tests. In medical research, a model has been developed to predict the ability to survive after using certain antidotes to nerve agents. The feasibility of antitoxin protection from intestinal generalized shock has been demonstrated. These are

representative accomplishments in the areas of electronics, armaments, and medical science. Additional accomplishments by major Army Commands are as follows:

a. (U) Electronics Research and Development Command (AH44, AH46, AH47, A31B, B53A, AH63): An intensive effort to develop new near-millimeter wave sources has led to the successful operation of a 70 Gigahertz (GHz) orotron, believed to be the first tunable, near-millimeter wave source of its type built in the United States. In addition, the design of an adaptation of the Soviet gyrotron has been completed. When fabricated, it is expected to produce 1 kilowatt of 240 GHz radiation which will also be a first for the United States in ultra-high frequency microwave radar. The sensitivity of a fluidic angular rate sensor was substantially increased, to approximately one-tenth of the earth's rotation rate, thus making the device suitable for incorporation in the proposed fluidic navigation system for land vehicles. Pattern recognition techniques were applied to radar target signatures of tactical vehicles and resulted in a high probability of covert target classification in two-target encounters; e.g., tank vs. truck. Electron beam microfabrication techniques were developed for the production of covert data link devices. Enhanced resolution and writing speed was accomplished by the use of X-ray photoresists (masks). This will make possible the fabrication of microelectronic circuits with vastly improved computational speed and capacity. A unique spectrophone was developed which for the first time makes possible realtime field measurements of absorption of radiation by clouds, fogs, dust, and battlefield obscurants. Accomplishments in the area of night vision technology and electro-optics are reported in a separate descriptive summary (A31B).

b. (U) Tank-Automotive Research and Development Command (AF22): A methodology was developed which automatically formulates and integrates the equations of motion and constraint to represent the chassis, roadwheel and track motion, and to account for nonlinear suspension, terrain-vehicle interaction, and vehicle tractive action of armored vehicles. These results will have a significant impact on the design of combat vehicles including automatic fire control and gun/turret drive servo control systems. A method was developed to allow the determination and analysis of infrared signatures of both static and moving vehicles.

c. (U) Aviation Research and Development Command (AH45): The understanding of acoustic noise from a helicopter rotor was found to be dependent on nonlinear transonic aerodynamic behavior of the rotor. In particular, the extensive disturbance field of the transonic rotor was included in the classical linear formulations with the result that the theory and experiment are now in much better agreement--to the point where some preliminary rotor designs for minimum noise may be attempted. Other accomplishments of this program are discussed more fully in a separate descriptive summary (AH45).

d. (U) Army Research Office (BH57): This program has continued to advance science and engineering related to the

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solution of problems encountered in military applications. The program, which represents a major segment of the Army's research activities, is comprised of a vigorous and diverse collection of projects performed mainly in academic and not-for-profit institutions and covering the areas of atmospheric and terrestrial sciences, biological sciences, electronics, materials, mathematics, mechanics and aeronautics, physics, and chemistry. The work is totally coordinated with the in-house laboratories to assure responsiveness to specific Army problems. As such, this program functions as an information exchange point among the Army laboratories, thus promoting communication and preventing duplicative efforts. The many achievements and accomplishments of the past year are discussed in a separate descriptive summary (BH57).

e. (U) Army Research Institute (B74F): Research efforts were completed and transitioned to exploratory development in areas dealing with understanding the man-machine interface, computer augmentation of the performance of operational tasks by an individual, and improved training methods. The impact on the individual of large-scale, visually displayed information such as in a tactical operations center was studied, as well as a technique for improving the user's capability to manipulate displayed data such as maps in real time. Research was initiated on the problem of predicting personnel requirements early in the development of a weapon system.

f. (U) Toxic and Hazardous Materials Agency (AH68): The basic reaction mechanisms in munition plant wastewater for carbon adsorption of the explosive RDX and HMX have been determined so that treatment economics can be improved. New, more reliable and cost-effective methods have been developed to estimate the environmental effects of chemicals used in military applictions. A new mass-spectroscopic technique has been developed to provide faster detection of trace quantity pollutants.

g. (U) Armament Research and Development Command (AH43, AH60, AH61, A71A): A shaped charge jet break-up model has been developed and compared successfully with experimental data for several liner materials. This model will be transitioned to exploratory development programs to develop antiarmor warheads with increased lethality. A new ductile chrome has been developed as an erosion-resistant plating for gun barrels. Preliminary tests show a fivefold increase in tube life. Other accomplishments in the ballistic research (AH43) and large caliber armament (AH60) areas are discussed in separate descriptive summaries. A mathematical technique has been devised and implemented that will enable fire control systems to recognize and completely describe targets at any given aspect angle. The effects of varying the composition of tungsten-based alloys used in penetrator materials were established. Calculations of the light-scattering capabilities of hollow particles, foamed particles, flakes, and fibers indicate that all these types are more effective at screening smokes than the more conventional homogeneous spherical particles.

h. (U) Mobility Equipment Research and Development Command (AH51): A new concept for the accurate calculation of

electromagnetic scattering from buried objects has been developed which will provide the first reliable foundation for a theory of detection of buried plastic mines. Several new types of fuel cell catalysts have been developed and studies of catalytic action and poisoning have been carried out to improve the theoretical understanding of fuel cell performance.

i. (U) Human Engineering Laboratory (B74A): A theory of hearing loss due to the high-intensity noise from artillery weapons has been developed which radically revises previous views. This will be the basis for a better ranking procedure for hearing protection, and suggests design changes for weapons. A variety of experiments dealing with visual response, pattern recognition, eye movements, and eye-hand coordination in order to better understand the sensory response and performance of the individual soldier in various combat situations has been completed.

j. (U) Communications Research and Development Command (AH48): A new theory was developed to permit multielement antennas to be efficiently evaluated by computer. Also, theories were developed for designing tapered dielectric disc antennas and periodic dielectric rod antennas which are predicted to be useful in omnidirectional millimeter wave transmitters and receivers. A theory of millimeter wave propagation through a forest environment was developed using transport theory. A program to quantify the mechanisms responsible for radiation-induced losses in optical fibers indicated methods of reducing such losses by addition of new dopants and by radiation bleaching of the fibers.

k. (U) Missile Command (AH49): A technique was found for making an optical correlation guidance computer using a small laser diode. This is an important step in the development of a class of small, very inexpensive missile seeker systems which will autonomously acquire and track a target. Work in laser photochemistry has resulted in a very selective and controlled photoprocess which can be applied to materials synthesis. An example of this was the demonstration of the laser photo synthesis of decaborane, a critical propellant ingredient.

l. (U) Natick Research and Development Command (AH52): Progress was achieved in several aspects of the problem of providing for the soldier, food which is pure, more nutritious, tastier, and easier to prepare and store. It was discovered that the addition of four-percent corn oil to diets containing glycerol is beneficial in preventing fatty liver problems. A new radiometric technique was developed to allow the rapid screening of foods for bacterial content. A taste model was developed to better understand the criteria of food acceptance by the individual.

m. (U) Materials and Mechanics Research Center (AH42): Improved aircraft canopy material was developed which provides greater protection from high-energy laser radiation. The role of water vapor on the strength of glass fiber/epoxy resin laminates was discovered. A test procedure has been devised to analyze the attenuation of blast pressures by foams. A

criterion for the prediction of crack initiation in a material has been applied to the analysis of a breeching. The presence of volatile molybdinum was detected from the reaction of water vapor and gun steels, which could serve as an indicator of gun barrel erosion.

n. (U) Office of the Surgeon General (BS04, BS10): Accomplishments in this area spans a broad spectrum of medical research dealing with gaining a better understanding of the hazards and treatment of the individual soldier for diseases and injuries. Examples of the variety of work accomplished include the use of liposomes (artificial lipid membranes) to enhance the immune response to diseases such as cholera, the discovery that naloxone will block the depressant effects of hormones released during shock due to injury and thus aid in its treatment, and the demonstration of rapid changes in the saliva of animals exposed to the chemical warfare agent, Sarin, which would indicate a basis for a quick and reliable field test for exposed soldiers. A more complete description of accomplishments in this area may be found in the separate descriptive summaries for project BS10.

o. (U) Corps of Engineers (AT22, AT23, AT24, B52C): A computer simulation has been developed and validated which will accurately predict the power requirements and stability limits for a tracked vehicle executing any maneuver on a properly described soil. A model has been developed which allows an assessment of the rate at which ice will accrete on structures such as helicopter rotors and aircraft wing edges. A method of digitizing aerial photographs and then extracting data by the use of mathematical transform filters has been devised which will enable the identification of terrain-mapping features in a fraction of the time and cost as is presently required.

2. (U) FY 1981 Program: A new Area of Emphasis, Chemical Warfare and Chemical/Biological Warfare Defense, is being initiated in FY 1981. It includes research related to detectors and monitors, enclosure protection, protective clothing, antidotes and propylaxis, new munitions, and incapacitants. The FY 1981 program includes continuing effort in the Area of Emphasis of Millimeter Waves; Gun Propulsion; Fire Control; Mobility and Installation Energy; Command, Control, Communications and Intelligence System Engineering; and Microelectronics. Programs that are currently in progress within major Army commands are as follows:

a. (U) Electronics Research and Development Command: The 70 GHz orotron source is being optimized, and work on a 140 GHz device has been initiated. The 240 GHz gyrotron is nearing completion and its operating characteristics determined. Work is underway on techniques for transduction between optical and fluidic signals. This work will eventually lead to completely nonelectrical control systems which are inherently radiation hard and jamproof. A project to generate gigawatt (peak) levels of x-band radiation using a relativistic reflex klystron has begun. Such a device has potential application in elec-

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tronic warfare, radar, and communications systems. Antenna research is in progress which includes investigations of broadband adaptive array processors for obtaining deeper and wider wells in the antenna pattern. Electron beam microfabrication research is being extended to reach the submicron domain to meet the increasingly demanding requirements for realtime tactical signal processing. A major program to investigate the various aspects of ultrasmall electronic devices is being initiated and includes work on material processes and fundamental limitations. Work continues on the design and validation of interim models of the atmosphere, obscurants, and aerosols, and their effects on radiation. This work is closely coordinated with the many existing and potential users of electro-optic systems, who are interested in a full understanding of atmospheric parameters on performance of target acquisition and weapon guidance systems. The program in night vision and electro-optic technology is reported in a separate descriptive Summary (A31B).

b. (U) Tank Automotive Research and Development Command: Research is conducted on the mechanical properties and chemical structures of new elastomers to increase track pad life. The performance of engine/transmission systems under full power acceleration (burst power) are under investigation. Methods of incorporating millimeter wavelength signatures into the vehicle thermal signature model are being developed.

c. (U) Aviation Research and Development Command: An investigation to understand means to suppress acoustic signatures from rotorcraft has been undertaken. Several work units to investigate advanced turbine designs are also being conducted. A more complete discussion of this program may be found in a separate descriptive summary (AH45).

d. (U) Army Research Office: A description of this major contractual program with academic, industrial, and not-for-profit institutions is discussed in a separate descriptive summary (BH57).

e. (U) Army Research Institute: Research continues on methods for determining manpower and training requirements for complex weapons systems early in the design stage. The use of computer-aided instruction in training for operation of such systems is being studied. Emphasis is placed on the development of schedules for retraining and for the application of computer-aided instruction, simulation devices, and other job aids. A learning model is being developed for application to various conditions of drill and practice to better understand problem-solving strategies. Research is being completed on the effect on learning of verbal instruction, rewards, computer-assisted instruction, and feedback in organizational settings. The factors influencing performance in hazardous duty situations are being investigated.

f. (U) Toxic and Hazardous Materials Agency: The investigation of activated charcoal reacting with heterocyclic nitramines is being completed, yielding an evaluation of the optimum technology for the treatment of munition plant waste-

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water. Estimation methods of physico-chemical properties of compounds of environmental concern are being integrated into an interactive computerized network. A study is underway to determine the reactions and products occuring during the thermal degradation of munition production wastes, hazardous chemicals, and other surplus materials for the purpose of recovering useable byproducts and producing environmentally acceptable solid waste discharge.

g. (U) Armament Research and Development Command: Work on the design factors of lowered sensitivity, high-performance explosives is continuing. A performance model of magnetic and induction sensors for top-attack munitions is being developed. A six-degree of freedom approach to the modeling of projectile behavior and its relationship to weapon dynamic response is being explored. A study has been initiated to characterize tungsten filament-reinforced depleted uranium as a potential new penetrator material. A complete presentation of the current program in ballistic research and large caliber armament research may be found in separate descriptive summaries (AH43, AH60). Efforts have been initiated to develop a new small arms propellant having an improved gas generation schedule, reduced cost, and improved long-term stability. Better definition of the barrel-projectile response characteristics is being sought to enable the design of improved rotating bands and barrels with longer life. The theory of electromagnetic scattering from conducting fibers is being developed to better understand the use of such materials as battlefield obscurants. A major new Army thrust in the area of chemical warfare and chemical/biological defense (EW/CBD) is being initiated to bring the Army abreast of potential adversaries in this area. Ongoing work includes refining of indirect virus detection methods, examination of reaction rates of decontamination, and the investigation of new chemical agents based on analogs of the hydrogen phospites.

h. (U) Mobility Equipment Research and Development Command: Certain molecules previously shown to selectively absorb 1.06 micron laser radiation have been mixed with standard camouflage paints to test the practicality of using them to reduce the infrared signatures of camouflaged items. Self-extinguishing mechanisms for fire-resistant diesel fuel are being studied. Experiments are being performed to determine the usefulness of graphite intercalated compounds as lightweight low loss electrical conductors.

i. (U) Human Engineering Laboratory: An investigation is underway to examine the manner in which the individual makes choices and decisions based on the visual information received. Such work has a direct bearing on the manner in which soldiers are trained to operate complex weapons systems. Several tasks are being undertaken relating to defining and then raising the literacy level in the Army.

j. (U) Communications Research and Development Command: An integrated network management algorithm is being developed to function as a routing, congestion, and flow control in an internet (network of nets) environment. The system

will include various nets, architectures, and interconnection schemes. A study of platform effects on antenna directivity is continuing. The coupling between thin-wire antennas and out-of-band frequency is under investigation. A theory for the effects of foliage on UHF-level radiation is being improved and tested.

k. (U) Missile Command: A laser diode optical correlator is being constructed in breadboard form and tested. Work on holographic filters continues with a comparison of optical and digital correlation techniques for smart sensors which have a high degree of discrimination capability (such as differentiating a T-62 tank from an M-60 tank at arbitrary aspect angles). The search for new high-energy laser concepts continues, with work on induced and low dipole moment lasers.

l. (U) Natick Research and Development Command: Studies are being conducted to determine the manner in which certain carbohydrates interact to augment the deteriorating effects of glycerol. Work is underway to determine the extent to which food preparation affects the nutrient value. Work is proceeding on analytical systems capable of describing food wholesomeness and sensory quality, and relating them to the various food components. Fundamental photo/thermal mechanisms are being studied to determine methods of enhancing the radiation protection qualities of fabrics.

m. (U) Materials and Mechanics Research Center: Work is underway to obtain a better understanding of the physical characteristics of a variety of materials of military interest including polymers, ceramics, metals, epoxies, and alloys. The effects of various processes on polymer characteristics are being investigated to provide a guide for future applications. Polyethylene is investigated as a potential structural material. The effects of outdoor exposure on composite materials is being modeled and the model validated with measurements. Force-time and vibration frequency data for the analysis of tank track fatigue is being generated.

n. (U) Office of the Surgeon General: The current program of medical research includes work in areas relating to the protection of the individual soldier from disease and injury. Among these programs emphasis is placed on the medical defense against biological warfare agents, the prevention of infection in wound victims, a method for the optimum selection of anesthetic for a particular patient, and methods of mediating or ameliorating shock. A more complete description of the current program may be found in the separate descriptive summaries for project BS10.

o. (U) Corps of Engineers: A more economical method for defining deep foundation conditions for hardened military facilities is being developed. The model for determining the steering performance of tracked vehicles is being finalized. A program to develop a mathematical description for digital control of heating, ventilating, and air conditioning systems is being completed. A simulation of climate ice conditions applicable to northern NATO countries is being developed. Field

research exercise SNOW I will be conducted in Northern Vermont this year to determine the effect of snow on the atmospheric propagation of electromagnetic radiation such as that upon which various surveillance, tracking, and guidance systems depend. The collection of precise gravity data required for missile navigation will continue using inertial and gradiometric techniques.

3. (U) FY 1982 Planned Program: Approximately 80% of the program will be related to armaments, electronics, and medical research. Emphasis will be placed on the following areas of high-priority Army technological needs: millimeter waves; gun propulsion; fire control; mobility and installation energy; command, control, communication, and intelligence systems; microelectronics; and chemical warfare and chemical/biological warfare defense. The programs planned by the major Army commands are as follows:

a. (U) Electronics Research and Development Command: Both the orotron and gyrotron near-millimeter wave tube sources will be optimized. New concepts in solid state sources at these wavelengths will also be investigated. As the high-power X-band reflex klystron program concludes its research phase, a free electron laser will be designed and constructed to produce high-power tuneable radiation in the K-band region. A new phase of the highly sucessful acousto-optic signal-processing program will begin with an attempt to integrate all the optical components on a single device. An all digital adaptive array processor will be developed to control null patterns of a multibeam digital phased array antenna. Optimum X-ray resist materials and requirements for submicron devices will be formulated and transferred to industry. The effects of snow, fire products, and foreign and special smokes will be incorporated into a general battlefield obscuration model. Plans for advancing the night vision and electro-optics technologies will be reported in a separate descriptive summary (A318).

b. (U) Tank-Automotive Research and Development Command: The study of new track pad materials will be completed with the development of criteria for specifying material composition and mechanical design guidelines. The "burst power" program will continue with field tests to validate the model. An atmospheric transmission and background modeling effort will be interfaced with the vehicle thermal signatures work to provide information on how to design vehicles with low thermal signatures and low contrast with typical battlefield environments.

c. (U) Aviation Research and Development Command: Continued improvement in speed and hover capability will be sought through further research in materials and design of rotors. A comprehensive and reliable fatigue analysis will be developed for composite material helicopter structures. Additional plans for this program may be found in a separate descriptive summary (AH45).

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d. (U) Army Research Office: The planned efforts in this contractual program including an expanded program in CW/BW defense research are described in a separate descriptive summary (BH57).

e. (U) Army Research Institute: The institutional and occupational models of the all-volunteer Army and draftees versus volunteers will be completed. Work in progress on the most effective procedures for the display of information compatible with the way the user processes that information will be completed. Other tasks include the development of a handbook on the design of interface between users and computer-graphic systems, the development of a methodology of fault diagnosis, and an assessment of a program for improving general officer-level decisionmaking skills.

f. (U) Toxic and Hazardous Materials Agency: Investigations on the application of processes such as supercritical fluid reactions and ultrasound catalyzed oxidations to munition production wastes and surplus harzardous chemicals will be conducted.

g. (U) Armament Research and Development Command: A variety of ballistic research is planned including work on super burning rate propellants, advanced sabots, kinetic energy penetrators for hypervelocity guns, shaped charge jets, and radar-absorbing coatings. A more complete description of the planned program may be found in a separate descriptive summary (AH43). The effects of gun launch on the behavior of military explosives will be studied. Various studies to better understand the degradative processes of wear, erosion, fracture, and embrittlement of gun tubes will be undertaken. Additional information on the research in large caliber armaments may be found in a separate descriptive summary (AH60). Fire control research will center on new fast algorithms and filter concepts for recognizing and tracking targets. Linear filter theory will be applied to develop methods for resolving target features which are beyond the diffraction limit. The finite element method will be applied in an attempt to solve the crack propagation problem in small caliber armaments. This effort will yield the appropriate criteria for the onset of stress cracking and other wear and failure modes of gun barrels and other components. This effort will also provide the guidance to construct replacement schedules for the various gun components. Work in the major thrust area of chemical warfare and chemical/biological defense (CW/CBD) will be greatly expanded. A description of this work is given in a sparate descriptive summary (A71A).

h. (U) Mobility Equipment Research and Development Command: Work will continue on camouflage paints including a determination of the feasibility of developing binders for paints that can counter the 8-12 micron electromagnetic radiation threat. An investigation of the deterioration mechanisms of fuels will be initiated. The electromagnetic scattering models of imbedded mines will be completed.

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i. (U) Human Engineering Laboratory: Studies will be conducted on the effects of high-intensity light on the processing of auditory information as a way of determining the limitations of sensory overload. Such studies will lead to improved understanding of how complex systems can be operated under conditions of stress such as in combat.

j. (U) Communication Research and Development Command: Work will begin on developing a test facility for prototyping arbitrary distributed systems. A program to develop techniques to reduce color graphic images for digital transmission will be undertaken. Studies will be initiated to ensure the maximum degree of survivability of tactical communications, command, and control systems by designing the optimum isolation and integration of system components. The basic problems of low profile antennas will be examined.

k. (U) Missile Command: The tests of the breadboard optical correlator for seekers will continue in the MICOM Simulator Center. The technique of tomography using near millimeter will be explored as a means of distinguishing targets that are obscured by smoke. Fundamental concepts of future advanced performance missile systems will be investigated, including deformable wings and thrust vector control.

l. (U) Natick Research and Development Command: The relationship of nutrient stability to food-processing techniques will be investigated. The effects of food additives on the growth of spores which cause food poisoning will be studied. Also the effects of water activity, pH, temperature, and packaging on the ability of broad categories of food to be free of microbial health hazards and spoilage will be investigated. Understanding of a individual's acceptance or rejection of prepared foods continues to be a problem which will be attacked by trying to identify critical sensory determinants. Chemical stabilizations of enzymes that cause the deterioration of textiles will be attempted.

m. (U) Mechanics and Materials Research Center: The effects of organic media and their exposure to the outdoor environment on polymers and composites will be investigated. Special materials will be studied to determine their applicability for use as radar camouflage. Work will be continued on various aspects of the gun barrel erosion problem, approaches to reduce the effects of blast and ground surface effects on track materials, and the effects of oblique impact conditions which produce large bending effects on long-rod penetrators.

n. (U) Office of the Surgeon General: The planned program in medical research includes continuing work on the growth and study of biological agents and the development of antitoxins to counter them, the development of improved treatment methods for burn victims, a better understanding of injuries due to excess heat and cold and their treatment, the health hazards of higher frequency electromagnetic radiation, and other areas. A more complete description of the planned

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program including an expanded program in chemical/biological warfare defense is contained in the separate descriptive summaries covering project BS10.

o. (U) Corps of Engineers: The blast suppression characteristics of aerosol foams will be studied in a series of explosive tests. A mechanism to predict the cost of industrialized building systems will be completed. The results of the SNOW I exercise will be analyzed and future research directions will be generated based on this analysis. An improved missile launch area gravity model will be developed. The cartographic data base will be completely integrated with pattern recognition systems to provide automated image feature extraction.

This program element supports 2050 in-house personnel (1150 professional and 900 support personnel).

4. (U) FY 1983 Planned Program: The program is planned to develop fundamental information which addresses generic Army technological needs in the mission areas of close combat; fire support; air defense; combat support, engineering and mine warfare; nuclear (defense), bacteriological and chemical warfare; combat service support; communications, command, and control; tactical surveillance, reconnaisance and target acquisition; and aviation. A significant fraction of the effort will be dedicated to the areas of emphasis initiated in FY81 and as modified by planned developments in FY81 and FY82. The internal laboratory effort will be complemented by a vigorous extramural program in the scientific disciplines (mathematics, electronics, mechanics, aeronautics, materials, physics, chemistry, biology and the geo-sciences) involving some of the nation's best scientific talent, to develop their interest in Army technological needs and to minimize the effects of technological surprise.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #AH43 Title: Research in Ballistics
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: The objective of this research program is to advance the scientific areas of propulsion dynamics, launch and flight dynamics, warhead dynamics and mechanics, blast and kinetic energy projectile mechanisms and effects, ballistic protection, mathematical analyses, systems statistics, decision theory, and vulnerability. Major areas of emphasis in this program are devoted to the understanding of the processes involved in the operation of a weapon system such as the mechanics involved in gun barrel wear and erosion; the chemical kinetics under conditions of high temperatures and pressures in explosives and propellants; fluid dynamics and heat transfer involved in combustion, detonation, and incendiary processes; aerodynamics of projectiles, rockets, and missiles; and continuum mechanics controlling the interaction between explosives and metal. This research is a continuing integrated effort to provide the fundamental scientific and engineering base necessary to advance the myriad technologies involved in weapon systems and their components. This effort is relevant to the entire spectrum of weapon systems ranging from small arms to large projectiles, missiles, and warheads.

B. (U) RELATED ACTIVITIES: The Research in Ballistics program is related to Research in Large Caliber Armament (AH60), Research in Fire Control and Small Caliber Armament (AH61), and Research in Defense Systems for Chemical Biological Warfare (A71A), all in program element 6.11.02.A within the US Army Armament Research and Development Command. This program is closely coordinated with portions of the Army Research Office Program, Research in Scientific Problems with Military Applications (BH57), also in program element 6.11.02.A, and complements project AH80, Ballistics Technology in program element 6.26.18.A. This work is related to similar efforts conducted by the Air Force and Navy. Visits by other service personnel, participation in interservice technical groups, and interagency transfers of knowledge preclude unnecessary duplication of effort. Multichannel coordination is achieved through joint participation in The Technical Cooperation Program, North Atlantic Treaty Organization Advisory Group, and Data Exchange Agreements.

C. (U) WORK PERFORMED BY: Approximately 90% of the work will be performed in-house at the US Army Research and Development Command facilities at the Ballistic Research Laboratory, Aberdeen Proving Ground, Maryland. Participating Army facilities include components of Defense Acquisition and Readiness Command. Other Government Agencies' support will be provided by the Department of Energy, NWC (China Lake), and NASA. Principal contract support will be provided by Calspan Corporation, $100 thousand; H. P. White, $60 thousand; Dyne-East, $60 thousand; and the University of Delaware, $30 thousand. Requests for advisory assistance for three-dimensional computer codes will involve unknown contractors. Total estimated costs for all supporting efforts including government agencies and contractors are unknown but should not exceed $795 thousand.

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D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS

1. (U) FY 1980 and Prior Accomplishments: Developed and implemented two-dimensional two-phase Interior Ballistics Code that permits prediction of pressure, temperature, velocity profile in-bore, and projectile muzzle velocity. Completed theory of loads traveling at a constant speed in a hollow cylinder. Theory is pertinent to high-velocity strain effects in gun tubes. Developed computational model to describe oscillations of gas-filled bubble in liquids. Model applied to improvement of liquid propellant ignition processes. Measured physical properties of black powder including surface area, pore size distribution, and internal free volume. Applied parabolized Navier-Stokes computational techniques to calculate magnus effects for boattailed shapes at supersonic velocities. Obtained, for the first time ever, inflight data on fuze clock rate, fuze events, and event times. Developed and validated linear theory to determine frequency and damping of inertial waves in liquid-filled shells. Analysis of unexpected large yaw and de-spin moments in spin-stabilized projectiles containing very viscous fluid showed that yaw growth depends nonlinearly on viscosity. Developed explosive phenomena model relating temperature to sliding velocity and pressure. Developed simplified methodology for obtaining equations-of-state information for explosive detonation products from cylinder expansion test data. Completed first diagnostic tests of shaped charges exploiting jetting principle. Analyzed adiabatic shear in rolled homogeneous armor using tracer planes of chemical inhomogeneity, plugging velocities, thermal analysis, and phase changes. Completed three-dimensional, finite element computations of yawed kinetic energy (KE) penetrator impacting armor. Computer graphics show fine details of impact and structural response at various times. Completed general theoretical analysis of three transmission line accelerator cavities. Work supports small, lightweight electron accelerator devices for charged particle beam technology. Developed statistical sampling plan to assess availability of facilities for transporting munitions during national emergencies. Stochastic differential game formulation of duel between intruding tank and defensive gun has been solved in one-dimensional case.

2. (U) FY 1981 Program: The combustion of conventional propellants and super burning rate formulations are being analyzed to determine feasibility of 3-D stress analysis code. Introduce parameters that consider rate-sensitive constitutive behavior and complete calculation of thick-walled elastic cylinder response to internal traveling load. Model mechanisms of propellant combustion and evaluate new concepts in high-force solid propellants. Compute transonic magnus forces and moments for ring airfoil devices. Develop theoretical model to explain liquid-filled shell instability for very viscous payloads. Combine data on gun-emptying process and blast alterations caused by muzzle devices with composite flow field model to guide concepts for mitigating effects of muzzle blast. Obtain design factors for explosives with lowered sensitivity but no loss in performance. Analyze early and superfast jet formation, nonconical collapse, and heavy-rod lethal mechanisms for antiarmor devices. Obtain advanced computer techniques incorporating state-of-the-art theories and basic physical data on shaped charge and fragmentation phenomena and transfer techniques to design methods. Expand data base on material behavior under

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dynamic loading. Quantify deformation, stress fields, and penetration perforation parameters for long-rod penetrators. Develop-improve loading from conventional HE and nuclear rounds. Broaden scope to include nonideal blast effects caused by thermal precursors and dust. Provide target signature data and performance simulation model for magnetic and inductor sensors for top attack munitions. Develop theory for millimeter and other electromagnetic wave absorption by coatings. Provide theoretical guidance for compact pulsed power supplies for 6.2 charged particle beam program. Extend stochastic differential games to force-on-force scenarios. Initiate research on distributed decision processes (DDP). Support experimentation and testing by providing design of experiments for efficient collection of data, analysis of results and sample size requirements. Reduce research and development costs through techniques of order statistics and nonparametric statistical methods. Begin research in vulnerability fundamentals. Develop constitutive methodology for structural composites used in aircraft construction. Correlate constitutive models for dynamic, finite strain plasticity.

3. (U) FY 1982 Planned Program: Evaluate superburning rate propellants, advanced sabots, and kinetic energy and HE projectiles for use in hypervelocity traveling charge air defense gun. Establish burning rate, thermodynamic efficiency, and ignition conditions for novel propellants. Extend implicit Alpha multiphase technique to simulate packed-bed propellant and to include advanced turbulence models. Obtain experimental data on muzzle device to validate model. Formulate engineering model of blast from guns with muzzle brakes. Begin full-scale tests of muzzle blast control techniques derived from scale model concepts. Evaluate suitability of substituting laboratory gyroscopic flight simulator for certain full-range flight tests. Examine new and unique mechanisms for accelerating metals; e.g., electro/explosives, novel jet formation, and nonconical geometries. Explore acceleration mechanics for jet velocities beyond current state-of-the-art devices. Specify advanced KE penetrator materials with dynamic behavior insensitive to variations in manufacture but capable of withstanding launch and penetration forces. Simplify method for obtaining fracture parameters and obtain constitutive data from experiments. Develop computational techniques for simulating thermal/blast loading from conventional HE charges and nuclear warheads. Develop approach for coupling loading and response simulations that will account for interacting effects. Experimentally validate theoretical models for radar-absorbing coatings. Generate fast algorithm for tactical fire control to minimize processing delays in battery and weapon-level computers. Fabricate optimum magnetic or inductive sensor for application to top attack weapons. Evaluate sensor performance through laboratory and quasi-static field tests. Conduct analysis of electric propulsion techniques. Measure radial density profiles of propellant gases in the bore of a 30 mm or larger gun barrel. Evaluate transportable intense mono-energetic X-ray sources for measuring propellant gases in larger guns at test ranges. Exploit stochastic differential games (SDG) and distributed decision processes (DDP) to obtain robust information and control structures for artillery command, control, and communications systems. Evaluate material failure theories considering multiaxial stress states and incorporate germane theories into response models for predicting structural failure in military targets. Establish capability to predict structural failure in military targets by evaluating material failure

Project: #AH43 Title: Research in Ballistics
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

theories for multiaxial stress states. Incorporate anisotropic material behavior into the ADINA finite element 3-D stress analysis code. This project supports 180 personnel (94 professional and 86 support personnel).

4. (U) FY 1983 Planned Program: Develop two-phase-flow interior ballistic (IB) models to treat influence of propelling charge parameters, ignition and pressurization profiles. Incorporate parasitic components; e.g., wear-reducing liners into 2-D, two-phase axisymmetric flow IB model. Provide methodology for design and development of artillery propelling charges. Examine effectiveness of coherent antiraman spectroscopy (CARS) as diagnostic tool to analyze high-pressure flames. Perform holographic measurements of flow fields adjacent to igniting propellants. Apply Alpha code to predict muzzle exit conditions and compare with experimental data. Generate analytical guidelines for reducing probability of muzzle flash and associated blast. Compute flow within real howitzer muzzle brake and couple brake exhaust flow to free field blast. Examine computationally and experimentally details of man/blast interacting flow fields. Exploit thin-layer Navier-Stokes codes for predicting effects of unsteady flow field phenomena and flow fields within significant regions of separated flow. Measure pitching moment of supersonic tubular projectiles. Identify and model processes by which HE ignition occurs as a result of external stimuli. Identify principal mechanical properties of explosives which control reaction violence when munitions are deformed. Initiate work in electro-explosion conversion whereby electrical energy can be converted into hydrodynamic pressure for direct use. Computerize basic relations in jet formation for applications to enhance lethal mechanisms and develop costs needed for techniques to design advanced shaped charges. Extend theoretical and experimental base to develop dimensional models of high-velocity penetration/perforation in anisotropic-inhomogeneous passive targets. Expand armor-penetrator interaction model to consider effects of material properties. Extend instrumented impact experiments to novel materials and very high velocity impact. Modify particle dynamics of penetration model to treat behind-armor effects for reactive armors. Complete theoretical and experimental work on radar-absorbing coatings. Evaluate techniques for improving target identification through exploitation of coherent electromagnetic beams and signal processing. Conduct theoretical analysis and evaluation of charged particle beam plasma target interactions to identify potential countermeasure techniques. Provide theoretical support for artillery command experiment and develop new faster algorithms for specific microprocessors in tactical fire control. Apply nonclassical statistical methods to smart munition sensor discrimination techniques. Develop constitutive models for composite materials used in aircraft construction. Construct stochastic models for reliability, vulnerability, and ballistic phenomena.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not Applicable.

Project: #AH43 Title: Research in Ballistics
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

7. (U) Resources ($ in thousands):

RDTE	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
Funds (current requirements)	6757	6663	7170	9300	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	6822	7400	8500	-	Continuing	Not Applicable

The $65K difference in FY80 is attributable to reprograming of funds by DARCOM. The reduction in FY 1981 is attributable to the application of Congressional reductions in the 6.11.02.A program and reductions for improved efficiency. The reduction in FY82 is in response to OSD direction for improved efficiency.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #AH45 Title: Air Mobility Research
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: This project supports research to advance the state-of-the-art in rotary-wing aerodynamics, structures, propulsion, mathematical models, and avionics. 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 is oriented toward advanced airfoils and rotors and will address basic fluid mechanics, acoustics, dynamics, control, and flight simulation. Structures research is oriented toward advanced materials and structural concepts such as advanced metal and composite aircraft components. Fatigue and fracture characteristics of these materials are being investigated, and fracture control procedures and techniques are being developed. Propulsion research is directed at small-engine technology to improve the internal aerodynamics of combinations of compressors, combustors, and turbines, and to increase turbine operating temperatures. Research is developing mathematical modeling techniques applicable to problems associated with air-mobility research. Avionics research is aimed at reducing the proliferation of visual displays in helicopter cockpits and enhancing the capability to maneuver safely at nap-of-the-earth altitudes.

B. (U) 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, Department of Transportation, and Department of Energy. 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 interservice 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, Interdependency Activities, 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 with industry and academic institutions that is implemented by the Army Research Office under project B357, Research in Scientific Problems with Military Applications. The results of investigations carried out under this program are coordinated with the exploratory development program supported under element 6.22.09.A, Aeronautical Technology.

C. (U) WORK PERFORMED BY: This work is performed by the Research and Technology Laboratories of the US Army Aviation Research and Development Command. The laboratories involved are located at Moffett Field, CA; Cleveland, OH; Langley, VA; and Ft. Monmouth, NJ. Much of this work is performed jointly with NASA Research Centers at the first three locations. The top known contractors for FY 1982 are Bell Helicopter Textron, Ft. Worth, TX; Dynamic Engineering, Inc., Newport News, VA; General Applied Sciences Laboratory, Westbury, NY; Lockheed Georgia Company, Marietta, GA; and Spectron Development Laboratory, Mountain View, CA. The remaining contract program will involve twenty contractors for a total of approximately $2 million.

Project: #AH45 Title: Air Mobility Research
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Performance and acoustic measurements of the advanced UH-1H rotor in the V/STOL wind tunnel have been completed. Results indicate that a substantial increase in payload can be realized for a UH-1H with a reconfigured rotor. A comparison of two current hover performance theories with experimental data has shown good correlation when experimental wake measurements are included, indicating a need to improve theoretical wake geometry generation. Fuselage aerodynamic testing of a foreign helicopter model in the V/STOL wind tunnel has been completed. The Generalized Rotor Aeroelastic Stability Program (GRASP) has been formulated and is ready for coding. Further refinement of high-speed impulsive noise theory has been achieved. Studies of internal flows in a variable geometry combustor were completed. Studies on the internal flows and mixing within a JT8D combustor and their effect upon emissions were completed and preliminarily reported. A preliminary design computer code for centrifugal compressors has been completed. Internal flow measurements have been obtained in a 20-foot-diameter axial flow compressor rotor. A 2-lb/sec, 6:1-pressure-ratio, radial-bladed compressor has been investigated with a vaneless diffuser and two pipe diffusers. AVRADCOM TR 80-C-13 (NASA TP 1708) and AVRADCOM 80-C-15 (NASA TM 81532) have reported results of recently completed off-design performance models for radial turbines with pivoted nozzle vanes. Formulated and completed bearing hydrodynamic theory and published report. In jointly funded gear programs with NASA, the first task of surface geometry analysis for spiral bevel gears have been completed. Major efforts are underway to establish the long-term durability of newer composite materials in Army helicopter applications. This will lead to reduced maintenance and life cycle costs of all future air mobility systems. Significant progress has been made in several design technology areas related to helicopter structure. Among them are extended use of minicomputers, improved methods of structural integrity, and the introduction and characterization of new materials.

2. (U) FY 1981 Program: Recent 2-D test data on airfoils designed for attack helicopter rotor blade applications is being integrated into a new blade design in an effort to provide additional insight into the rotor aerodynamic design process. Data obtained from the experimental oscillating airfoil program is being consolidated, and a report will be released to industry providing the first consistent set of data on unsteady stall characteristics for a range of airfoils for use in dynamic loads prediction. Coding of the GRASP analysis is being completed for the hover flight condition and made available to industry. Techniques developed to couple rotor design variables to high-speed rotor acoustic emission are being expanded to treat blade-vortex interaction noise in order to provide a more detailed understanding of rotorcraft acoustic signatures. A highly backswept (50 degrees) 2-lb/sec, 6:1-pressure-ratio centrifugal compressor is being designed and procured to assess the effect of backsweep on performance. A 10-lb/sec, 4:1-pressure-ratio, optimum specific speed compressor is being designed and procured for the 10-lb/sec, test rig for the purpose of obtaining internal flow measurements using the

Project: #AH45 Title: Air Mobility Research
Program Element: #6.11.02.A Title: Defense Research Sciences
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new Laser 2 Focus (L2F) instrumentation. Internal flow measurements using the L2F are being taken to verify internal flow codes for low-specific-speed centrifugal-type stages. A comprehensive analytical design using latest available loss models is being initiated. A contract is being awarded for laser velocimeter mapping of internal flow fields in radial turbines with variable geometry. Tests of contoured end-wall stators and design codes for radial turbines are being completed. Several felt-ceramic combustor liner materials are being evaluated for durability and heat transfer characteristics. A theory of hydrodynamic lubrication is being extended to include cavitation. An investigation of a fully ceramic seal system is being extended. A wear theory to include transient thermal effects is being extended; and research on polyimide resins for composites is being continued. Other research underway includes an analysis of composite material behavior in helicopter environments; improved methods of structural integrity verification, structural weight miniaturization, and the development of better mathematical methods for vibration analysis; theoretical and empirical investigation of attenuation mechanisms and nonlinear processes in coherent fibers for airborne heterodyne sensors; and a perceptual investigation of computer-generated topographic symbology for aviation displays.

3. (U) FY 1982 Planned Program: Development of rotor aerodynamic design methods will continue with emphasis on capability to provide significant increases in speed as well as improved hover performance. Rotor wake theoretical and experimental efforts will be increased with the objective of providing greater interaction between acoustics, dynamic stall, and transonic research programs. The GRASP analysis will be extended to include forward flight conditions. Acoustic research will concentrate on the effects of rotor blade aerodynamic design on noise signatures. A 10-lb/sec, 8:1 compressor will be fabricated and studied to obtain overall performance and detailed measurements in the blading. A comprehensive analytical turbine design model and a study of the effect of countoured end-wall stator configurations on turbine performance will be completed. Optimized designs of felt-ceramic combuster liners will be generated and evaluated in a flame-tube rig. Evaluation of a full annular swirl combustor will be completed. A cavitation and dissolved gas theory of hydrodynamic lubrication will be completed, and analysis of gear toothforms for lower noise will be continued. Research will be conducted on the long-term durability evaluation of composite material, the development of a comprehensive and reliable fatigue analysis method for composite helicopter structures, and the rapid exploitation of new emerging material-processing technology and structural design concepts. A single-mode fiber in coherent fibers for airborne heterodyne sensors will be fabricated and an analysis of computer-generated topographic symbology to estimate degree of enhancement achieved by the use of color will be investigated. This project supports 140 in-house personnel (75 professional and 65 support personnel).

4. (U) FY 1983 Planned Program: Airfoil development for specific mission requirements will continue. Development of improved mathematical models for rotor wakes will continue. Research in fundamental rotorcraft structural dynamics will be

Project: #AH45 Title: Air Mobility Research
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

expanded to include areas such as rotor/drive-train/engine control dynamics. The internal flow of the two 4:1 centrifugal compressors having different speeds will be studied utilizing laser instrumentation. Results will be compared with available 3-D viscous codes. The optimized full annular felt-ceramic liner will be evaluated and a comparison of the effectiveness of various advanced liner-cooling techniques reported. Dilution jet-mixing and high combustion outlet temperature (3000 degrees) performance studies will be initiated, and an elevated bearing temperature study will be completed. Research of the long-term durability evaluation in composite material, the development of a comprehensive and reliable fatigue analysis method for composite helicopter structures, and the rapid exploitation of new emerging material-processing technology and structural design concepts will be continued. The programs concerning the coherent fiber for heterodyne sensors and the computer-generated topographic display investigation will be completed. Research on airborne environment sensors, airborne full-color display for computer-generated symbology, and solid state strapdown sensor for magnetic heading reference will be initiated.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not Applicable.

7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	5595	5849	7039	8100	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	5745	6750	7800	-	Continuing	Not Applicable

The resources requested under this project will serve to support the basic objective of providing the technological foundation for advancing the Army's air mobility capabilities. This includes new concepts in materials, structures, flight dynamics, and engines. The FY80 reduction to this program is due to minor reprograming within the technology base. The FY81 reduction is attributable to Congressional reductions. Reduced funding in FY82 is the result of recalculation of the technology base growth ramp based upon the FY81 budget and reprograming to other programs.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #BH57 Title: Research in Scientific Problems with Military Applications
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: This project supports research to increase knowledge in mathematics and the physical, engineering, environmental, and biological sciences directly related to long-term national security needs and to the solution of identified Army problems. It provides part of the scientific base for subsequent exploratory and advanced developments in Army-related technologies and for new or improved military functional capabilities in areas such as communications, detection, tracking, intelligence, surveillance, air defense, weapons, munitions, aircraft, missiles, propulsion, land vehicles, guidance and control, navigation, energy conversion, materials, armor, structures, military construction, and personnel support. The Electronics, Materials, Mathematics, Mechanics and Aeronautics, Physics, and Chemistry programs are described in separate Descriptive Summaries. Atmospheric sciences research provides the technology necessary to analyze smoke, dust, and aerosol (fog, cloud, rain and snow) degradation of weapon system operating in the ultraviolet through centimeter wavelengths, and particularly electro-optical and near-millimeter sensor performance under realistic battlefield conditions. Terrestrial sciences research is concerned with earth surface and subsurface conditions, and with remote sensing of these conditions relevant to military mapping and to assessment of camouflage and limitations to mobility and military construction. Biological sciences research in such areas as biochemistry and microbiology supports development of an adequate defense capability against chemical and biological weapons, contributes to reduced costs through increased lifetime of materiel and protection of subsistence items, lessens the impact of Army activities on natural environments, and increases effectiveness of the soldier. This project is divided into scientific areas as follows: 01-Atmospheric and Terrestrial Sciences; 02-Biological Sciences; 03-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.

B. (U) RELATED ACTIVITIES: This is primarily a contractual program. It is coupled with and related to in-house laboratory work in the Defense Research Sciences, and close coordination is maintained with both the administrators and bench scientists in the laboratories. The Navy, Air Force, National Aeronautics and Space Administration, Department of Energy, National Science Foundation, Department of Interior, National Bureau of Standards, Department of Human and Social Services, other government agencies, government agencies of allied nations, and the industrial community conduct related research. Coordination to assure that there is no unnecessary duplication is accomplished by program reviews; exchange of program information, research and technology resumes and technical reports; interservice and interagency liaison; and attendance and participation of Army representatives at annual reviews held by the Office of the Undersecretary of Defense for Research and

Project: #BH57 Title: Research in Scientific Problems with Military Applications
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

other government agencies, government agencies of allied nations, and the industrial community conduct related research. Coordination to assure that there is no unnecessary duplication is accomplished by program reviews; exchange of program information, research and technology resumes and technical reports; interservice and interagency liaison; and attendance and participation of Army representatives at annual reviews held by the Office of the Undersecretary of Defense for Research and Engineering. Coordination occurs through sponsorship of meetings and conferences, attendance at professional and scientific society meetings and review of the scientific literature.

C. (U) 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 five contractors are: Massachusetts Institute of Technology, Cambridge, MA; Stanford University, Stanford, CA; University of Wisconsin, Madison, WI; University of Illinois, Champaign-Urbana, IL; and Stanford Research Institute, Menlo Park, CA. There are, in addition, approximately 300 grantees and contractors. The value of the additional grants and contracts is $31,067,000.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Research relating optical scintillation of a laser beam to the average wind component perpendicular to the propagation path has made possible the development of a laser crosswind sensor which will be used on the new Abrams tank. It is estimated that considerable increase in the first-round hit probability will result from the elimination of the crosswind error in the total error budget of tank gunnery. A model has been developed for prediction of missile propellant secondary smoke formation which reveals the path of a missile and degrades the performance of missile laser beamriders and gunner target designator guidance systems. Properties of atmospheric particulate materials in powder and crystal form were determined for use in the smoke/obscuration program. Results have been obtained of anomalous water vapor absorption in the spectrum from the infrared through the near-millimeter wavelergth region that will result in improved accuracy of electro-optical sensors used for missile guidance and target designators. The first reliable measurements and analysis of incoming and outgoing shortwave and long-wave radiation at the top and floor of an evergreen forest, and in the open, have been obtained, providing design criteria for camouflage and for electro-optical sensors used for night vision, reconnaissance, and target acquisition in tropical environments. Techniques have been developed for assessing the impact of off-road vehicles on terrain as a function of soil type, precipitation, and topography. This will allow more effective land management at military installations in arid and semiarid areas of the Southwest. A soil stability investigation has resulted in major improvements in design criteria for earth embankments exposed to water erosion, earth structures subjected to earthquakes of explosion-induced shock, and the formation of craters by large explosion charges. Models for coupled heat and

Project: #BH57 Title: Research in Scientific Problems with Military Applications
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

moisture transport in freezing and thawing soils have been developed which provide new criteria for construction of foundation roads and cross-country movement analysis in cold regions. Results obtained on the mechanisms by which bacteria control synthesis of botulinum toxins will lead to faster techniques for food safety analysis and prevent toxin formation in improperly handled foods. New equipment and techniques were developed for measurement of electrical properties of living tissues in man and animals. These techniques will be important in establishing acceptable exposure levels for microwave radiations (including radar) and combined stress or drug and radiation effects. An apparatus was designed (and a patent obtained) to keep bacteria active in a maintenance state so that all energy is used for work and none for bacterial growth. Thus food, medicines, or fuels could be produced by fermentation more efficiently, and waste disposal would be rapid with no increase in biomass. Research on combat rations resulted in a determination of position and chemical nature of the fatty acids of selected glycerides. Accomplishments under the Electronics, Materials, Mathematics, Mechanics and Aeronautics, Physics and Chemistry programs are reported in separate Descriptive Summaries.

2. (U) FY 1981 Program: The current program is balanced between research responsive to a stated need or which supports ongoing programs in Army laboratories, and high-risk work with the potential of long-term contributions to future Army technologies. The Electronics, Materials, Mathematics, Mechanics and Aeronautics, Physics and Chemistry programs are reported in separate Descriptive Summaries. Work in the Atmospheric and Terrestrial Sciences stresses a major new effort to define the effects of clear air atmospheric turbulence, severe weather, and the "dirty" battlefield environment (dust, smoke and enhanced turbulence and turbidity due to burning vehicles and vegetation) on the angular resolution and imaging properties of near-millimeter wave sensors; the effects of cold fog, ice fog, snowfall and snow-covered terrain background on transmission and imaging properties of infrared and millimeter sensors in a cold region environment; forest canopy-atmospheric energy exchange relating to target signature background modeling; atmospheric processes influencing transport and diffusion of dust, screening smokes, and chemical and biological agents over the battlefield; seismic-acoustic coupling, seismic propagation and signal analysis for detection, identification, and location of sources of acoustic and/or seismic signals, as well as the effects of changing surface conditions such as snow cover and frozen soil on the signals; and new techniques for the improvement of our capability to characterize atmospheric conditions (turbulence, aerosols, humidity, temperature, wind, etc.) along electromagnetic transmission paths through the atmosphere. Work in the Biological Sciences includes defense against biological warfare with innovative research in remote detection and identification of biological agents, including the use of immunoassays. Research basic to the control of insect and animal pests that damage stored products and the protection of rations from autoxidation is underway.

Project: #B1157 Title: Research in Scientific Problems with Military Applications
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

3. (U) FY 1982 Planned Program: The FY 1982 program will maintain a balance between long-term basic research and research with potential for near-term payoff. Planned programs for the Electronics, Materials, Mathematics, Mechanics and Aeronautics, Physics and Chemistry programs are reported in separate Descriptive Summaries. Other research will be directed to obtaining increased capability in cloud and aerosol physics, utilizing a unique cloud simulation facility (ROMULUS) which will provide a highly controlled laboratory for investigating microphysical processes involving aerosols, condensation, and sublimation, leading to the formation and dissipation of clouds, fog, rain, and snow. Measurements will be made of slant path visibility modeling of fog in Germany; atmospheric effects on electro-optical transmission in the Near East environment. Models will be developed for the spatial and temporal water vapor distribution in the atmosphere which has a dominant effect on electromagnetic wave propagation and quantifying aerosol (both liquid and dry) effects on high-energy laser transmission in the atmosphere. Improvements in capabilities to remotely sense atmospheric conditions will be integrated (particularly precipitation over small drainage basins) into meso-scale hydrological forecasting. Research effort will be pursued to understand the scattering by irregularly shaped randomly oriented particles. Work in the Biological Sciences will include research on noncholinergic nerve impulse transmitters potentially involved in nonlethal incapacitation of man. The mechanisms of visual observation will be studied to identify training procedures for improved recognition of camouflaged targets. Additional funds in an amount of five million dollars in FY82 have been requested to allow significant growth of research in chemical and biological warfare defense, to be an integral part of the Army plan for an expanded program in the chemical and biological defense and chemical warfare areas. The growth will be based in part on the expansion and acceleration of efforts initiated in FY80 and 81, but more prominently on fresh opportunities to explore new concepts in chemical detection and identification, active and passive protection materials and systems, and formulations to cleanse surfaces and the environment, and destroy hazardous traces of agent. Proposals offering insight and understanding in the relevant areas of the biological sciences, material sciences, engineering and physics will continue to be actively sought and cooperation/coordination with managers of those programs at ARO required.

4. (U) FY 1983 Planned Program: Work in the Atmospheric and Terrestrial Sciences will be pursued to improve capabilities to (a) remotely sense, model, and depict soil characteristics, wind and stability conditions in the lower atmosphere, and slant path visibility through dust and sandstorms in the Near East environment, (b) to predict high-energy laser propagation, and (c) to compensate ionospheric effects on high-frequency position location of enemy command and control centers. The Biological Sciences program will include research to increase the speed and sensitivity of detection and identification of BW agents. Ways will be sought to use microorganisms to destroy unwanted recalcitrant molecules. New approaches will be sought for previously unsolved problems. Flexibility to initiate new thrusts as promising scientific areas and corresponding Army needs become evident will be maintained.

Project: #BH57
Program Element: #6.11.02.A
DOD Mission Area: #510 - Defense Research

Title: Research in Scientific Problems with Military Applications
Title: Defense Research Sciences
Budget Activity: #1 - Technology Base

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not Applicable.

7. (U) Resources ($ in thousands):

RDTE	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
Funds (current requirements)	38092	46508	62295	74000	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	38608	49000	60500	-	--	Not Applicable

Reduced funding in FY80 reflects minor reprograming within the technology base. The FY81 reduction is attributable to the application of Congressional reductions and decreases for improved efficiencies. The FY82 increase reflects an increase of $5.0 million for research; a downward readjustment of contractual efforts in electronic devices, food research, and gun propellant synthesis at universities totaling $1.624 million in response to OSD direction for improved efficiency; and downward inflation readjustment of $1.081 million.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Technical/Scientific Area: #03 Title: Electronics
Project: #BH57 Title: Research in Scientific Problems with Military Applications
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: Support of basic research in the electronics scientific area is provided to the most outstanding scientists in universities, research institutes, and industry. Research support leads the state-of-the-art and has the potential to produce significant technological breakthroughs and cost reduction in electronics technology for defense. The principal objective is to provide a technology base in selected areas of electronics, communications, and computers to satisfy present and future Army requirements and to produce significant new capabilities essential to maintaining technological superiority over potential adversaries. Research is supported to produce new and original scientific knowledge which will be applied in the fields of sophisticated communications systems and networks including electronics warfare and data communications; solid state electronics including properties of materials for semiconductors, magnetics and dielectrics; design of advanced integrated circuits including computer-aided design and ultra small electronics; systems for surveillance, target acquisition, guidance, and observation under adverse battlefield conditions; and computer systems including tactical computers and distributed computing systems.

B. (U) RELATED ACTIVITIES: Extensive coordination is effected within the Army and DOD to assure that research supports Army and DOD needs and goals and that there is no unnecessary duplication of effort within the Army or DOD. An informal group of senior Army research managers meets several times a year at the various Army electronics research activities for familiarization with ongoing research and identification of important research goals. Research proposals considered under this task are also reviewed by all appropriate Army activities. This task includes participation in the management of the Joint Services Electronics Program jointly conducted by Army, Navy, and Air Force. Each Army Research Office (ARO) staff member continually conducts personal interactions with scientists in the Army and other military and government funding agencies for purposes of coordinating programs and transferring contractually generated basic knowledge to active Army projects. The ARO also conducts management and technical assessment of the Army laboratory research programs for DARCOM headquarters. Each year ARO sponsors seminars and workshops with intraservice and interservice participation to disseminate technical results and identify critical needs.

C. (U) WORK PERFORMED BY: This program is managed by the US Army Research Office, Research Triangle Park, NC. The top five contractors are: Stanford University, Stanford, CA; Massachusetts Institute of Technology, Cambridge, MA; Columbia University, New York, NY; Georgia Institute of Technology, Atlanta, GA; and the University of Southern California, Los

Technical/Scientific Area: #03 Title: Electronics
Project: #BH57 Title: Research in Scientific Problems with Military Applications
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Angeles, CA. The total number of additional contractors is 47; the total dollar value of these additional contracts is $3,939,818.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Surface acoustic wave devices are used to process large amounts of data at very high speeds. For the last two years research has supported the modeling of shallow bulk acoustic waves which propagate deeper into the device material at twice the operating frequency of standard surface acoustic waves. A model has been devised and experimentally verified which will enable the Army Electronics Technology and Device Laboratory to design and build a highly stable oscillator in the 1-2 gigahertz (GHz) region needed for missile homing systems at the Army Missile Command. Gallium arsenide is a material which has significant advantages for use in microwave devices and high-speed integrated circuits; however, there exist a number of technical problems, such as obtaining good electrical connections to the material. Research supported under this task has found a solution to this problem. A major thrust in the Army is the development of high-speed optical communications systems which use fiber optics. A major technical barrier is the development of semiconductor optical sources for these systems. By mode-locking semiconductor laser diodes with external reflectors and saturable absorbers, optical pulse lengths as short as 16 picoseconds have been observed which can be used as sources in very high bit rate digital integrated optics communication systems. A major thrust within the DOD is to develop millimeter wave (30-300 GHz) systems which can "see" through adverse battlefield conditions. Devices for operation at these frequencies are beyond the capability of current technology. The current maximum frequency of conventional devices such as IMPATT diodes is limited by the time it takes charged carriers to move through the device. A technique has been developed for analyzing and designing devices which use ribbing along a waveguide whereby gain is accumulated in synchronism with the propagation of the charged carriers. The frequency limiting effect of the transit time device has been eliminated, and in addition a means of electronically controlling the frequency of millimeter wave oscillators has been obtained. Also, techniques have been demonstrated for the fabrication of a rugged, integrated, millimeter wave superheterodyne receiver on a single wafer of semiconductor material such as silicon. The design employs balanced mixing to minimize noise and special fabrication procedures needed for the integrated design of efficient millimeter wave devices. The available radio frequency spectrum for communication is fixed, and yet the number of signals being generated especially in a battle situation continues to increase rapidly. A major objective of research is to develop means to have many users on the same communication channels which do not interfere with each other and which are resistant to enemy jamming. One approach is the use of spread spectrum. Research has produced a new set of binary code sequences known as bent-function sequences for spread spectrum systems which enables many more users without interference and greater resistance to jamming. The code is recognized as the best available

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Project: #BH57 Title: Research in Scientific Problems with Military Applications
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code division multiple access signal set for spread spectrum and is being proposed for use in military systems by the Hughes and Sperry Corporations. It is universally recognized that future generations of very complex, very large-scale integrated circuits cannot be produced without computer-automated design. Specifically, the Army has a need for a limited number of highly complex custom integrated circuits. A design system has been generated which minimizes the man-machine interaction at the design level of digital systems interfaces. The simulator is now being used at the National Bureau of Standards. This automation tool has cleared the path for producing digital integrated circuit designs directly from formal specifications.

2. (U) FY 1981 Program: The current year's program focuses upon the attainment and utilization of basic knowledge related to Army needs in the following fundamental areas of electronics: Physical Electronics: Particular attention is being devoted to the finding of new electronic materials, the understanding of physical laws and advanced processing techniques (for example, molecular beam epitaxy to create an extremely well-defined integrated structure) which will lead to superior device and ultimately system performance. Specifically, a new special program on Ultra-Small Electronics Research (USER) is being expanded with emphasis on growth of submicron devices and transport in constrained dimensions. This research is at the leading edge of a new electronics revolution which will allow highly complex systems to become practical; such systems are quiet radar, notebook-size computation and data storage to be used in fire control, and widespread use of secure communications. Controlled growth and doping of materials required for far infrared applications is being pursued, and is applicable to the Army's night vision devices. Research conducted on this topic contributes strongly to the science base for future integrated circuits. Electronics Devices: Electron devices as used here relate to semiconductor devices where transit time effects, millimeter and submillimeter wave generation and photon-electron interactions are of importance. An outstanding and critical problem is the attainment of a solid-state near-millimeter wave technology which will be utilized in systems for the surveillance of the battlefield under adverse conditions. A special program under this task is being pursued to investigate techniques which will lead to portable, reliable near-millimeter wave sources. Also, the total integration of near-millimeter wave circuits into one system is receiving enhanced attention. Antennas and EM Detection: The area of printed and conformal antennas is of highest priority. The ultimate goal of this effort is to obtain basic knowledge for the design of an antenna system which is conformal to the mounting platform and takes advantage of the natural radiation characteristics of the parent structure. Some specific applications for such design techniques are in missile antennas, proximity fuze antennas, and vehicular antennas such as on tanks. In support of the near-millimeter wave program, novel techniques are being investigated which will lead to the integration of complete systems including antenna, source, and signal processing on a single "chip". Circuits, Networks and Related Systems: A major thrust of this program is in the investigation of techniques which will lead to the automated design of very large integrated circuits. The military has the need for small quantities (as compared to commercial markets) of custom and special-purpose integrated circuits. Because of the complexity of

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modern system requirements, these devices can only be obtained in a timely, cost-effective manner through automated design techniques. Because Army communication and signal processing systems are pushed to higher and higher frequencies, research is being supported to obtain a complete understanding of the entire electronic system performance, and reliability all the way down to the circuit and device level including modeling and layout. Signal Processing, Communications and Related Systems: Emphasis is being placed upon fundamental research in multidimensional digital and electro-optic/acoustic-optic/hybrid signal processing to improve speed and accuracy in military systems. The environment of modern warfare is one of high levels of interference and jamming. To achieve the goal of continued, reliable operation under adverse electronic battlefield conditions, coding techniques, error correction, and data compression techniques and fast synchronization are of critical importance to all aspects of digital systems. Included in this task are techniques to utilize distributed control of communication networks to insure continued operation under dynamic conditions encountered in the battlefield. Computers and Information Processing: Army battlefield computer systems diverge from commercial systems in that they must be physically rugged and utilize resilient code. The focus of this current effort is to obtain optimized software and microminiature hardware for realtime computation and control. Small computer applications in the tactical environment necessitate the study of distributed processing and inter-Processor communications. Such studies focus upon task allocation and techniques to maximize concurrency in distributed systems. Since institutional funding has been recognized to be highly productive and synergistic, more than half of the available resources are being applied to the Joint Service Electronics Program (JSEP) and smaller block funded efforts. JSEP provides triservice support and management of research programs at selected universities to conduct long-range research relevant to military needs. The level of effort of this total program is $9.1M; the Army contribution is approximately $3M. Universities now involved in this program are: Harvard University, University of Illinois, Ohio State University, Texas Tech University, Stanford University, Massachusetts Institute of Technology, Columbia University, California Institute of Technology, Georgia Institute of Technology, University of Southern California, University of Texas, Cornell University, University of California at Berkeley, and Polytechnic Institute of New York. Additionally, programs are being supported in the area of very large-scale integration (VLSI) and digital communication systems at a level of approximately $250K each.

3. (U) FY 1982 Planned Program: Many contracts in this program are incrementally funded for three years; therefore, the FY82 program will necessarily include continuing efforts initiated with FY80 and FY81 funding. Coordination with Army, DOD, and other government agencies will continue to assure that research is focused on valid Army and DOD needs and to avoid duplication of effort. Research in physical electronics and electron devices will continue to emphasize progress in ultra-small submicron electronics research. Emphasis initially will be on understanding materials and physical phenomena such as encountered in small dimensions where conventic laws may no longer apply and ballistic transport theory may have

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to be developed. As preliminary results are achieved in FY82, these results will be incorporated in very large-scale integrated circuit design research. A major continuing thrust will be computer-aided and completely automated design of complex very large-scale integrated circuits. During FY82 it is anticipated that basic approaches will be identified and that approaches for more sophisticated aspects such as incorporation of automated testing and hardware interfacing will begin to receive more emphasis. It is also anticipated that early millimeter wave device development will have progressed to the point where integration of components into systems will be emphasized. Research components for digital integrated optical communications should also be evolving during FY82 and research will be needed on techniques for combining these components into systems. Incorporation of millimeter wave systems and integrated circuits with advanced capability and formulation of complex digital data communication systems and networks are certain to produce new and unique problems in digital signal processing, distributed computing, and computer architecture. Continuing emphasis will be placed on multidimensional signal processing and techniques for higher speed and throughput and for reduced error rates in digital signal processing. Part of this continuing thrust will be the development of optical computing and processing and interface of optical with digital electronics. Basic fundamental science in these fields will be available but methods for designing systems and evaluating combined system performance will be needed. Digital signal processing, digital communication theory, and VLSI circuits will have been progressing more or less independently. In FY82 there will develop a great need for research to integrate these technologies. For example, new digital signal processing theory must be utilized in the control and implementation of complex distributed communications networks using distributed computers. Hardware architecture design techniques must be developed which will be compatible with VLSI/VHSI and USER technology to make use of the developing capability for automated and computer-aided design of VLSI/VHSI and USER to obtain low-cost, useful, and reliable systems.

4. (U) FY 1983 Program: The planned program for FY 1983 is a continuation of the research efforts described in the preceding section. Direct support of the Army's needs will aim at reducing leadtime for systems development and assuring cost effectiveness with increased reliability. The following topics will receive emphasis and are expected to impact on Army electronic systems: Millimeter and Submillimeter Waves, Circuit Integration, Ultra-Small Electronic Research, Novel Electronic Materials and Engineering Devices, Communications in Multisignal Environments Devices, Communications in Multisignal Environments, Distributed Computer Systems, Signal Processing and Information Display.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

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7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	8389	8486	13807	16072	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	8255	10590	13040	-	Continuing	Not Applicable

FY80 funds were increased to fund new programs in ultra submicron electronics. The FY81 decrease is due to Congressional reductions. The increase in FY82 reflects increased emphasis by the Army in microelectronics.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Technical/Scientific Area: #04
Project: #BH57
Program Element: #6.11.02.A
DOD Mission Area: #510 - Defense Research

Title: Materials
Title: Research in Scientific Problems with Military Applications
Title: Defense Research Sciences
Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: The scientific area of materials contributes to the science and technology base through the investigation of relationships between the composition, structure, defects, processing, and useful properties of materials in order to help satisfy short- and long-range Army requirements. In order to accomplish this objective, the aims are: to discover the relation between composition and structure of materials and the useful properties of those materials; to learn the principles whereby those properties may be dependably reproduced for application toward solution of Army problems (e.g., improvement of strength and fracture toughness of materials of armaments, armor, aircraft, and vehicles; protection against degradation in service or storage; improvement of electric, magnetic, and optical materials for communication, guidance, and control, and for energy storage or transmission; and discovery of processing techniques that provide improved reliability of materials in components); and to develop simple, reliable, inexpensive procedures for testing and analysis of materials and components. The Army's FY 1981 Science and Technology Objectives Guide; frequent coupling with DoD laboratories and agencies, and other Federal agencies including the National Science Foundation, National Bureau of Standards, National Aeronautics and Space Administration, and Department of Energy; participation in technical meetings; foreign intelligence (provided through The Technical Cooperation Program and by the Foreign Science and Technology Center) assist in guiding the selection of topics to be supported in the program.

B. (U) RELATED ACTIVITIES: This program is related to parts of 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; AH45, Air Mobility Research; AH47, Electronic Devices Research; AH48, Electromagnetic Propagation and Antenna Research; AH49, Missile and High Energy Laser Research; AH51, Combat Support Research; AH52, Research in Support of Equipment for the Individual Soldier; AH60, Research in Large Caliber Armaments; and AH61, Research in Fire Control and Small Caliber Armament. Close coordination is maintained with the Navy, Air Force, Defense Advanced Research Projects Agency, National Aeronautics and Space Agency, Department of Energy, and the National Science Foundation. Coordination meetings are held on a regular basis (e.g., Interagency Materials Group).

C. (U) WORK PERFORMED BY: This program is managed by the US Army Research Office, Research Triangle Park, NC. The top five contractors are: Massachusetts Institute of Technology, Cambridge, MA; Battelle Memorial Institute, Columbus, OH; University of Pennsylvania, Philadelphia, PA; Lawrence Livermore Laboratories, Livermore, CA; and Pennsylvania State University, University Park, PA. The total number of additional contractors is 56. The total dollar value of these additional contracts is $3,093,173.

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Project: #BH57 Title: Research in Scientific Problems with Military Applications
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Significant progress has been made in understanding the gas flow dynamics which contribute to hot gas erosion in gun tubes. The program on environmental degradation of polymers and polymer matrix composites has made significant progress in understanding the hygrothermal effects on mechanical properties of these materials. During the last year, research on processing of semiconductor (MNOS) materials used in Army computers and charge coupled devices (CCDs) for infrared detector arrays led to a change in manufacturing procedure which will make the devices hardened against ionizing radiation and operational at cryogenic temperatures needed for their mission. Research on the effects of rare-earth alloy additions to steel used for armor applications led to the discovery of how to process these materials to improve their resistance to ballistic impact and Army laboratories are already attempting to scale up the work for armor applications. A laser photoacoustic technique has been developed which can readily detect deleterious flaws in materials used for turbine components, such as those used for helicopter and tank engines. This nondestructive evaluation technique also has potential for inspection of electronic integrated circuits for microscopic flaws beneath the surface of the metallized conductor path. Research on the effects of certain impurities in high-carbon steels, used by the Army in armor, fragmentation munitions, high-hardness wear-resistant gears, and other automotive components, has led to understanding of the processing of these materials which will improve their reliability and mission performance. A novel nondestructive evaluation technique, called vibrothermography, was shown to be effective in detecting defects in full-size production composite helicopter rotor blades which were undetectable by other methods currently available. This technique could provide better quality control on new rotor blades, as well as provide a capability to monitor the formation of deleterious flaws during use so that timely replacement could preclude catastrophic failure. A second nondestructive evaluation technique, called optical probing of acoustical emission, was developed which has the potential to revolutionize studies of phenomena such as fast crack propagation which are relevant to Army problems in armor and penetrators. Research on the glass formation regions in the technologically important Si-Mg-O-N and SiY-O-N ceramic systems will lead to materials with dimensional stability for the Army's future high-temperature ceramic turbines and adiabatic diesels for automotive applications. Research on the chemistry of the fiber-matrix interface in epoxy matrix composites, such as those used in helicopter and missile components, has led to recommendations for the processing of these materials which will reduce their susceptibility to hygrothermal degradation.

2. (U) FY 1981 Program: A broad program of research into hot gas erosion relevant to critical degradation of gun tubes, turbine engines, and missile components was initiated during FY 1978-79. Significant advances in mechanistic understanding of hot gas erosion phenomena in hot, turbulent, reactive gas flows have been made, leading to potential avenues for

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protecting materials in future applications in which the temperature, pressure, and gas reactivity are projected to be much more extreme. That program will be continued, and further advances will be forthcoming. Several other areas are identified as special areas of interest owing to their importance to Army needs, their timeliness, and their potential for large payoff. One such thrust which is being expanded is the behavior of materials under high rates of energy impingement; e.g., ballistic shock and laser pulsing. Synthesis, processing, and characterization of electronic, optical, and magnetic materials are receiving increased emphasis. Exploration of novel processing (such as rapidly quenched powders, ion implanted surfaces) and compositional systems to produce nonequilibrium materials are continuing to receive attention because of their potential as novel magnetic materials and protective coatings for gun tubes and turbines, for example. Novel nondestructive evaluation techniques are being expanded as an area of emphasis. Protection of materials and components from environmental degradation continues to receive attention; e.g., new defenses against aggressive environments (alloys, coatings, storage conditions) and establishment of testing procedures which will accurately predict the long-term performance of materials in service. Special attention is being given to basic improvements in materials for armor, aviation, C3 systems, large and small caliber weapons, penetrators, troop support systems.

3. (U) FY 1982 Program: Research will be continued as described in the FY 1981 program with emphasis on ultra high loading rates (including shock and penetrations), novel nondestructive evaluation of materials, effects of aggressive environments (including inside gun tubes and engines) on degradation of materials, barriers to degradation, improved processing of materials for reproducibility, gradient materials (e.g., composites and optical components), magnetics, and materials for chemical warfare defense.

4. (U) FY 1983 Program: Research will continue as described in the FY 1982 Program with emphasis on the mechanisms of material response to complex loading and higher rates in more aggressive atmospheres, gradient materials for optical and mechanical use, processing and stability of materials on ultra small dimensional scales; and substitute materials for critical or strategic constituents.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not Applicable.

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7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	4978	7005	7600	10112	Continuing	Not Applicable
Funds (as shown in FY 1980 submission)	4870	6140	7590	0	Continuing	Not Applicable

A separate Congressional Descriptive Summary was not submitted on this scientific area in FY 1980. FY80, 81, and 82 funds have been increased to support additional programs in composite materials and materials for chemical warfare defense.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Technical/Scientific Area: #05
Project: #BH57
Program Element: #6.11:02.A
DOD Mission Area: #510 - Defense Research

Title: Mathematics
Title: Research in Scientific Problems with Military Applications
Title: Defense Research Sciences
Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: The objectives of this project are twofold. The primary objective is to support the development and acquisition of basic knowledge and research in the mathematical sciences which includes work applicable to such Army problems as ballistics, fire control, mechanisms, guidance and control, field and laboratory testing, and simulation and modeling. The program is designed to account for both long- and short-range Army needs. The second objective is to provide assistance and advice to Army installations in the application of mathematical trends and developments. In addition, a very successful program of bringing investigators to certain Army laboratories for extended periods has been instituted. This program allows for an in-depth introduction to specific Army problems and for significant interactions with Army scientists. Also, a training and orientation program has been developed which emphasizes the presentation of mathematical techniques with Army utility. A continuous program of Army-wide conferences is sponsored both to promote communication among Army scientists and to foster interchanges between Army and non-Army scientists. Finally, mathematical results of foreign researchers are considered.

B. (U) 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 review, exchange of program data sheets and technical reports, and attendance and participation of representatives at annual reviews sponsored by the Office of the Under Secretary of Defense for 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.

C. (U) WORK PERFORMED BY: This program of contracts is managed by the US Army Research Office, Research Triangle Park, NC. The top five contractors are: University of Wisconsin, Madison, WI; Stanford University, Stanford, CA; University of California, Berkeley, CA; Brown University, Providence, RI; and Carnegie-Mellon University, Pittsburgh, PA. There are in addition 85 contractors. The value of the additional contracts is $2,740,000.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: It has been increasingly recognized that many important physical phenomena such as occur in combustion, ballistics, optics, communications, and solid state electronics are nonlinear. Significant

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Project: #BH57 Title: Research in Scientific Problems with Military Applications
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fundamental progress has been achieved in the areas of analytical and computational methods for nonlinear, unsteady phenomena, the development of reliable mathematical software, and on robust statistical procedures. These results will impact applications of shock waves which influence projectile trajectories. Shocks or discontinuities occur in many important classes of fluid dynamics, shock wave propagation from nuclear blasts, and shocks formed from helicopter rotors. Recently, a highly accurate numerical method for solving the differential equations which describe such situations in two dimensions has been developed. The procedure, based on the random choice method, offers increases in accuracy and resolution of shocks without significant increases in computation time. There is a considerable interest in procedures for unsupervised target recognition and identification. Several complementary efforts have contributed significantly towards this goal. A statistical method for the construction of the boundaries of noisy images obtained from electronic detectors has been developed. This procedure, which can be implemented on parallel processors, results in extremely fast image recovery time, and produces very well-defined images. Simultaneously, a new robust regression technique has been developed which is quite efficient for two-dimensional image discrimination. This method is far better than the classical least squares approaches for the reconstruction and identification of images because it does not distort the image shape to enhance the fit. The method is particularly relevant to the problem of automated target recognition because this procedure distinguishes features such as the differences in lengths of gun tubes and tank turret profiles without the overall shape and size of the image. The regression method will potentially provide an unsupervised target recognition capability when used with the new image finder. Kalman filters have been effective in estimating the state in dynamical systems of practical interest which are subject to stochastic disturbances and measurement noises. A simple procedure has been developed for approximating time-varying Kalman filters, employing a geometric series approach. This algorithm can be readily implemented on low-cost microprocessors, or microcomputers, such as for the digital control efforts which use realtime control of turret systems.

2. (U) FY 1981 Program: The program for FY81 is based on the continuation of efforts begun in FY79 and FY80 in the areas of nonlinear analysis, statistical data analysis and computational methods including mathematical software. In addition, a new program is being initiated in the area of fast algorithms. Such algorithms are created by the careful exploitation of the special structures arising in certain classes or problems. This area is motivated by the ever-increasing use of microprocessors in Army technology, especially fire control.

3. (U) FY 1982 Planned Program: It is planned to continue the expansion of the program in fast algorithms and to maintain the other thrusts of FY81. In addition, a program aimed at large-scale scientific computation and the impact of highly parallel devices on such areas as computational mechanics and computational statistics among others will be initiated. Such an emphasis is motivated by the increasing sophistication of Army systems and their corresponding models

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and the need to develop new and essentially parallel algorithms to exploit this technology.

4. (U) FY 1983 Planned Program: The program in large-scale scientific computing will be continued, and in addition, the program will be critically reviewed for possible gaps and for saturation of other areas. The program will then be shifted to reflect current promising scientific avenues with a strong potential for Army relevance.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	5072	5411	6965	8742	Continuing	Not Applicable
Funds (as shown in FY 1981 Submission)	5260	6520	8130	-	Continuing	Not Applicable

The FY80 funds were reprogramed to other research-funding support efforts. The FY81 decrease is attributable to the application of Congressional reductions. The FY82 decrease is the result of adjustments to FY81 cuts and reprograming into other research areas.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Technical/Scientific Area: #06 Title: Mechanics and Aeronautics
Project: #BH57 Title: Research in Scientific Problems with Military Applications
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: Research activities supported in this project are closely focused on the disciplines of combustion sciences, fluid dynamics, and solid mechanics, and though this task addresses a broad set of research problems in varied scientific fields, the totality of the effort greatly contributes to the future technology base from which significant improvements in US Army mobility, firepower, and service support can be made. Advances in combustion science are of prime interest to any modern army. Apart from such clearly combat-related problems as explosions and projectile and rocket propellants, mobility is a key factor in modern strategy. A more detailed understanding of the intricate, interdisciplinary combustion processes will form the basis of future advances in Army engine design and fuel and propellant improvement. Research in fluid dynamics is oriented toward the development of improved or new technology for those Army weapons which involve air vehicles or the use of liquid working fluids. The behavior of both gases and liquids under various forces and motions is of great importance to the improvement of gun-launched projectiles, missiles, helicopters, turbomachinery, and fluidic or hydraulic devices. Research in solid mechanics is concerned with the integrity of structures and components through an understanding of stress and deformation states resulting from complex loadings. Consequently, this technical area pervades all Army weapons systems and material and, accordingly, plays a critical role in developing the technology for improved Army weapons, ammunition, aircraft, missiles, ground vehicles, and protection of personnel and structures.

B. (U) RELATED ACTIVITIES: Because of the breadth of this research task, it is related to research programs at many of the Army Laboratories, the other services, and several other Government agencies. Within the Army, the related projects of primary importance to this task are AF22, Research in Vehicle Mobility; AH42, Materials and Mechanics; AH43, Research in Ballistics; AH45, Air Mobility; AH49, Missiles and High Energy Laser Research; AH51, Research in Large Caliber Armament. Consequently, great care is exercised to insure coordination and to preclude unnecessary duplication of effort. Annual assessments of these research projects at the Army Laboratories provide a forum for direct exchange of technical information regarding contracts of common interest, progress in specialized areas and identification of research results having potential application to Army problems as well as timely dispensation of technical information and opportunity for Army Laboratory scientists to actively interact with the scientific community. Also during the year, there are frequent contacts between the scientific staff of the Army Research Office and these laboratories during which current research developments are discussed. Likewise, research contracts, conferences, and symposia of mutual interest to the Air Force Office of Scientific Research, Naval Air Systems Command, and the National Aeronautics and Space Administration are currently being jointly sponsored, necessitating frequent exchange of reports and other information to keep each organization informed of current developments. The mechanics and aeronautics program of the Army Research Office is presented and reviewed along with those of the Navy and

Technical/Scientific Area: #06 Title: Mechanics and Aeronautics
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Air Force at annual reviews of the Department of Defense in materials, mechanics, structures, and aerodynamics. Coordination of related programs at other Government agencies such as the National Aeronautics and Space Administration, National Science Foundation, and Department of Energy is maintained by frequent exchange of reports, discussions between scientific staff and joint support of research contracts and national or international conferences and symposia. In the latter case, Army and other Department of Defense scientists and engineers may participate in and attend these meetings, at no fee, and several copies of the proceedings are received for internal Army distribution.

C. (U) WORK PERFORMED BY: This research program is implemented by means of contracts with universities, industry and non-profit research institutions and is managed by the US Army Research Office. The top five contractors are Princeton University, Princeton, NJ; University of Illinois, Urbana and Chicago, IL; Massachusetts Institute of Technology, Cambridge, MA; Stanford University, Stanford, CA; and Rensselaer Polytechnic Institute, Troy, NY. The number of additional contractors is 55. The estimated total dollar value of these additional contracts is $4,000?000.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: An engineering design tool has been developed for describing the blow-by flow processes during tube launch of missiles. The resulting computer program predicts the effects of various blow-by alleviation devices and evaluates new launcher designs for mal-launch reductions. A numerical analysis and computer program has been developed for describing the details of the precursor shock and flow evolution in large caliber gun muzzle blasts. This analysis sets the initial conditions for describing the post-launch environment and consequently represents a significant step for describing the mechanisms in muzzle flash and flash-induced blast. An analytical method has been developed for predicting transonic flows past nonaxisymmetric projectiles. This analysis predicts the forces and moments produced by non-conical boat-tail projectiles in transonic flow and has been experimentally verified. Advances have been made on extending durability of engine wall coatings so that the concept is now ready for field testing. Mechanisms governing detonation wave propagation have been determined for fuel-air explosives. In penetration mechanics, calculations have been completed on stress and strain in dynamic situations for both elastic-plastic and viscoelastic materials based on the development of non-local elasticity. A new constitutive theory for elastic-plastic behavior of fibrous composites for loading and unloading with holes and notches has been solved. An analysis describing the effects of atmospheric turbulence on the motion and stability of helicopter rotor blades and the difficult problem of helicopter rotor-fuselage structural dynamics has been developed.

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2. (U) FY 1981 Program: Research programs in solid mechanics, fluid dynamics, and the combustion sciences are being vigorously pursued with expected progress in determining high-impact loading fracture processes, fundamental processes of wear in high-speed sliding devices, novel nondestructive testing concepts, analytical theory for rotor wakes, ground interference on main and/or tail rotors, acoustic diagnostic techniques for gas turbine-type combusters, effects of catalytic walls on combustion and details of liquid propellant combustion processes. Special emphasis is being placed on research on novel methods of electromagnetic acceleration, ultra-high loading rates, propulsion aerodynamics, and ignition and combustion of propellants in order to meet critical Army needs in these areas as well as to capitalize on unique research opportunities.

3. (U) FY 1982 Planned Program: Research programs continued from FY81 will be expanded to accomplish an understanding of three-dimensional propagation of shocks in Army materiel and to determine design criteria for using composite materials in structures. Studies on novel nondestructive test techniques and their evaluation will be emphasized. Theories for describing missile plume effects during missile maneuver, rotor wake interference with the ground under maneuver conditions and analysis of unsteady motion of supersonic projectiles will be developed and evaluated. New programs will be initiated on the characterization of synfuels for Army application, the effects of adiabatic walls in engine environment and long-term synfuel stability.

4. (U) FY 1983 Planned Program: Research focused on solid mechanics, fluid dynamics and combustion represent a logical and integrated continuation from FY82 and will, in addition, embrace such important topics as new concepts for dynamic balancing of rotating machinery, rational theory of vibrations, beneficial use of residual stress in design of structures, analysis of bank-to-turn tactical missiles, rotor wake effects on performance and stability and control in nap-of-earth environment, combustion chamber design for adiabatic/catalytic walls, and novel diagnostic techniques for high-pressure/temperature combustion events.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

7. (U) Resources ($ in thousands):

Technical/Scientific Area: #06 Title: Mechanics and Aeronautics
Project: #BH57 Title: Research in Scientific Problems with Military Applications
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	4664	5615	6670	7064	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	4970	6380	7690	-	Continuing	Not Applicable

The FY80 reduction reflects reprograming to other research projects. Decrease in FY81 reflects the application of Congressional reductions. Decrease in FY82 is the result of a decrement due to prior year reductions and reprograming into research areas.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Technical/Scientific Area: #07
Project: #BH57
Program Element: #6.11.02.A
DOD Mission Area: #510 - Defense Research

Title: Physics
Title: Research in Scientific Problems with Military Applications
Title: Defense Research Sciences
Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: The past support of physics research has led to significant benefits to Army and DOD technological and operational capability; for example, in identification of targets, in weapons and their precision guidance, and in general combat support technology. This is a continuing program to match the opportunities presented by the development of physics to generic military science and technology. The program also serves as a means of developing a working relationship of the nation's best physics research talent with the Army technical community. The program is also a means of exploiting new physics opportunities, such as was the case with the extensive research in laser physics on which precision weapons guidance is now based. The areas of primary Army impact are intelligence, surveillance, and target acquisition; weapons development and guidance; combat support including obscured visibility operations; air and missile defense. The primary subdisciplinary areas contributing to these objectives are atomic and molecular physics, physics of condensed matter, plasma physics, optics and lasers, and cross-disciplinary topics.

B. (U) RELATED ACTIVITIES: This program relates to parts of 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; AH46, Research in Combat Surveillance and Target Acquisition; AH47, Electronic Devices Research; AH48, Electromagnetic Propagation and Antenna Research; AH49, Missile and High Energy Laser Research; AH60, Research in Large Caliber Armaments; AH61, Research in Small Caliber Armaments; AH63, Research in Electronic Warfare; A31B, Night Vision and Electrooptics Research; and B53A, Research in Atmospheric Sciences. A direct exchange of common interests is accomplished among the Services and other government agencies on a continuing basis to avoid unnecessary duplication of effort.

C. (U) 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 five grantees and contractors are: University of Rochester, Rochester, NY; University of Arizona, Tucson, AZ; Massachusetts Institute of Technology, Cambridge, MA; Cornell University, Ithaca, NY; and Hughes Research Laboratories, Malibu, CA. There are in addition 55 grantees and contractors. The value of these additional grants and contracts is $3,810,298.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: A sustained period of support of Dr. Leo Esaki, winner of the Nobel prize

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for physics in 1973, has resulted in a variety of novel electronic semiconductor devices, such as ultra high speed transistors. The devices are based on the concept of the "superlattice," which is a manmade construction of atomic layers of semiconducting material. This construction has dramatically different electronic characteristics than conventional electronic integrated circuit materials on which present-day microprocessors, electronic controls, displays, etc., are based. The superlattice construction has been used to demonstrate how advanced electronic oscillators, control devices, and detectors with emphasis on high frequency performance, may be constructed. A variety of physics phenomena have been developed which will impact image transducers. The most familiar example of an image transducer is the cathode ray tube of a television, which performs the function of converting an electronic image to one that the human can respond to. However, this same type of device frequently is applied to analysis of electromagnetic signals, for example those received by radar, in interpreting target characteristics. Advances have been made in areas of liquid crystal, Pockels and electroluminescent phenomena as they relate to transducers for display and signal processing. A broad problem exists in the protection of electronic systems, for example radar receivers, from electromagnetic pulses due to lightning or nuclear weapons bursts. In coordination with the Army Electronics Command, a protective device has been developed which is based on a dramatic change of electrical resistance in certain metal oxide materials (this is a familiar effect to solid state physicists, known as the Mott transition). Films of these materials have been produced which have a high degree of reproducibility as well as good electrical switching properties. These results are important milestones in the development of a model for the switching mechanism and an understanding of how to manufacture many devices with high yield. The Army's interest in developing near-millimeter wave systems for radar and guidance systems that will operate in the fog or smoke screens was given a boost by continued development of a submillimeter radiometer using a Schottky diode and quasi-optical components. The sensitivity of this radiometer has been increased by a factor of a thousand over previous results. Related to this detector development, advances have been made in the development of near-millimeter radiation sources or transmitters. Very high peak powers have been generated by a Cerenkov radiation device and also by an optically pumped far infrared laser. A very novel concept for the excitation of laser transitions has been demonstrated under joint financial backing by the Air Force Office of Scientific Research and the Army Research Office. The technique, known as atomic pair absorption, refers to a process in which two colliding atoms are simultaneously "pumped." This widely broadens the options available in laser design. This type of laser is distinguishable from the normal laser which involves the excitation of a single rather than multiple atomic species. Laser annealing is an important step in the repair of damage caused in the fabrication of semiconductor devices such as bipolar transistors. Advances in the basic understanding of the mechanisms for the laser annealing process have been carried out. In a related effort basic understanding of the physics of failure mechanisms of metal oxide semiconductor field effect transistors, widely used in military electronics, has been developed. A rather thorough study has been made of photoionization of positive ions; that is, the process in which electrons are removed by light from these basic ionic species. Computer

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codes were developed for all of the positive ions of the periodic table and have been used as a component of in-house laboratory computer simulations of the effect of nuclear weapons on radar and communications. Surface roughness of microscopic dimension is an important factor in such diverse areas as semiconductor electronics and the adhesion of atoms to surfaces as a precursor to chemical reactions. Several fundamental calculations have been made on the effect of surface roughness on the forces between atoms involved in these situations. Similarly, models have been developed for the forces that exist between an impurity atom and the host atom of an alloy. Information of this type is required to develop a fundamental understanding of the limits of performance of materials and critical steps in their fabrication.

2. (U) FY 1981 Program: The current program is focused on the following subdisciplinary areas of physics: Atomic and Molecular Physics: The detailed study of the structure of atoms and molecules, how they behave in collision with one another, exchanging energy and sometimes charge, is at the root of everyday technological experience (for example lasers) as well as some extraordinary applications such particle beam and high-energy laser weapons. The current program emphasizes topics relevent to the generation of near-millimeter laser sources for the obscured visibility problem, the search for alternate infrared sources and detectors useful in night vision and remote sensing applications, processes that are relevant to the propagation of signals through the natural and disturbed atmosphere, the development of nonlinear optical techniques to enable laser tunability, and features of the excited state of atomic and molecular species involved in explosive reactions. Classical Phenomenology: This term relates to the areas of physics that have traditionally been of interest to physicists; namely, electricity and magnetism, optics, acoustics, heat flow, and mechanics. The present program emphasis is on laser-related optics, laser processes, nonlinear optics, optical materials, and integrated optics. Although the laser has made a significant impact on military systems and operations, it is still a relatively immature technology. This program addresses the physics of laser oscillators to access any desired wavelength quickly, in a practical device configuration. Prior support of this program in an area known as nonlinear optical processes has stimulated several new concepts which are being developed further. The techniques of phase conjugation, spectral upconversion and optical bistability, for example, will provide new options for high-power laser beam correction and propagation, electronic warfare, infrared imagery, explosive diagnostics, and fiber image transmission. Condensed Matter: The emphasis in this program is to determine the fundamental forces that govern the structure of materials and the details of the electronic properties of materials. The former topic is fundamental to Army interest in the processing of and limits of performance of structural materials under severe shock, for example. The latter topic, the physics of electronic materials, is the basis of the electronics revolution. Advanced electronics in the future will be limited by the behavior of charge carriers confined to very small volumes. Consequently a part of this program is driven by a need to understand the physics of very small electronic devices. The program also includes the topic of unstable lattices which relates to solids with large optical effects as well as materials

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Project: #BH57 Title: Research in Scientific Problems with Military Applications
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that are explosive. Other topics being investigated in this area include the physics of deep electron traps which may dominate sensitivity of electronic materials to radiation, the physics of materials crucial to infrared (night vision) detection, and the development of switches to protect electronic components from electromagnetic pulses. Cross-Disciplinary Physics: The close relationship between physics and the other disciplines and with technology is reflected in this part of the program. This research is concerned with problems in these interface areas such as materials sciences, electromagnetic technology, and various electrical and magnetic devices.

3. (U) FY 1982 Planned Program: The FY 1982 program will include continuing efforts initiated with funding from the two prior fiscal years. Emphasis will be placed on the following topics: Near Millimeter Waves: Research will be pursued in near millimeter wave source concepts, near millimeter receivers, and the optical properties of materials. This research is fundamental to the capability to acquire targets and guide weapons under obscured visibility conditions. Optical Processing: The development of optical processing using coherent and noncoherent optics may have a significant effect on signal-processing applications which involve extremes of high data rate throughput; for example, imagery. Work to be pursued in this area is also relevant to radar signal-processing, target acquisition, and terminal guidance. Electrical Switching: Fundamental research will be carried out relating to the problem of interrupting extremes of current. If successful, the work would have an enormous impact on particle beam and high-energy laser weaponry, nuclear weapons simulation, and electromagnetic propulsion. Laser and Optics: Research is planned to bring laser technology to "off-the-shelf" maturity, through improved wavelength accessibility, efficiency, and configuration. Research in this area is also expected to yield new concepts for imagery, fiber optic transmission, electronic warfare, and remote sensing. Special Atoms and Molecules: Research will be directed to the study of unconventional atoms and molecules such as spin-aligned hydrogen, Rydberg atoms, piezoelectric polymer molecules, and selected state collision processes. Recent results in these topics suggest new approaches to some old problems including explosive initiation, photon counting detectors, fuze design, thermal vision, the prediction of electromagnetic propagation, and various gaseous electronic control devices. Surfaces, Interfaces, and Thin Films: Research is planned on the nature of surface and interfaces, which is basic to electronic components and various materials problems including gun barrel erosion and wear, and critical materials fabrication. Dielectric Properties of Materials: Investigation of the physics of dielectric materials including ferroelectrics and electro-optics is planned to enhance the capability of detection devices such as the pyroelectric vidicon and solid state imagers. Unconventional Imagery: The development of systems using laser illuminators and near-millimeter wave transmitters will require techniques to handle imagery which is of low resolution (near millimeter) or produces special effects by virtue of its coherence; for example, laser speckle. Research will be initiated to suggest means of handling image information under these circumstances. Transducer and Display: Display devices are based on various phenomena including electrochromism, the Pockels effect, plasma

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radiation, and the liquid crystal. This program will exploit these and other phenomena for display and signal-processing applications. The relationship between displays and other types of transducers such as the incoherent to coherent converter for signal processing is very close. Infrared Materials: Research on the physics of materials used in infrared imaging detectors will be continued in order to derive an understanding of the long-term reliability of night vision detector materials, and to explore the potential of applying these materials in unusual geometries. Defects In Crystals: Since defects in the crystalline state have a significant influence on many materials used by the Army, research will be continued in this area. For example, defects are expected to limit the speed of advanced electronic circuits, affect the behavior of energetic materials, and the strength and failure of structural materials. Physics of Energetic Materials: Research will be aimed at understanding the physics associated with explosives and propellants, modeling of flame phenomena, and to develop methods of characterizing explosives in a fundamental manner. Research in this area may influence the manufacture of energetic materials and lead to improvements of properties such as reliability.

4. (U) FY 1983 Planned Program: The FY 1983 program will be based on a continuation of the work described in the foregoing sections. We expect that major changes will be particularly visible in the areas relating to near millimeter wave research, electrical switching, optical processing, and ultra sub-micron electronic physics.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	5026	7377	9140	9575	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	5825	7430	9240	-	Continuing	Not Applicable

The funding differences between the FY 1981 submission and current requirements reflect minor changes in emphasis. The FY80

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Project: #BH57
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decrease represents reprograming to other technology base efforts. The FY81 decrease is attributed to the application of Congressional reductions. The FY82 decrease is mainly due to a propagation of prior year cuts in the overall program in accordance with the tech base ramp.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Technical/Scientific Area: #08 Title: Chemistry
Project: #BH57 Title: Research in Scientific Problems with Military Applications
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: In recent discussions centered upon revitalizing interest in defense against chemical agents, the 1980's were referred to as the "decade of the Chemical Army." Notwithstanding such aphorisms, fundamental chemical investigations have provided and will continue to provide a broad technology base for meeting Army requirements. By probing the intricacies of molecular structure and interactions, we can fulfill mission goals of providing advanced detection and identification methods for chemical agents and pollutants, techniques for chemical decontamination and pollution abatement, novel materials tailored to Army needs (e.g., explosives, propellants, camouflage materials), and mechanistic insight which leads to a multitude of improvements in vital Army technologies including combustion of fuels and propellants and electrochemical energy conversion. The Science and Technology Objectives Guide FY 1981 defines both short- and long-term problems confronting the Army. These objectives are reflected in the fundamental and applied research plans developed by the Army laboratories and strategy developed for our program. A close working relationship with laboratory staffs is maintained through working group meetings on topical problems which promotes interface with the scientific community from both the Government and private sector. The interface established promotes the development of new scientific areas at the laboratories and ensures return transfer of technology to the private sector.

B. (U) RELATED ACTIVITIES: The chemistry program is closely coordinated with and is responsive to the research objectives of the pertinent Army laboratories. This is demonstrated through the close relationship of the program to ten other 6.11.02A projects. Close coordination and information exchange is maintained with other DOD agencies as well as with the Environemental Protection Agency, the National Aeronautics and Space Administration, the National Scieince Foundation, the Department of Energy, and the Petroleum Research Fund.

C. (U) WORK PERFORMED BY: This program is managed by the US Army Research Office, Research Triangle Park, NC. The top five contractors are: Stanford Research Institute, Menlo Park, CA; Stanford University, Stanford CA; California Institute of Technology, Pasadena, CA; Virginia Polytechnic Institute and State University, Blacksburg, VA; and Cornell University, Ithaca, NY. The total number of additional contractors is 80. The total dollar value of these additional contracts is $5,380,000.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Steady progress in understanding the relationships between molecular

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Project: #BH57 Title: Research in Scientific Problems with Military Applications
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

structure of polymers and their useful properties has been marked by the establishment of molecular features in polyurethane rubbers which control their elasticity. This discovery may permit tailormade synthesis of rubbers which have a wide variety of uses ranging from conformable foams and coatings, to durable structural materials with applications ranging from cargo containers to tank track pads. A new synthesis of decaborane has been developed which may save many millions of dollars in the production of burning rate modifiers for rocket propellants. The simple synthetic method would utilize over 100 tons of government-owned pentaborane. A coating has been developed for pressure-sensitive quartz crystals which will permit them to serve as highly sensitive and selective detectors for organophosphorus compounds. The devices resulting from these crystals are both inexpensive and portable and promise to detect chemical agents down to concentrations of about 1 part per billion.

2. (U) FY 1981 Program: The strategy to significantly increase the funding level of multidisciplinary contracts is expected to continue in order to focus a wide range of talents upon critical Army problem areas. Efforts focusing upon elastomers, combusion of propellants and explosives, and synthesis of new energetic materials are being continued. A substantive effort is being initiated in the area of chemical/biological warfare defense. Increased efforts in detection and identification of agents, protective materials and protection, and decontamination technology are being pursued which include studies of ultrasensitive proximate and remote sensing devices, self-regenerating polymeric films, and permeability studies in membranes and fibers. Attention to the synthesis and chemistry of high-energy compounds (propellants and explosives) is continuing and a promising new class of explosives is being explored both theoretically and experimentally. A significant emphasis in combustion of propellants is continuing which takes advantage of emerging scientific areas such as nonlinear optical techniques and laser diagnostics. Studies of boron-based burning rate modifiers are being expanded only to include low-flame-temperature propellants. A well-balanced program of polymer studies aimed at structure/property relationships is continuing with expansion anticipated mostly in the area of elastomers and high modulus fibers with uses such as tank track pads, personnel body armor and other high stress environments. The program in synthetic chemistry responsive to new materials with specialized properties is being continued.

3. (U) FY 1982 Planned Program: Most of the program described above will be continued due to the fundamental character of the work and its long-range nature. An increased effort will be developed in the area of catalysis to support novel surface chemistry programs which permit not only control of the course of chemical reactions, but also achievement of the end result with less expenditure of energy. Research will be directed to an increased understanding of the stability and sensitivity of high-density, high-energy materials and new synthetic approaches to their fabrication. Additional funds in an amount of five million dollars in FY82 have been requested to allow significant growth of research programs in chemical defense. These programs are to be an integral part of the Army's expanded program in chemical and biological defense and

Technical/Scientific Area: #08 Title: Chemistry
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chemical warfare. The growth will be based in part on the expansion and acceleration of efforts initiated in FY80 and 81, but more prominently on new opportunities to explore new concepts in chemical detection and identification, active and passive protective materials and systems, and formulations to cleanse surfaces and the environment and destroy hazardous traces of agent. The community of scientists and engineers engaged in chemical defense problems will be significantly broadened as a result of the November 1980 Working Conference on "Defense Against Chemical Agents: Research Needs and Opportunities," and should be further increased by funding the new ideas elicited by the Army in academic and industrial institutions. A much larger population of prospective contractors with heightened awareness of the chemical defense area has resulted, and new areas of needed work have been identified. Close coordination will be maintained with the Air Force and Navy, with the Army Medical Research and Development Command, and especially with Chemical Systems Laboratory and Natick as the DARCOM laboratories having specific mission responsibilities in the area. Proposals offering insight and understanding in the relevant areas of the biological sciences, material sciences, engineering, and physics will continue to be actively sought and cooperation/coordination with managers of those programs at ARO required.

4. (U) FY 1983 Planned Program: Continued analysis of Army research and development programs will be continued to maintain cognizance of problem areas as they develop and reorient programs to be responsive to new Army requirements in chemistry. In addition to the more readily perceived short-term problems, a strong fundamental component of the chemistry program will be pursued to assure constant restoration of the technology base and guarantee long-range response to future Army requirements. The large increase in FY82 contracts for chemical/biological warfare defense research will require a longer term commitment to contractors and potential contractors for FY83 and beyond fundings.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

7. (U) Resources ($ in thousands):

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	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	4880	7051	11849	9246	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	4810	6040	7480	0	Continuing	Not Applicable

FY80 and 81 increases reflect new emphasis on support for chemical and biological warfare defense research. A $5.0 million increase in FY82 will support work addressing additional needs identified by top-level scientists and engineers in DOD to expand and accelerate FY82 critical tasks essential to the development of an adequate defense against the biological and chemical warfare Threats. The Army's "Chemical and Chemical/Biological Warfare Defense Technology Base Enhancement Program" calls for exploiting new concepts in chemical warfare agent detection and warning, individual and collective protection, decontamination, and casualty prevention. This critical and urgent need to strengthen our CW/BWD posture has been pointed out by a large number of threat studies. Other work units within this program in chemical synthesis and food research were reduced in response to OSD direction for improved efficiency.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #AH60 Title: Research in Large Caliber Armaments
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: Research in Large Caliber Armaments supports the Army's armament development programs in scientific areas of unique Army need in order to establish a basis for the development of sound future weapons and munitions. It consists of research in the following scientific areas: energetic materials (explosives, propellants, and pyrotechnics) and physics of armament (ultra-high pressure physics, physics of failure and reliability, systems structural analysis, and munitions). In energetic materials, the thrust is toward development of new materials; understanding their behavior in ignition, initiation, combustion, and detonation; and their effects and degradation to permit safer, more efficient and effective development, manufacture, use, and disposal of munitions. With regard to new energetic materials, emphasis is on the development of explosives and propellants of reduced vulnerability, of explosives for use in munitions of increased capability to penetrate armor, and of pyrotechnics as decoys to defeat heat-seeking missiles. In the physics of armament, the thrusts are new and advanced armament materials, enhanced erosion life and accuracy of gun barrels, increased structural reliability of armament components leading to new armament systems and capabilities. The remainder of the effort is devoted to developing an understanding of unique problems in armaments to permit the design of longer life, safer, and more efficient gun tubes, recoil mechanisms, and mounts.

B. (U) RELATED ACTIVITIES: Related research is performed by the Navy, Air Force, National Aeronautics and Space Administration, and the Department of Energy. 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 the Office of the Secretary of Defense level, coordination is achieved through active participation in Joint Technical Coordinating Groups and program reviews sponsored annually by the Office of the Under Secretary of Defense for 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 by data exchange agreements on various aspects of the program. This project is closely coordinated with the program element 6.11.02.A, project AH43, Research in Ballistics; 6.11.02.A, project AH61, Research in Fire Control and Small Caliber Armament; and program element 6.26.03.A, Large Caliber and Nuclear Armaments Technology. The objectives of this project are also supported by contracts and grants placed by the Army Research Office under project BH57, Research in Scientific Problems with Military Applications, in program element 6.11.02.A.

C. (U) WORK PERFORMED BY: This project is managed and directed by the Large Caliber Weapon Systems Laboratory at Dover, NJ. The in-house scientific efforts are performed at the Large Caliber Weapon Systems Laboratory and the Benet Weapons Laboratory at Watervliet, NY. Augmentation of the in-house effort is accomplished through contracts and grants with

Project: #AH60 Title: Research in Large Caliber Armaments
Program Element: #6.11.02.A Title: Defense Research Sciences
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industry, universities, and other government agencies. The six largest contractors that will receive support under this project are: Geo-Centers, Inc., Newton Falls, MA; Princeton University, Princeton, NJ; Lehigh University, Bethlehem, PA; New York State University, Albany, NY; Iowa University, Ames, IA; and General Electric Corporation, Burlington, VT. An additional 11 contractors will receive funds totaling approximately $275,000 under this project.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Fundamental research aimed at reducing the vulnerability of explosives and propellants has provided the following information. The removal of a nitro (NO2) group from the aromatic ring was found to be the important rate-controlling reaction in the thermal ignition of triaminotrinitrobenzene (TATB). Cyclotrimethylenetrinitramine (RDX) can be significantly desensitized, with only a 6% decrease in explosive yield, by replacing one nitro group by a nitroso (NO) group. Preliminary tests on a newly designed activator, which simulates breech pressures and rise times, indicate that Composition B is more susceptible to ignition when voids are present than is trinitrotoluene (TNT). Eleven additives to ammonium nitrate (AN) were investigated as crystalline phase stabilizers to eliminate volume changes in HE casts containing AN. Tiger code calculations and ignition delay measurements were conducted on a variety of mixtures of AN and candidate substances to study the factors that can result in ideal detonation. Study of the stabilization of nitrocellulose by dilute ammonium hydroxide was completed. Flame spreading rates in black powder appear to depend on grain surface porosity. Holography shows molten surface reaction zones from which molten burning particles emanate and that these particles provide an efficient heat transfer mechanism. Propellents subjected to laser radiation have been studied by photoelectron spectroscopy, and it was found that degradation is similar to that induced by slow thermal decomposition. In the area of enhanced explosive output, calculations of detonation rates indicate that polynitrocubanes may be superior to HMX in explosive energy by as much as 50% and accordingly two different synthesis procedures were initiated for the preparation of nitrocubanes. To further the development of decoys used to defeat heat-seeking missiles, procedures and instrumentation were developed for measuring the emission of pyrophoric materials in the 8-14 region. In order to produce more uniform explosive casts and therefore reduce the premature probability, three additives were found to improve the dispersion of wax in TNT. In the area of advanced armament materials, a new form of cadmium sulfide (CdS) has been synthesized by high pressure which exhibits equal or greater than 30% exclusion of field at 77°K, which is a phenomenon limited to superconducting materials. Sound velocity, as a function of pressure, has been measured in depleted uranium penetrator material. In the area of wear and erosion reduction, a new form of ductile chrome has been developed which, compared to conventional chrome, exhibits a fivefold increase in erosion life in 20mm tests. Through electrodeposition, amorphous tungsten alloys of cobalt, iron, and nickel have been synthesized which exhibit transition temperatures as high as 1100 degrees centigrade. In efforts to increase the structural reliability of armament components, it was found that a titanium-aluminum laminate mate-

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DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

rial exhibits a 22% increase in penetration resistance as compared to the same areal density of rolled homogeneous steel armor. A new technique to enhance the adhesion of chrome on super-alloys has been developed to increase the strength of these components. In an effort to understand certain unique armament problems, a model has been developed which will be used to investigate the source of discrepancy between the predicted and the measured dynamic weapon response.

2. (U) FY 1981 Program: Continue the use of molecular spectroscopies to identify rate controlling reactions in thermal ignition of explosives. Measure shock temperature in explosive solids. Use "pop gun" activator, which simulates pressure and rise times in the gun breech, to measure the response of Comp B as a function of interior spherical cavity diameter. Investigate the role of fracture in initiation and study frictionally induced temperature rises in RDX against various surfaces. Investigate in greater detail nickel oxide, Mississippi Chemical ternary mixture, and cellulose as crystalline phase stabilizers for ammonium nitrate (AN) and compare with potassium nitrate. Prepare experimental billets of amatols (50/50 TNT/AN) with the various phase-stabilized ANs and compare these for dimensional stability and hydroscopicity. Continue research on modification of AN for ideal detonation. Continue synthesis of new materials with improved ignition, burning rate, and flame temperature properties. Study the relationship between the temperature sensitivity of propellants and their mechanical and physical properties. Explore the laser ignition of igniters and propellants; study the relationship between propellant surface ignitability and temperature sensitivity. Investigate and verify the postulated mechanism for chemical suppression of flash and develop a laboratory method for ranking flash suppressants. Perform depth profile studies on steel and gun barrel liner materials exposed to propellant combustion products using photoelectron spectroscopy techniques. Initiate the synthesis of nitrocubanes. Determine various additives to control surface temperature and durations of pyrophoric compositions for visible and IR flares. Develop molecules capable of acting as emulsifiers to disperse waxes in Comp B melts. Quantitative definition of role of chlorine on exclusion of field behavior in CdS will be established together with the study of similar behavior in other excitonic solids. The equation of state of deplated uranium as a function of pressure will be developed. The potential of ion sputtering deposition of tantalum and alloys will be pursued, and the properties of amorphous tungsten alloys as a function of deposition parameters will be examined. Modeling of projectile behavior and its relationship to weapon dynamic response are being explored, and efforts initiated into the study and characterization of tungsten filament-reinforced depleted uranium, a potential new penetrator material. Random choice methods for modeling of the wave behavior in muzzle blast are being investigated. The study of residual fatigue strength as a function of ballistic damage in laminate materials is being completed.

3. (U) FY 1982 Planned Program: In Energetic Materials Research, continue experimental and theoretical investigations on the effects of simulated gun launch conditions on the behavior of military explosives, and measure effects of shock, friction and high g rates on sensitivity. Complete all fundamental studies relating to understanding the factors entailed in

Project: #AH60 Title: Research in Large Caliber Armaments
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

modifying the phase transition properties of ammonium nitrate (AN). Continue synthesis of new propellant ingredients and initiate studies on the viscoelastic behavior of gun propellant to determine the rheological, time-temperature response under various loading conditions. Study interphase between igniter combustion and propellant ignition. Initiate study on the decomposition of propellants by flash radiolysis and analyze the primary chemical species. Continue studying laser ignition of propellants. Examine the flash-suppressing efficiency of inorganic materials other than potassium salts. The extent of penetration of gases in the chrome plating of gun barrels will be measured to determine their role in plating failure. Continue work on the synthesis of polynitrocubanes as improved performance explosives. Complete the evaluation of pyrophorics for both decoy and marker applications. Continue investigations on the use of zirconium in delay and igniter compositions. Complete the assessment of optimum wax-dispersing agents and their effect on behavior and properties of TNT and Comp B castings. In physics of armaments, studies will concentrate upon the definition of the mechanisms of pressure induced exclusion of fields in CdS and other excitonic materials to formulate the basis for practical exploitation. Efforts will be initiated in equation of state measurements in tungsten penetrator materials and pressure synthesis of energetic materials. Means of enhancing the properties of electrodeposited chrome will continue with emphasis upon both current modulation and introduction of electro-chemically active species. The potential of ion deposition of tantalum alloys will be established. Development of molybdenum base alloys for homogeneous erosion-resistant refractory liners will be pursued. Amorphous state efforts will be extended to other tungsten alloys, property optimization, and study of electronic structure versus properties. Fundamental approaches to establish recoil orifice parametric definition, muzzle blast reduction and development of elastic-viscoplastic methods for application to armament materials and structures will continue. Efforts will be initiated into the study of delayed fracture mechanisms in penetrator materials and approaches to optimization of force transfer between sabot and penetrator in kinetic energy rounds. This project supports 90 personnel (67 professional and 23 support personnel).

4. (U) FY 1983 Planned Program: Develop small-scale laboratory techniques to measure sensitivity of explosives. Initiate synthesis of new compounds for potential application as igniters, propellants, and combustible-case ingredients. Continue work on laser ignition of propellants and on flame-spreading to include fixed igniter configurations. Conduct transient burning rate experiments. Initiate work on organic flame suppressants for propellants. Spectroscopic techniques, previously developed to study gun barrel erosion, will be applied to high-pressure guns. Complete synthesis of polynitrocubanes and other nitrated macrocycles. Initiate studies on repetitive laser-schlieren system for shaped-charge jet experiments. Initiate study on the reaction of nitric oxide and ozone to produce chemiluminescence in the near-IR region. Complete study on the effect of impurities on Comp B as related to shell loading parameters. Pressure synthesis and characterization of unique magnetic/superconducting materials and high-energy/density explosives will continue. Enhancement of gun tube life by wear and erosion reduction will be pursued through new refractory coating and homogeneous material development.

Project: #AH60 Title: Research in Large Caliber Armaments
Program Element: #6.11.02.A Title: Defense Research Sciences
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Mechanisms of metal transfer will address the copper-refractory couple and the problem of muzzle wear. Amorphous material research will concentrate upon optimization of strength in relation to recovery temperature and electronic structure. The quantification of the models of dynamic response will be pursued towards design methodology to enhance firing accuracy. New approaches toward recoil energy absorbtion and muzzle blast control with minimum compromise in performance will be initiated. Fracture mechanics under dynamic conditions will address penetration performance versus properties through definition of the mechanisms of delayed fracture and shelf life predictions of heavy metal penetrators. Composite technology will continue to be pursued for enhancement of penetrator performance and reduction in force transfer during launch.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not Applicable.

7. (U) Resources ($ in Thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	5365	5319	6274	7200	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	5515	6500	7620	-	Continuing	Not Applicable

The decrease in FY80 is due to a Congressional directive to reduce service support contracts ($55K) and reprograming of funds to higher priority Army programs. The decrease in FY81 is attributable to the application of Congressional reductions. The decrease in funding in FY82 reflects the reprograming of funds to higher priority Army programs.

The resources requested for this project will support the Army's research efforts to improve large caliber armaments by improving both the propellants and explosives for the munitions and the materials for improved weapons performance.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #BS10 Title: Research on Military Diseases, Injury and Health Hazards
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: This science base addresses research to identify and assess means of preventing and treating those diseases which affect combat effectiveness of the soldier, define potential military health hazards of new communications and weapons systems, establish human tolerances to these hazards, and understand the mechanisms that will allow for the development of treatment modalities to reduce disability and death. Basic maxillofacial science research is conducted to identify, control and treat the oral health of military personnel that may adversely impact on military operations. This program will also firmly establish the science base required to develop safe and efficacious systems of CW agent antidotes by studying the mechanism of action of CW agents, antidotes, prophylactics, therapeutics, and defining the pharmacokinetics of CW agents and their alteration in pharmacologic intervention. These technologies are essential elements of the medical RDT&E program because they provide the science base from which all new products, techniques and methodologies are derived.

B. (U) RELATED ACTIVITIES: Research is performed in support of Army program elements 6.27.70.A, Military Disease Hazards Research; 6.27.34.A, Medical Defense Against Chemical Agents; 6.27.72.A, Combat Casualty Care Technology; 6.27.77.A, Systems Health Hazard Prevention Technology; 6.27.75.A, Combat Maxillofacial Injury; 6.37.50.A, Drug and Vaccine Development; 6.37.32.A, Combat Medical Materiel; and 6.47.17.A, General Combat Support, Project D832, Combat Medical Materiel. Duplication of effort across the services is avoided by coordination and collaboration with the Air Force, Navy and Uniformed Services University of the Health Sciences. Coordination with other intergovernmental agencies including the National Institutes of Health, and Department of Health and Human Services insure information exchange at the working and administrative levels to avoid duplication of effort.

C. (U) WORK PERFORMED BY: Work is conducted by in-house laboratories of the US Army Medical Research and Development Command at the Walter Reed Army Institute of Research, Washington, DC; US Army Medical Research Institute of Infectious Diseases, Fort Detrick, Frederick, MD; US Army Research Institute of Environmental Medicine, Natick, MA; US Army Aeromedical Research Laboratory, Fort Rucker, AL; US Army Institute of Surgical Research, Fort Sam Houston, TX; Letterman Army Institute of Research, Presidio of San Francisco, CA; US Army Institute of Dental Research, Washington, DC; US Army Biomedical Laboratory, Aberdeen Proving Ground, MD; US Army Bioengineering Research and Development Laboratory, Fort Detrick, Frederick, MD; and overseas special foreign activities of the Walter Reed Army Institute of Research located in Thailand, Malaysia, Germany, Brazil and Africa. Approximately 23% of the research is conducted under contracts with universities, non-profit organizations and industry. The five top contractors are Iowa State University, Ames, IA; JAYCOR, Inc., Del Mar, CA; University of California, San Francisco, CA; Medical College of Ohio, Toledo, OH; and The Regents of the University of California, Berkeley, CA. There are 63 other contractors funded in the amount of approximately $3,181,000.

Project: #BS10 Title: Research on Military Diseases, Injury and Health Hazards
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: In the area of infectious disease research, a candidate live oral vaccine against dysentery was developed by a new technique combining typhoid fever and Shigella organisms. Specific cellular receptors were demonstrated to exist for bacterial exotoxins that cause intestinal and generalized shock, thereby establishing the feasibility of antitoxin protection. A non-human primate model for African sleeping sickness was developed for potential vaccine studies. A culture method for animal intestine was developed to study the pathogenesis of diarrheal diseases. In the area of combat casualty care research, naloxone, a drug presently used to reverse the action of narcotics, has been found to be promising in reversing hemorrhagic shock from injury or infection. White blood cell function in response to burn injury has been developed. In the area of weapon systems health hazards, high frequency hearing losses attributed to low frequency noise sources were demonstrated. User and developer agencies were provided with biomedical effects data on primates exposed to low-level laser radiation. Blast overpressure from artillery was demonstrated to cause pinpoint hemorrhages in the larynx (upper airway) before onset of lung injury; this may be a much sought after indicator of threshold above which injury to lung will occur. In the area of facial injury, new methodology was developed for application to bone extension using ceramics and base metal alloy for use in fabrication of maxillofacial prostheses. In chemical defense, the toxic material present in atropine injectors stored more than two years was identified. A mathematical model was developed to predict the percent survival afforded by an antidote used after exposure in varying amounts of nerve agents.

2. (U) FY 1981 Program: Research will be expanded on medical defense against biological toxins of BW importance to enable their isolation, purification, biophysical-chemical characterization, and investigation into the mechanisms of action on host cells. The science base in support of medical defense against biological agents of BW importance will be expanded to include new techniques for growing organisms in quantity; their physical and chemical characterization; identification in animals of immunological response to them; their mechanism of transmission and the action of anti-microbial compounds on them. The immunogenicity of recombined Salmonella/Shigella organisms will be examined. Component proteins of scrub typhus rickettsiae will be assayed in mice for protective ability as potential vaccines. In combat casualty care research, research will be conducted to identify means by which the body prevents wound infection. Efforts to define the cause of intestinal hyperactivity which causes intestinal perforation in severely burned soldiers will be continued. A biomedical data base will be developed to choose the best anesthetic for patient survival. The role of hormones and hormone-like substances in mediating shock will be investigated, and methods and pharmacologic substances developed to modify or ameliorate shock. Methods to enhance cellular oxygen transport to kidney and brain will be investigated so that these two vital organs can be protected during shock. In weapon systems health hazard research,

Project: #BS10 Title: Research on Military Diseases, Injury and Health Hazards
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

studies of factors which predispose individuals to heat injury will be completed. Animal modeling of the stages of freezing cold injury will be continued. Studies of stress-induced inappropriate aggressive behavior will be initiated to understand means by which stress and fatigue produce troop unit breakdown. Investigations of health hazards of millimeter wave weapons will be initiated. Investigations of health hazards of low-level laser exposure to eye, skin and other body organs will be continued. Acute effects of artillery blast overpressure will be determined in a small animal model. Efforts in facial injury will concentrate on bone resorption following trauma; investigation of the potential of various compact materials for developing maxillofacial prostheses, and determination of the potential of microencapsulated antibiotic as long term slow release agents for control of post-traumatization infections. Studies will be initiated to evaluate the efficacy of a facial protective device to minimize effects of high velocity missile wounds. In chemical defense, the sites and mechanisms of action, distribution, and transport of CW agents and antidotes will be determined. The metabolites and degradation products of nerve agents and antidotes will be identified and quantitated, and the mechanisms by which sublethal nerve agent exposures induce sleep and arousal deficits will be assessed.

3. (U) FY 1982 Planned Program: Research on medical defense against biological toxins and microbial agents of BW importance will be expanded. Work will begin on a system of field adaptable tests for rapid identification and diagnosis of potential BW agents/disease. Studies to determine the active site on toxins and to determine the means by which bacterial toxins are processed by mammalian cells will be initiated. New studies will characterize fully the hepatitis A virus using a recently developed technique (monoclonal antibodies) to identify viral antigens for use as potential vaccines. The labile nature of the Group B meningococcal polysaccharide and proteins makes it difficult to reproduce the vaccine from lot to lot; studies will be initiated to overcome this difficulty. Research will produce a detailed examination of the unusual response in mice to the individual scrub typhus antigens that are potential vaccines. Potential vaccine strains consisting of genetically-altered typhoid fever bacteria showing various antigens of Shigella flexneri will be constructed. Personnel to be utilized: 165 professional and 200 support. Studies to identify the mechanisms of action of various classes of anti-shock compounds will be continued. Basic research will continue to develop new treatment methods in burn and penetration wounds and to determine the cellular basis of acute kidney failure following wounding, shock and infection. Personnel to be utilized: 83 professional and 104 support. The science base for support of health hazard assessment research will continue to concentrate on descriptions of mechanisms of heat and cold injury and new approaches to prevention and treatment. Parametric studies of small animal models of chest wall impact from blast overpressure will be initiated. The data base on health hazards of specific micro- and millimeter waves and new types of laser radiation will be broadened. Personnel to be utilized: 94 professional and 117 support. Studies to establish parameters to predict disability and death from maxillofacial wounds in the high intensity combat environment will be initiated. Studies to develop a suitable copolymer system for segmental replacement of the trachea and esophagus following traumatic injuries will be

Project: #BS10 Title: Research on Military Diseases, Injury and Health Hazards
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

continued. Personnel to be utilized: 6 professional and 10 support. Studies will be expanded on the mechanisms of nerve-agent-induced respiratory arrest. Pharmacologic studies will be expanded to address the effect of nerve agents on the acetycholine receptor and the alteration of membrane permeability by the binding of acetylcholine agonists/antagonists. Initiate investigation of the mechanisms of vesicants on the tissue levels of RNA and DNA and the levels of formed alkylated products and therapeutic measures to promote healing of vesicant induced skin lesions. Personnel to be utilized: 35 professional and 55 support. Total personnel to be utilized: 383 professional and 486 support.

4. (U) FY 1983 Planned Program: Research on medical defense against biological toxins and microbial agents of BW importance will continue. The genes which code for antigens which induce protective immunity in malaria, African trypanosomiasis, and leishmaniasis will be cloned within bacteria or other microorganisms. The actions of experimental antiparasitic liposomes as drug carriers, and their effects on parasite metabolism will be elucidated further. Research will continue on defining genes of enteric bacteria which cause dysentery. Work on new high hazard viruses with significant BW potential will be initiated. The required basic information to develop improved techniques for patient resuscitation, stabilization healing and treatment will be provided. In weapon systems health hazard research, electrophysiological studies of mechanisms of injury from low-frequency noise will be completed. Studies of brain chemical alterations consequent to chronic stress exposure will be initiated. Studies of coherent and incoherent light exposure to individual neural and photochemical processes to establish laser safety levels will be expanded. The auditory and nonauditory effects of blast overpressure will continue to be studied. Basic microwave and laser radiation investigations will be continued. Maxillofacial wound analysis will be continued. Efforts to standardize animal models for quantifying medical effects of chemical agents, prophylactics and antidotes will be continued.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

Project: #BS10
Program Element: #6.11.02.A
DOD Mission Area: #510 - Defense Research

Title: Research on Military Diseases, Injury and Health Hazards
Title: Defense Research Sciences
Budget Activity: #1 - Technology Base

7. (U) Resources ($ in Thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	21102	22273*	39922**	32600	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	21102	25320	28900	-	Continuing	Not Applicable

* The reduction in funding is due to Congressional decrements.

** Increase of $12 million due to the FY 1982 Budget Amendment to the Expansion of Chemical Warfare/Chemical and Biological Defense (CW/CBD) Basic Research. Reductions in the overall program are in response to OSD direction for improved efficiency.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Technical/Scientific Area: #A
Project: #BS10
Program Element: #6.11.02.A
DOD Mission Area: #510 - Defense Research

Title: Military Disease Hazards Research
Title: Research on Military Diseases, Injury and Health Hazards
Title: Defense Research Sciences
Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: In an effort to prevent disease casualties, this science base establishes methodology for developing means of preventing and treating those diseases which affect combat effectiveness of the soldier. Research is conducted utilizing state-of-the-art knowledge and techniques in those medical sciences essential to the elimination of infectious diseases as a military medical problem. This includes the science base necessary to develop adequate medical defense against biological warfare (BW) agents.

B. (U) RELATED ACTIVITIES: Related work is performed under Program Element 6.27.70.A, Military Disease Hazards Technology, Project A870, Risk Assessment of Military Disease Hazards, and Project A871, Prevention of Military Disease Hazards; and Program Element 6.37.50.A, Drug and Vaccine Development, Project A808, Drug and Vaccine Development. Army representation on Department of Defense coordinating committees and other inter-governmental agency coordination councils insures coordination at the working and administrative levels to prevent duplication of effort. Army scientists serve as consultants to the World Health Organization and have access to this organization's studies, reports, and publications. Other coordination is accomplished by personal contacts at the operating level, site visits by project officers, organization of technical 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.

C. (U) WORK PERFORMED BY: About 80% of the work is conducted by in-house laboratories at Walter Reed Army Institute of Research, Washington, DC; the US Army Medical Research Institute of Infectious Diseases, Fort Detrick, Frederick, MD; the US Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, Frederick, MD; and Letterman Army Institute of Research, Presidio of San Francisco, CA. Approximately 20% of the research is conducted under contracts with universities, non-profit organizations, and industries. The top five contractors are Mount Sinai School of Medicine, New York City, NY; Columbia University, New York City, NY; University of California, Berkeley, CA; Yale University, New Haven, CT; and the University of Alabama, Birmingham, AL. Thirty-one other contractors are also funded in the amount of $1,811,000.

Technical/Scientific Area: #A
Project: #BS10
Program Element: #6.11.02.A
DOD Mission Area: #510 - Defense Research

Title: Military Disease Hazards Research
Title: Research on Military Diseases, Injury and Health Hazards
Title: Defense Research Sciences
Budget Activity: #1 - Technology Base

D. (U) PROGRAM ACCOMPLISHMENTS:

1. (U) FY 1980 and Prior Accomplishments: A novel mouse assay system was developed which will enable rapid and efficient testing of enteric vaccines. A candidate live oral vaccine against typhoid fever was successfully hybridized with Shigella, the organism causing dysentery. Rickettsial species were separated by examining their constituent purified radioactive proteins. This finding will reduce the confusion on multiple antigenic types causing disease and aid in the identification of protective immunogen. Insect tissue culture cell lines were established to produce large numbers of the vector stages of trypanosomiasis so that potential vaccines could be investigated. Genes encoding various cell structures, important to the disease-producing capability of various enteric bacteria, have been identified permitting further genetic and biochemical studies. Demonstrated that specific cellular receptors exist for bacterial exotoxin. Cell receptors allow toxins to enter susceptible cells. A new synthetic medium has been devised for culturing high levels of Legionnaires' disease bacteria with no loss in virulence.

2. (U) FY 1981 Program: Research will be expanded on medical defense against biological toxins of BW importance to enable isolation, purification, biophysical-chemical characterization, and investigation into the mechanisms of action on host cells. The science base in support of medical defense against biological agents of BW importance will be expanded and will include techniques for growing organisms; physical and chemical characterization; identification of immunological components; mechanisms of transmission. The virus of hepatitis A will be grown in various cell culture systems. The immunogenicity of the hybridized Salmonella/Shigella organism will be examined. Component proteins of scrub typhus rickettsiae will be assayed in mice for protective ability as potential vaccines. Using monoclonal antibodies, the antigenic relationships of the serotype proteins from different group B meningococcal strains will be analyzed. Work will begin to characterize immunochemically the antigens of malaria which are responsible for protective immunization.

3. (U) FY 1982 Planned Program: Research on medical defense against biological toxins and microbial agents of BW importance will continue. Studies to determine the active site on toxins and to determine the means by which bacterial toxins are processed by mammalian cells will be initiated. Work will begin on a system of field adaptable tests for rapid identification and diagnosis of potential BW agents/disease. Specific identification of agents is required to assess impact on operational and medical management of anticipated casualties. Research will define cultural methodologies for producing viruses; physical and chemical characterization; immunological components; molecular and cellular action of the viruses on target organs; identification of attenuation markers; the molecular and cellular action of antiviral compounds on viruses and host cells; and mechanisms of

Technical/Scientific Area: #A
Project: #BS10
Program Element: #6.11.02.A
DOD Mission Area: #510 - Defense Research

Title: Military Disease Hazards Research
Title: Research on Military Diseases, Injury and Health Hazards
Title: Defense Research Sciences
Budget Activity: #1 - Technology Base

transmission. The Legionnaires' disease bacteria's toxin will be isolated and purified to determine the toxin's role in various forms of the disease. New studies will characterize fully the hepatitis A virus using monoclonal antibodies to identify viral antigens for use as potential vaccines. The labile nature of the Group B meningococcal polysaccharide and proteins makes it difficult to reproduce the vaccine from lot to lot; studies will be initiated to overcome this difficulty. Research will produce a detailed examination of the unusual response in mice to the individual scrub typhus antigens that are potential vaccines. Potential vaccine strains consisting of genetically-altered typhoid fever bacteria which also show various antigens of Shigella flexneri will be constructed. Personnel to be utilized: 165 professional and 200 support.

4. (U) FY 1983 Planned Program: Research on medical defense against biological toxins and microbial agents of BW importance will continue. The genes which code for the antigens which induce protective immunity in malaria, African trypanosomiasis, and leishmaniasis will be cloned within bacteria or other microorganisms. Elucidate further the actions of experimental antiparasitic drugs, liposomes as drug carriers, and the effects of parasite metabolism. Research will continue on bacterial plasmids aimed at defining genes of enteric bacteria which causes disease. Work on new high hazard viruses with significant BW potential will be initiated. Work will continue on a system of field adaptable tests for rapid identification and diagnosis of potential BW agents/disease. Research will continue to define cultural methodologies for producing viruses; physical and chemical characterization; immunological components; molecular and cellular action of the viruses on target organs; and cellular action of antiviral compounds on viruses and host cells.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

Technical/Scientific Area: #A
Project: #BS10
Program Element: #6.11.02.A
DOD Mission Area: #510 - Defense Research

Title: Military Disease Hazards Research
Title: Research on Military Diseases, Injury and Health Hazards
Title: Defense Research Sciences
Budget Activity: #1 - Technology Base

7. (U) Resources ($ in Thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	12279	10263*	14880**	TBD	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	10797	12583	14361	-	Continuing	Not Applicable

* The reduction in funding for FY 1981 is due to Congressional decrement.

** Increase of $2.3 million due to the FY 1982 Budget Amendment to the Expansion of Chemical Warfare/Chemical and Biological Defense (CW/CBD) Basic Research. Other work units in this area were reduced in response to OSD direction for improved efficiency.

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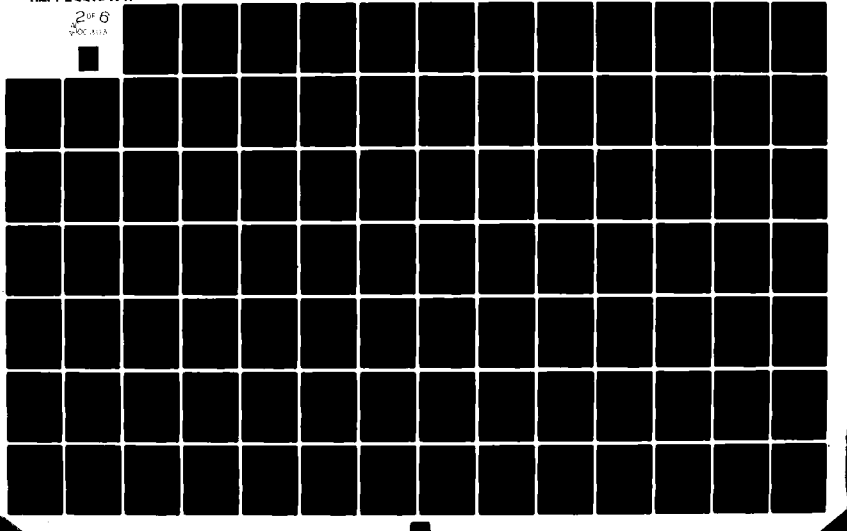

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #CO
Title: Systems Health Hazard Research
Project: #BS10
Title: Research on Military Diseases, Injury, and Health Hazards
Program Element: #6.11.02.A
Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research
Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND DESCRIPTION: The science base of this program is maintained to establish methodologies, procedures, and instrumentation technology to support research aimed at medical assessment and prevention of health hazards generated by military hardware systems, extreme environments, and combat operations. Basic research focuses on health hazards of military materiel and on medical factors which limit soldier effectiveness. The goals are to identify factors which make a situation stressful, to define and model specific chemical, physiologic, and psychologic mechanisms that translate environmental stressors into physical or behavioral manifestations, and to identify elements of the environment or in the individual, which can mitigate the effects of stress or prevent performance decrements and/or psychiatric breakdowns. Studies define physiological stresses and behavioral decrements resulting from such adverse environments as heat, cold, and high terrestrial elevation or from stressors (e.g., toxic gases, blast overpressure, vibration, impact, and noise) which accompany the operation of weapon systems. Studies are also conducted on factors which limit soldier performance (e.g., combat stress, continuous operations, rapid translocation) or enhance it (e.g., physical fitness and various forms of exercise). Medical neuroscience research also provides support to meet requirements to enhance the sustainability of individual and unit combat effectiveness to maximum biologic limits and to prevent psychiatric battle casualties by increasing the soldier's resistance to breakdown from sustained exposure to combat. Such research is critical because (1) conventional battle scenarios are expected to have three to five times the intensity of those of World War II and will expose soldiers to excessive numbers of unusual stressors, both singly and in combination, which will tax their ability to perform and survive on the battlefield, and (2) there are likely to be unprecedented numbers of psychiatric battle casualties (some estimates up to 50%). Many of these casualties are preventable and soldiers so exposed represent the largest recoverable pool of replacements on the battlefield. Research for assessment of Army-unique toxic chemical hazards (e.g., smokes and obscurants) and specialized technologies for microwave, millimeter wave, and laser research are also supported at a basic science level.

B. (U) RELATED ACTIVITIES: This research provides the science core to support exploratory development for Program Element 6.27.77.A, Systems Health Hazard Prevention Technology; DA Project 6.27.77.A/878, Health Hazards of Military Materiel and 6.27.77.A/879, Medical Factors Limiting Soldier Effectiveness; and for DA Project 6.11.02.BS04, Identification and Health Effects of Military Pollutants, and DA Project 6.27.20.A/835, Military Medical Environmental Quality. Research coordination and collaboration, exchange of research findings and technology transfer are effected in numerous ways: through the conduct of joint projects enacted through intra- and inter-military service agreements; by sponsorship of basic research contracts in both university and industrial research centers; by frequent exchange of data with scientists in research centers, universities, and nonmilitary governmental agencies both in the United States and abroad (particularly in NATO nations); and

Project: #CO — Title: Systems Health Hazard Research
Project: #BS10 — Title: Research on Military Diseases, Injury, and Health Hazards
Program Element: #6.11.02.A — Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research — Budget Activity: #1 - Technology Base

publication of significant findings in scientific journals. Such interchange of ideas, data, and scientific reports promotes systematic growth and advancement of the basic science data base required to support work in the Systems Health Hazard Research and Prevention Technology Areas and minimizes duplication of efforts.

C. (U) WORK PERFORMED BY: In-house research is conducted by the Walter Reed Army Institute of Research, Washington, DC; US Army Aeromedical Research Laboratory, Fort Rucker, AL; US Army Research Institute of Environmental Medicine, Natick, MA; Letterman Army Institute of Research, Presidio of San Francisco, CA; and US Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, MD. The five largest contractors are: Medical College of Ohio, Toledo, OH; JAYCOR, DelMar, CA; Ohio State University Research Foundation, Columbus, OH; University of Wisconsin, Madison, WI; Virginia Commonwealth University, Richmond, VA. Six additional contracts totaled $280,000 during FY 1980.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Determined that acute viral infection significantly reduces soldier's aerobic fitness, muscle strength, and endurance even though the relationship between the clinical indicators of such illness and a soldier's strength and performance is not apparent. Research on the effects of high-intensity, low-frequency noise on auditory injury and speech range hearing loss was conducted over the last three years. High-frequency hearing losses attributable to low-frequency noise sources were demonstrated and documented. The mechanisms are still under investigation. Completed literature review for the development of a short test battery for long-range prediction of chronic toxicological health effects. Initiated development of immunotoxicological assays in animals predictive of long-term health effects in man. Through toxicological evaluation of screening tests and bioassays for colored dyes in smoke munitions, identified several dyes as carcinogenic. Developed a miniature wrist-worn sensor/recorder for long-term monitoring of troop rest-activity cycles in the field. Initiated study of day/night and biological rhythmic effects on cognitive task performance to develop models of soldier effectiveness during continuous operations. Completed structural and functional description of newly discovered spinal cord pathways modulating brain control of blood pressure. Provided user and developer agencies with biomedical effects data on primates exposed to low-level laser radiation. Administered specialized visual function tests to personnel engaged in laser hardware development to determine nature and extent of retinal change attributable to laser radiation exposure. Discovered that blast overpressure injury occurs in the larynx (upper airway) before lung injury is experienced. Detected biochemical changes occurring in early lung injury by assessing lung injury in animals exposed to firing of artillery weapons. Determined dose-response curve relating the number of noise/blast exposures and peak pressure experienced with the incidence of mild laryngeal injury.

Project: #CO Title: Systems Health Hazard Research
Project: #BS10 Title: Research on Military Diseases, Injury, and Health Hazards
Program Element: #6.11.02.A Title: Defense Research Sciences
DOD Mission Area: #510 - Defense Research Budget Activity: #1 - Technology Base

2. (U) FY 1981 Program: Complete studies of factors which predispose individuals to heat injury. Continue animal modeling of the stages of freezing injury. Develop measures of anaerobic fitness capacity to characterize the physiological response to high-intensity exercise. Develop a single-cell neurophysiology laboratory to investigate cellular activity in mammalian retinas. Specify effects of vibration on dynamic visual acuity. Complete electrophysiological investigation of mechanisms of injury from low-frequency noise. Initiate bioassay study of nitrotoluene compounds for carcinogenic activity to validate sensitivity and accuracy of test as a predictor of oncogenicity in military compounds. Study brain neurotransmitter interrelations and mediator roles in the effects of stress and other state changes on the body to explore pharmacologic means of stress alleviation. Continue development of animal models for issues related to chemical defense and exposure to toxic and abused chemical agents. Begin laboratory studies of stress-induced inappropriate aggressive behavior to understand means by which stress and fatigue produce troop unit breakdown. Establish laboratory to study bioeffects of millimeter wave weapons. Continue animal investigations on nonhuman low-level laser exposure. Examine function of movement-controlling brain cells in response to exposure to stress-related chemicals and stimuli to understand how stress disrupts skilled movement. Establish laboratory for examination of roles of auditory cues on vigilance and attention to understand means by which stress and fatigue produce decrements in individual performance in continuous operations. Continue anatomic and physiologic description of brain regions mediating normal functions of internal body organs. Conduct specialized electrophysiological testing during and after repeated and chronic low-level laser exposure. Initiate studies of low-level laser flashes on visual function in nonhuman primates. Develop and refine biochemical markers of early lung injury. Develop laboratory chest-wall impact instrumentation. Assess the efficacy of protective devices for raising threshold pressures of lung or laryngeal injury. A research plan will be developed to study the hematological hazards of military systems.

3. (U) FY 1982 Planned Program: Identify biochemical and hormonal alterations permitting adaptive tolerance to heat exposure. Examine heat acclimatization due to plasma volume expansion. Develop animal model for high-altitude pulmonary edema. Evaluate phenytoin as therapeutic agent to reduce altitude-induced pulmonary hypertension. Develop means for shifting energy metabolic pathways during exercise. Collect data on the spatial/temporal tuning of single retinal ganglion cells as a function of eccentricity. Begin developing animal models of photo reception for study of chemical agent effects on visual performance. Refine electrophysiological measures for a study of injury to the auditory system. Determine interactive effects of noise and vibration on hearing. Validate neurotoxicologic testing battery in animals developed to be predictive of human behavioral/performance effects of military importance. Complete bioassay study of nitrotoluene compounds as a means to develop an accurate and sensitive test system for evaluating oncologenicity of military compounds. Explore pharmacologic blockade of stress-induced changes in regional brain neurotransmitters. Develop in vitro models of pituitary

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gland function for use in stress modeling. Initiate exploration of chemical defense animal models with particular attention to functional decrements in performance and life-sustaining body systems following exposure to antidotes. Complete construction of a millimeter wave anechoic chamber, a continuous wave transmitter system, and an elliptical reflector/antenna. Analyze laser coherency effects as compared to effects of incoherent monochromatic sources. Initiate parametric studies of small animal models of chest-wall impact from blast overpressure. Validate biochemical markers of subclinical lung injury. Determine cumulative effects of exposure to blast overpressure in small animal model.

4. FY 1983 Planned Program: The effect of plasma volume expansion on heat acclimatization will be validated in a field setting. Pharmacologic approaches will be developed to enhance oxygen transport in animals at high altitude. Investigations will be initiated to define the mechanisms operative in development of muscular fatigue. Will assess the retinal mechanisms of different types of visual contrast detection as a function of luminance level. Continue work with the effects of chemical agents on visual performance. Complete electrophysiological studies of mechanisms of injury from low-frequency noise. Explore preventive treatment drug agents for auditory injury. Develop improved quality of toxicologic assays for screening mutagenicity potential in Army relevant chemicals. Initiate studies of brain chemical alterations consequent to chronic stress exposure. Continue exploration of safe pharmacologic routes to minimize disruption of normal brain chemistry by stress. Complete construction of a high-peak-power microwave exposure system and of permittivity analysis instrumentation. Begin high-peak-power exposure studies. Expand studies of coherent and incoherent light exposure to individual neural and photochemical processes to establish laser safety levels. Expand electrophysiological testing of nonhuman subjects to monitor the neural evidence of retinal alteration after laser exposure. Conduct retinal swelling experiments for incoherent and coherent light exposures.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not Applicable.

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7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	5036	5790*	7361**	8478	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	5403	6587	7516	0	Continuing	Not Applicable

This program is being restructured in FY 1981. In order to show a continuous funding track, the FY 1981 Congressional Descriptive Summary was written as though the restructuring had already taken place. In fact, the dollar figure shown for FY 1980 is a compilation of funds from BS01, BS02, BS07, and BS08. The reduction in funding for FY 1980 from last year's submission reflects end-of-year reallocations to make more effective use of available funds.

* Reduction in funding is due to Congressional decrement.

** Reduction due to an adjustment of the technology base ramp in FY82-86.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Technical/Scientific Area: #E

Title: Medical Chemical Defense Science Base/Mechanisms of Action of CW Agents and Antidotes

Project: #BS10

Title: Research on Military Diseases, Injury and Health Hazards

Program Element: #6.11.02.A

Title: Defense Research Sciences

DOD Mission Area: #510 - Defense Research

Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: The substantial increase in funding in this scientific area culminates from a major reorientation and reorganization of the US Army's Medical Chemical Defense Research and Development Program. This reorganization and reorientation was initiated by the ad hoc review of the Chemical Warfare/Chemical Biological Defense Research and Development Program, as directed by the Deputy Chief of Staff for Research, Development, and Acquisition, and resulted in the 1 July 1979 (FY 1980) transfer of the US Army Biomedical Laboratory and the medical chemical defense mission from the US Army Materiel Development and Readiness Command to the Army Medical Department. This scientific area, BS10/E, Medical Chemical Defense Science Base/Mechanisms of Action of CW Agents and Antidotes, supports the entire development of the science base for medical chemical defense for the Army, which is the Executive Agency for this mission and as such must address joint service requirements. The overall objective of this research is the elimination of the significant science base deficiencies that currently exist and thereby provide the science base prerequisite to the ultimate development of medical life support materiel essential to enable survivability on the chemical warfare battlefield. The research focuses on the definition of mechanisms of action of threat chemical warfare agents and drugs with life saving potential with the ultimate goal of developing safe and efficacious prophylaxes, pretreatment compounds, antidotes, and therapeutic compounds, and decontaminants to prevent a loss of tactical advantage on the integrated battlefield. The specific objectives and requirements of the research effort are: definition of the mechanisms of action by which chemical warfare agents, in lethal or sublethal doses and/or repeated exposure, exert their sequence of effects and relate these effects to exposure dose and pharmacokinetics of the agents to establish a valid basis for pay off in development of new and improved prophylaxes, pretreatment compounds, antidotes, therapeutic compounds, and decontaminants; establishment of the foundation basis for the differential and rapid diagnosis of chemical warfare agents in biological specimens by utilizing state-of-the-art capabilities; definition of the mechanisms by which anti-chemical warfare agent compounds exert their effects and relate these effects to drug dose, pharmacokinetics, and chemistry of the drug to establish a basis for new approaches for soldier self-aid and the follow-on medical care required to hasten the return of casualties to duty and minimize the occurrence of residual impairment; definition of the pathophysiologic and pharmacokinetics (skin absorption, adsorption, permeability, distribution, cellular pathophysiology, biochemical process of detoxification, metabolism and elimination) of chemical warfare agents to provide biomedical criteria to establish an improved basis to medically manage chemical warfare casualties, criteria for patient decontamination which will provide patient survivability and the safety and operational effectiveness of combat service support personnel involved in evacuation, handling, and treatment of chemical agent contaminated casualties.

Technical/Scientific Area: #E

Project: #BS10
Program Element: #6.11.02.A
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Title: Medical Chemical Defense Science Base/Mechanisms of Action of CW Agents and Antidotes
Title: Research on Military Diseases, Injury and Health Hazards
Title: Defense Research Sciences
Budget Activity: #1 - Technology Base

B. (U) RELATED ACTIVITIES: This scientific area supports Program Element 6.27.34.A/Project A875, Medical Defense Against Chemical Agents. Duplication of effort within the Army is avoided by central management of the program on Medical Aspects of Chemical Defense by the US Army Medical Research and Development Command. Duplication of effort across the services is avoided by coordination and collaboration with the Air Force and Navy, as required by the Army as the Executive Agency for the DOD chemical defense effort. All work is coordinated with quadripartite and NATO nations through meetings and Data Exchange Annexes.

C. (U) WORK PERFORMED BY: Two contractors are supported by this effort: Iowa State University, Ames, IA; and Army Research Office, Research Triangle Park, NC. In-house research is funded at the US Army Biomedical Laboratory, Aberdeen Proving Ground, MD; and the Walter Reed Army Institute of Research, Washington, DC.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Nerve-agent-induced respiratory arrest was found in an animal model to be due to a loss of synchronized firing of respiratory related neurons in the brainstem. This indicates the need for treatment compounds which are active in the central nervous system. Sleep patterns, which are a sensitive measure of central nervous system activity, were found to be disrupted for at least nine months by a single, acute, sublethal exposure to nerve agent. Responsiveness to environmental events was also found to be reduced as evidenced by elevated arousal thresholds. These results also indicate central nervous system effects of nerve agent and imply the requirement for long-term treatment for individuals having single, acute, sublethal exposure to nerve agent. A mathematical model was developed to predict the protection afforded by an antidote as a function of toxic agent and species body weight. The organophosphate insecticide, DFP, which has been used as a scientific model for central effects of nerve agent poisoning, was found to be an inappropriate model for the study of mechanisms of action of certain nerve agent. The toxic materiel present in atropine injectors stored more than two years was identified.

2. (U) FY 1981 Program: Physiological and neurophysiological/neuropharmacological techniques will be used to continue assessment of the direct effects of nerve agent on respiratory arrest by examining respiratory related neural units in the brainstem of cats. Central and peripheral actions of nerve-agent-produced respiratory arrest will be differentiated. Assessment of persistent sleep and arousal deficits by a single, acute, sublethal exposure to nerve agents will be continued. Functional mapping and distribution of nerve agent will be initiated. Autoradiographic, histological, pharmacological, and neuropharmacological techniques at several levels of resolution will be used to determine potential sites of action. Radiolabelled chemical warfare

Technical/Scientific Area: #E

Project: #BS10
Program Element: #6.11.02.A
DOD Mission Area: #510 - Defense Research

Title: Medical Chemical Defense Science Base/Mechanisms of Action of CW Agents and Antidotes
Title: Research on Military Diseases, Injury, and Health Hazards
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agents and antidotes will be used to define sites and mechanisms of action, distribution, metabolism, and elimination. Initiate identification of electrophysiological correlates of exposure to nerve agents, both chronic and acute, lethal and sublethal, with and without exposure for potential use as "physiological signature" unique to each of the above conditions. Development of mathematical models integrating time into the existing model relating body weight, toxic agent, and antidote will continue. Biochemical alterations in skin produced by DFP as a model for cutaneous pharmacokinetics of nerve agents will be determined. Comparisons of the mechanisms of skin penetration in two pig skin models will be concluded. Comparisons of the histological characteristics of skin from hairless dogs with human skin will be made. The route of penetration of toxic substances in skin and the effects of skin hydration in vivo on skin permeability will be determined.

3. (U) FY 1982 Planned Program: Studies will be expanded on the mechanisms of nerve-agent-induced respiratory arrest. The differentiation of central and peripheral effects of nerve-agent-induced respiratory arrest will be initiated and accelerated. Studies of functional mapping using radiolabelling to a larger number of animal models and physiological areas of interest to include brainstem, respiratory sites, cardiac and diaphragmatic sites, and auditory projection areas will be expanded. Pharmacologic studies of the effects of nerve agents on the acetycholine receptor and the alteration of membrane permeability by the binding of acetycholine agonists/antagonists will be expanded. Pharmacologic studies of the use of anti-nerve agent antibodies as markers for determining cellular site of nerve agent action will be initiated. The use of synergists as experimental probes for mathematical model testing will be initiated. Investigation of the mechanisms of vesicants on the tissue levels of RNA and DNA and the levels of formed alkylated products and therapeutic measures to promote healing of vesicant induced skin lesions will be initiated. Expanded extramural efforts on the following areas will be initiated: mechanism of action and sequence of effects of nerve agents, antidotes, and combinations of both on function and interaction of neurotransmitters and modulators on energy supply systems in the nervous system; on central nervous system control of temperature and water and electrolyte balance, on nervous system control of respiratory and cardiovascular functioning; on cognitive and psychomotor function, and on visual and auditory functions; mechanisms for delayed and long-term neurotoxic and neuropathologic effects of nerve agents. Personnel to be utilized: 35 professional and 55 support.

4. (U) FY 1983 Planned Program: Characterization of persistent nerve agent effects on sleep and arousal will be completed and identification of mechanisms of nerve agents involved in long-term effects will be initiated. Physiological sites of action

Technical/Scientific Area: #E

Project: #BS10
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of nerve-agent-induced respiratory arrest will be finalized. Central and peripheral sites of action of cyanide on respiratory arrest will be differentiated. Functional mapping and distribution studies of nerve agents will be concluded. Physiological assessment of the significance of binding sites and their relevance to toxicity and incapacitation will be initiated. Pharmacologic investigation of allosteric interactions, the examination of the importance of peripheral versus central acetylcholinesterase, the development of mathematical models relating body weight, toxic agent, antidote, and time, and the use of synergists to validate the mathematical models will be completed. Examination of exogenous factors such as vehicle, air, temperature, wind speed, humidity, and cutaneous blood supply on the cutaneous penetration of chemical warfare agents will be initiated. Assessment of recombinant DNA technology, mechanism of action of new oximes, recent immunobiological advances to determine distribution and site of action of nerve agents will be initiated. Mechanisms of chemical warfare agent detoxification by the body and ways to pharmacologically enhance detoxification will be defined. Mechanisms of action of anticonvulsants for the development of drugs to control nerve-agent-induced seizures will be defined.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

7. (U) Resources ($ in Thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	1074	2352	13678*	5456	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	-**	-	-	-	Continuing	Not Applicable

* Increase of $9.7 million due to the FY 1982 Budget Amendment to the Expansion of Chemical Warfare/Chemical and Biological Defense (CW/CBD) Basic Research.

** Congressional Descriptive Summary for FY 1981 was not submitted since the program was less than $5.0 million.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #A31B — Title: Night Vision and Electro-Optics Research
Program Element: #6.11.02A — Title: Defense Research Sciences
DOD Mission Area: #110 - Defense Research — Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: The Army must improve its ability to fight during periods of darkness and limited visibility. The objective of this project is to exploit new concepts for passive and active infrared (IR) detectors and imagers, electro-optic (EO) approaches to near-millimeter waves, new lasers, smart sensors, digital and electro-optic image processors, target signature and performance modeling. The most promising results of this project will be reduced to practice in exploratory development of day/night vision and automatic locating and tracking systems. Research on low-cost, uncooled thermal imaging concepts is conducted to permit electro-optical target acquisition device solutions to such diverse high-volume Army requirements as day/night riflesights, crew-served weapon sights, IR drivers' and pilots' viewers and terminal homing seekers. This research emphasizes studies of lasers, electro-optic materials, tunable filters, both spectral and spatial (adaptive optics) charge coupled device (CCD) imagers and thermo-optical imaging concepts. Research on monolithic elements for far-infrared focal plane arrays is directed at low-cost, high-performance thermal imaging requirements such as long-range surveillance FLIRS and fire-and-forget autonomous seekers. Research addresses materials studies of 3-5 micron and 8-10 micron monolithic mercury cadmium telluride focal planes. Smart sensors and autonomous seekers are technology areas of intense military interest and importance. Research is required on automatic target acquisition algorithms or rules applicable to imaging seekers and multispectral cuers. Research is also required as a basis for advance critical military areas such as advanced target trackers and very high bandwidth compression for data links. The program on near-millimeter wavelength lasers is directed toward the eventual development of laser radars and imagers operating near 1 millimeter to provide all-weather battlefield surveillance and target acquisition capability.

B. (U) RELATED ACTIVITIES: Close coordination is maintained with the other Army laboratories as well as the Navy, Air Force, and Marine Corps, DARPA and other government agencies, academia and industry to avoid duplication. Through the Joint Logistics Commanders, coordinating groups have been established to ensure that maximum use is made of limited assets; e.g., the Navy is developing 3-5 micron second-generation infrared detectors, while the Army is developing infrared detectors sensitive to 8-14 micron energy and on uncooled detectors. The Air Force is working on extrinsic silicon technology of infrared detectors. The Army has responsibility for the configuration management of the first-generation thermal imaging common modules used by all services. In addition, an active international program of technical cooperation is maintained with many countries, particularly those of NATO and the Quadripartite countries.

C. (U) WORK PERFORMED BY: This work is performed by the Night Vision and Electro-Optics Laboratory, Ft. Belvoir, VA. The six largest contractors are: Rockwell International, Thousand Oaks, CA; Hughes Research Corp., Malibu, CA; Honeywell

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Incorporated, Minneapolis, MN, University of California, Los Angeles, CA; Raytheon Corp., Sudbury, MA; and GTE-Sylvania, Waltham, MA. There will be 10 additional contractors receiving approximately $3,500,000.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: A revolutionary uncooled imaging approach was conceived; theoretical performance analysis was carried out indicating that uncooled performance levels at, or exceeding current thermal systems now going into production, are possible. Experiments to date indicate basic approach is valid but requires additional work to demonstrate single detector performance. Uncooled systems offer the advantage of considerable reductions in systems cost and size by virtue of the elimination of cooling requirements. Research on photovoltaic HgCdTe on CdTe has been ongoing with initial emphasis on 1) growth of single crystal cadmium telluride of sufficient quality for epitaxial growth of photovoltaic mercury cadmium telluride thin layers as the sensor layer for the 8-14 micron spectral region and 2) demonstration of charge transfer in an n-type cadmium overlayer for signal readout and ultimately image processing on the focal plane. This concept will allow sufficiently high sensitivity that, when combined with on-chip image processing, will provide significant improvement in countering poor weather and smoke. Extensions of the approach will allow, in one sensor, capabilities in all spectral bands from 1 micron to 14 microns so that, with a broadband tunable filter, a multisensor for smart sensing and all-weather operation will be possible. In FY80 significant improvements have been made in the quality of the CdTe substrates from the point of view of defect density, twinning and overall morphology. Schottky-type CdTe CCD test devices (110 element) have demonstrated .99 transfer efficiency, the limit in precision of a 10-element device. New frequency-agile laser materials in the 0.4-2.0 micron spectrum have been identified and experimentation initiated. Saturable absorber dyes have been evaluated in the near IR region with promising results as new Q-switching materials. An automated fluorescent lifetime measurement has been designed and fabricated in support of new material evaluation efforts. Double pulse carbon dioxide (CO^2) lasing for crosswind sensing has been demonstrated. Gain measurements of CO_2 isotopes have been demonstrated. High-efficiency pulsed RF waveguide CO_2 laser has been demonstrated. Feasibility assessments of three novel E-O source concepts have been initiated. Passive detector array device concepts have been defined and initial measurement performed. Algorithms for target motion tracking from a moving platform have been developed under the pattern matching study. Investigations have been started to extend the intelligent bandwidth compression techniques to permit compression ratios of 10,000:1 for antijam protection. A program has been initiated for passive battlefield identification friend or foe by means of acoustic signature. An extensive series of search experiments have shown how target acquisition time for electro-optical viewers depends upon environmental factors such as target signature and background complexity and on viewer characteristics such as resolution and field of view. Investigations of the target recognition capabilities of staring arrays indicate that these arrays are fundamentally limited by sampling effects. Initial schemes have been developed to bound the capability of smart sensors to detect simpler targets.

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2. (U) FY 1981 Program: A single-element scaled-up uncooled detector is being demonstrated to prove the basic theory of the new uncooled imager approach. Experiments have been initiated to demonstrate a small-area uncooled array to assess cross-talk in the sensing and readout mechanisms. Problems in the production of photoconductive detectors for the common modules and the significant improvements through research on CdTe substrates have led to a major program redirection of the mercury cadmium telluride research to address an approach for improving the yield and labor-intensive steps in the processing of photoconductive (PC) common module arrays, based on liquid phase epitaxial growth of PC HgCdTe on CdTe. For a period of 18 months the research in this area will be carried out to solve the basic problems of CdTe and PC HgCdTe directed towards the application of increasing the availability, at a lower cost, of common module detector arrays. Electrically tunable spectral filters for the 3-5 and 8-14 micron regions are being evaluated both as bandpass and bandstop filters and transitioned to 6.2. New frequency-agile laser materials are being investigated for laser properties in the 0.4-2.0 micron spectrum. A tunable near IR laser cavity is being studied and designed for optimum efficiency of these new materials. New nonlinear crystals ($AgGaS_2$, $CdGeAs_2$) are being investigated for efficient second harmonic generation of far IR lasers. Automated laser material evaluation facilities are being expanded for active/passive characterization. Research is beginning on mechanisms affecting sealed lifetimes of CO_2 waveguide and TEA lasers including gas additives and catalysts. Injection locking of a TEA laser will be demonstrated using a fast switched local oscillator. Research aimed at improving the efficiency of TEA lasers by utilizing dielectric electrodes has been initiated. Research into methods of efficiently generating CO_2 laser radiation by RF excitation is being conducted. Efficient planar antenna coupling techniques for passive detection arrays are being established. Feasibility of three novel local oscillator (LO) concepts for passive detection arrays (plasmon, cyclotron resonance, quantum well, TUNNETT) are being determined. Bandwidth compressed imaging with ratios of 10,000:1 will demonstrated in computer simulation. Automatic array detection techniques are being developed for point infrared targets. Acoustic classification algorithms are being developed and the effect of vehicle self-noise will be considered. Development of an autocuer performance model has been started. Laboratory experiments are being performed to quantify search strategy and efficiency while field experiments will be pursued to confirm a search rate/field of view relationship previously established in the laboratory. A detailed comparison of staring and conventional viewers is being performed to determine if staring system performance is significantly less than conventional system performance as prior evidence suggests. A preliminary autocuer model is being developed and used to analyze existing autocuer techniques.

3. (U) FY 1982 Planned Program: The small-area uncooled array (Thermo/Optical) will be completed and its performance assessed. Based on these results research will be initiated to optimize fundamental performance characteristics and transitioned to 6.2. The effort on PC HgCdTe on CdTe will be completed and transitioned into the ongoing 6.3 program to develop detector arrays based on this approach. The photovoltaic HgCdTe on CdTe research discussed under FY80 and prior will be

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resumed and use of this approach for multispectral sensors will be examined. Broadband electronically tunable spectral filters will be investigated which can be tuned from 1 to 14 microns. Special emphasis will be placed on the tuning response time for the application of countermeasure protection of IR sensors against tunable laser damage. Broadband filters, when used with multispectral sensors, will allow spectral correlation techniques to be applied to the smart sensor problem by exploiting the unique combination of spectral signatures for multiple bands. Broadband tunable laser materials will be explored for continuous tuning over the 0.4-2.0 micron spectrum. Near IR/far IR combiner optics will be studied for incorporation of tunable solid-state and gas laser outputs. Lifetime studies of CO_2 lasers and dielectric electrode work will be completed. Investigation of RF excited waveguide IR gas lasers for applications requiring high stability and special modulation effects will continue. Development of wideband tunable lasers (8-20 microns) will be initiated and methods for efficiently generating nanosecond pulses in CO_2 lasers will be explored. Best solid state LO and radiation coupling technique for planar detection arrays and best coherent 220 GHz source will be selected. Planned program multisensor approaches to automatic detector recognition and cueing will be investigated. Techniques will be developed for the fusion of image data from a variety of multiple sensor sources. Work will continue on development of modes for smart sensors. The model will be expanded to include the multiple sensor concept. Investigations of control-dependent cueing will be started. Investigations will be performed to expand the search model, in particular to include effects of operator task loading. The effect of high image noise levels and partial target obscuration on target detection and recognition criteria will be established. Target screener model development will continue and a synergistic multispectral model for artificially intelligent sensors including acoustic, magnetic, and seismic devices will be formulated. This project supports 76 in-house personnel (50 professional and 26 support personnel).

4. (U) FY 1983 Planned Program: Continue optimization of fundamental performance of the uncooled Thermal/Optical imager and phase to 6.2. Basic nature of device will allow inherently, two-dimensional optical image processing for a smart sensor; this research will be initiated. CdTe will be homoepitaxially grown by MBE. The MBE-grown layers will be assessed and compared with LPE-grown material as a charge coupled device. CdTe/HgCdTe multilayers will be grown with properties suitable for a 8-14 micron monolithic focal plane array. Correlation will be made of HgCdTe/insulator properties using surface spectroscopic and MIS-CV analysis for HgCdTe photodiodes. Junction formation and materials processing will be assessed in CdTe. The relationship between passivation techniques and HgCdTe photodiode leakage will be identified. Filters will be demonstrated which can be tuned continuously from 1 to 14 microns. They will be evaluated for speed of response, tuning accuracy, filter bandwidth and rejection and transmission of narrow-bandwidth radiation. This work will transition to 6.2. Research of adaptive spatial filtering techniques (adaptive optics) will be initiated to solve the problems on image degradation by atmospheric turbulence, and image angular vibration, and to enhance low-contrast imagery, associated with poor atmospheres, for seeing thru fogs and smokes by two-dimensional spatial filtering. New high-efficiency tunable laser materials will be identified to cover the 0.4-14 micron spectrum. Advanced nonlinear optical materials will be identified for

Project: #A31B Title: Night Vision and Electro-Optics Research
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demonstrated which can be tuned continuously from 1 to 14 microns. They will be evaluated for speed of response, tuning accuracy, filter bandwidth and rejection and transmission of narrow-bandwidth radiation. This work will transition to 6.2. Research of adaptive spatial filtering techniques (adaptive optics) will be initiated to solve the problems on image degradation by atmospheric turbulence, and image angular vibration, and to enhance low-contrast imagery, associated with poor atmospheres, for seeing through fogs and smokes by two-dimensional spatial filtering. New high-efficiency tunable laser materials will be identified to cover the 0.4-14 micron spectrum. Advanced nonlinear optical materials will be identified for frequency-doubling inserts to the new tunable laser materials. Research on nanosecond pulse generation, including the use of isotopes for wavelength agility will continue. Wideband tunable laser development will continue. New concepts for integrating multifunctional IR laser devices with second-generation FLIR sights and advanced fire control systems will be investigated. Planar detector array with on-chip LO will be fabricated, and tunable NMMW E-O source feasibility assessment initiated. A model for a smart sensor capable of predicting performance will be completed. Extension of the modeling effort to bandwidth compression will be included. Context-dependent approaches to automatic cueing will be tested in computer simulation. The multisensor approach will be expanded to include merging of infrared imagery data with the acoustic classification methods. Efforts to further expand, update, and validate static and dynamic performance models for electro-optical sensors will continue including development of techniques to evaluate observer/smart sensor interactions. Smart sensor modeling efforts will continue by addressing advanced fire-and-forget concepts and camouflaged target detection capabilities.

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

6. Major Milestones: Not applicable.

7. Resources ($ in thousands): The resources requested under this project will serve the basic objective of providing the Army with the capability of conducting combat operations under conditions of limited or obscured visibility, or at night.

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	6894	6767	7938	9500	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	6494	7600	8780	--	Continuing	Not Applicable

Project: #A31B
Program Element: #6.11.02.A
DOD Mission Area: #110 - Defense Research

Title: Night Vision and Electro-Optics Research
Title: Defense Research Sciences
Budget Activity: #1 - Technology Base

The decrease in FY81 is attributable to the application of Congressional reductions. The FY82 decrease is based upon a recalculation of the technical base ramp and reprograming of projects in this program element. Further reductions in this program are in response to OSD direction for improved efficiency.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #A71A — Title: Reserve in Defense Systems
Program Element: #6.11.02.A — Title: Reserve in Defense Systems
DOD Mission Area: #110 - Defense Research — Budget Activities: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: This program provides fundamental information and new concepts in support of new or improved defensive systems against chemical and biological (CB) threat and a sound deterrence system of chemical munitions. It also provides research in aerosol and obscuration sciences in support of the Army smoke mission. Since the late 1960's, there has been a general decline in funding of basic research and exploratory development programs in support of CB defense and chemical deterrence. At the same time, the existence of a significant chemical offensive capability in the Warsaw Pact countries has been continually verified and is a major concern of DOD. The development of an integrated CB defense system is required to cope with the hazards of any potential CB threat environment. New concepts and a stronger scientific basis are needed from which to establish novel approaches to exploratory development related to individual and collective protection, detection and warning, decontamination and contamination avoidance, and training systems. Research is also needed in chemical deterrence to examine new agents, both lethal and incapacitating, and to evolve new concepts for delivery of chemical agents from a variety of munition systems. There is a Joint Service need for improved obscurants to provide protection from surveillance and target acquisition. The improvements required include obscuration in infrared and millimeter wave regions of the spectrum, faster emplacement for quick reaction protection, reduced toxicity, methods for eliminating smokes, and improved logistics of smoke agents and dissemination devices. Research in aerosol sciences and in the mechanisms of target obscuration is required in order to improve obscurant agents and for understanding the inherent limitations of obscurants which may be exploited to enhance operations under limited visibility conditions.

B. (U) RELATED ACTIVITIES: Close coordination is maintained with the Army Research Office, Office of the Project Manager Smoke/Obscurants, other Army laboratories as well as the Navy, Air Force, and Marine Corps, other government agencies, academia, and industry to avoid duplication, foster cooperation, and employ existing expertise wherever it can be found. Coordination is accomplished through program reviews, exchange of technical reports, interchange of seminars, inter-service liaison, formal briefings, and regularly conducting working-level scientific conferences on the national scale. Informal coordination occurs through visits to governmental, industrial, and academic laboratories, and review of scientific journal articles and government in-house reports. Contact is also kept with the outside research community through university sabbaticals under the Intergovernmental Personnel Act of 1970 and in-house research appointments under the National Research Council Research Associateship Program.

C. (U) WORK PERFORMED BY: This work is performed by the Chemical Systems Laboratory, US Army Armament Research and Development Command, Aberdeen Proving Ground, MD. The largest contractors in FY80 were: University of Texas, Fairleigh Dickenson University, Southern Research Institute, University of Florida, Drexel University, Panametrics, Inc., and University of Missouri. The total FY80 contractual effort was $488K plus $106K to other Army laboratories.

Project: #A71A
Program Element: #6.11.02.A
DOD Mission Area: #110 - Defense Research

Title: Reserve in Defense Systems
Title: Reserve in Defense Systems
Budget Activities: #1 - Technology Base

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Research accomplishments related to chemical decontamination and contamination avoidance included the successful preparation of several reagents for phase-transfer studies in the solubilization and reaction of chemical agents, the formulation of an empirical equation for diffusivity as a function of concentration in studies of permeation mechanisms of films by liquids and vapors, the discovery of a series of reactive soaps (micellar nucleophiles) for possible use in noncorrosive aqueous decontamination systems, the discovery that neutral alumina of high specific activity gave exceedingly high hydrolysis rates for an organophosphorus fluoridate (applicable to chemical agent or pesticide decontamination), and the formulation of a solution algorithm for transient fluid flow with multiple free boundaries for a study of the physics of the fluid flow on surfaces from liquid jets. Initial experiments on the possible use of photo-acoustic spectroscopy for chemical detection indicated that this technique can detect at least 0.05 milligrams of the chemical agent GB per cubic meter of air. Research was performed on the possible use of liquid crystals in detection. Research on the use of dichroic dyes as indicators of liquid crystal alignment in polypropylene films was completed. One of the discoveries was that auto-alignment of certain molecules can be achieved in thin microporous polypropylene films in the absence of liquid crystals. A chemometrics analysis was initiated of a data base on molecular association which produces fluorescence response in order to identify chemicals which do not pose an environmental hazard yet whose presence can be determined quickly through simple detection tests. Features of potential chemical agent simulants which appear to be most important in enhancing fluorescence through molecular association include length of the compound and the presence of specific structurally positioned regions. As part of an evaluation of the feasibility of laser fluorescence for remote biological detection, collaboration was instituted with the ERADCOM Night Vision - Electro-Optics Laboratory in ultraviolet laser studies specifically tailored for improving fluorescence excitation of aerosolized biological materials. Research plans were formulated for investigation of microwave techniques for biological realtime detection. Methodology was devised for enzymatic conversion of tissue cell constituents to fluorescent or colored products for virus detection. Research on chemical agent viscoelastic behavior resulted in a better understanding of the basic properties of thickened chemical agents that control their rheological action. The dielectric constant, a controlling factor in viscoelasticity, has been calculated for some simulant agents from nuclear magnetic resonance data. The conformational factors for a series of heterocyclic alcohols has been determined in a search for unusual structural features that may influence physiological properties. This is part of a search for new concepts in chemical agents. Studies in obscuration and aerosol research led to a number of findings. The light-scattering theory for small nonspherical particles was extended to include distribution of sizes and random orientation. This showed flakes and fibers to be very effective obscurants. The results were transferred to exploratory development. Physical origins of shape-dependent absorption phenomena in small particles were identified and research begun on potential fundamental limits to the amount of multispectral extinction attainable. Experiments on cooperative scattering

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by collections of spheres showed previously unnown large enhancements of light extinction and scattering. Radiative transfer calculations were extended to include treatment of infrared emission by smoke particles. The infrared spectra of various powders were successfully measured for optical constants using a new method based on polarized reflectance ratios. Additives were discovered which greatly reduce vapor pressure of diesel fuel, which may enhance the stability of diesel fuel smokes. A theory of the dependence of phosphorus smoke particle growth versus relative humidity or chemical composition of drops was completed. A theory of nucleation and drop growth in a high-temperature vapor jet was developed. Smoke elimination was demonstrated by heat injection using nondetonating fuel air explosive technology.

2. (U) FY 1981 Program: Research is being initiated on alternatives to the use of charcoal for air purification purposes. This includes heterogeneous catalysis using molecular sieves and electrolytic catalysis. Research on the use of carbon monoxide pulses for residual life determination of the reactivity of chemisorptive charcoals is being completed. A review of new concepts in residual life indicators is being updated. Surface-chemical agent interactions including adhesion and wettability of agent and substrate are being examined in the use of liquid jets for physical decontamination. Studies are being performed on the kinetics and mechanisms involved in the detoxification of chemical agents by reactive gas streams such as from a jet engine exhaust. Computer programs are being modified to enable simulation of the removal process of a viscous film with a continuous liquid jet. Emphasis in chemical decontamination is being placed on water-based noncorrosive decontamination systems such as microemulsions and micellar catalysis, the promotion of chemical reactions by porous solids and the chemical mechanisms of film permeation. Research is being initiated on the relative chemical reactivity of ordered and disordered crystals to chemical vapors for chemical detection purposes. Aminoanthraquinone dyes are being studied initially for reactivity to alkylating agents. The interactions are being followed spectrophotometrically by monitoring color change. Research begun in FY80 on optical effects arising from the physical absorption of chemical vapors into microporous films is being extended to chemisorptive liquid crystal systems. Research begun in FY80 on chemometrics analysis of a data base on molecular association effects which produce fluorescence response for simulant design is being completed. Enzyme-amplified methods for indirect detection of viruses are being refined for selection of the most promising approach for transfer to exploratory development. Microwave absorption by biological aerosols is being evaluated for consideration as a biological detection approach. Micro-optical pattern recognition and other principles for biological particle detection are also being studied. Studies initiated in FY80 on the synthesis and conformational analysis of heterocyclic amino alcohols as part of a broader search for new concepts in chemical agents are being completed. These studies are being extended to organo-phosphorus compounds. Novel reaction of hydrogen phosphites and their phosphinate analogs are being examined to determine equilibria between trivalent and tetravalent forms. New azabutadienes are also being sought for consideration as possible training and riot-control chemicals. Research is being completed on the mechanisms which impart viscoelasticity to fluids. Research is continuing in aerosol/obscuration sciences to provide knowl-

Project: #A71A Title: Reserve in Defense Systems
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edge and understanding in problems directly supporting the smoke technology programs. Computer programs are being refined for light scattering from small nonspherical particles. A study of powder spectroscopy methods to measure infrared extinction constants of obscurants is being completed. Aerosol calorimetry studies are being performed to measure heat balance in aerosol clouds and to study specific exothermic reactions in aerosol systems. Smoke models are being modified to include second order terms required to treat reactions between mixed aerosols, scavenging, coagulation in polydispersions, and electric charging. A study of falling trajectories of tailored scavengers for the elimination of smoke clouds is being concluded. An initial assessment of polarized light-scattering inversion for characterization of distributions of nonspherical particles is being completed.

3. (U) FY 1982 Planned Program: Research in support of chemical and biological defense, chemical deterrence, and the smoke program will be expanded in FY82. Leads uncovered in FY81 on alternatives to charcoal absorption for air purification and new concepts in residual life indicators will be pursued. Research will be initiated on the fundamental chemical processes occurring in a microwave plasma reactor for application to collective protection. Emphasis will be on characterization reaction kinetics and thermochemical data. Research will be initiated on surface-modified activated charcoal in order to establish a mechanistic basis to improve utilization of sorbents for the protective mask. Chemical agent-surface interaction studies in physical decontamination will be extended to cover additional parameters. Molecular dynamics experiments and flow theory hypothesis will be extended to the elucidation of fundamental mechanisms and physical-chemical properties controlling liquid transfer of aged thickened liquids between separating surfaces. The experimental pilot study begun in FY81 on mechanistic pathways for detoxification by reactive gas streams will be completed. Numerical and graphical simulation will be conducted for various film and jet configurations in the study of removal mechanisms of viscous films. Basic information will be sought on the role of material, thermal, mechanical, and radiative stresses on interfacial equilibria. A comprehensive review is planned on phase-transfer catalysis as an approach in decontamination methodology. Solubilization and reaction kinetics of various chemical agents in microemulsions will be performed as an extension of the research initiated in FY80. The chemistry of sulfur mustard and other alkylating agents wil be studied on alumina and other porous solids. Research is also proposed on the reactivity and mechanisms of radical-ion reactants in a search for new catalytic oxidation principles applicable to decontamination and contamination avoidance. Emphasis will continue on surface chemistry in order to gain an understanding of the factors which influence gas-solid interactions and reactions for new alarms and detectors. Sensitivity patterns will be established using piezoelectric crystals or semiconductors. Research on chemisorptive liquid crystal systems will be completed. Research will be performed on surface-enhanced fluorescence, photoacoustics and other electro-optic phenomena for application to detection. Chemometrics structure-activity relationships and three-dimensional molecular modeling will be performed to assist in design of new chemical training agents. New approaches will be sought to highly sensitive biodetection and pathogen specificity. New methods will be sought for

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isolating and detecting low concentrations of viral agents in samples collected in the field. Research will be performed on inactivation of bacteria and viruses by microwave or other radiative means and in combination with chemical disinfectants for possible synergistic effects. In the chemical deterrence area, studies on new analogs of hydrogen phosphites will be completed. New bicyclic organophosphorus compounds will be synthesized and their potential as chemical agents explored. The photochemical ring expansion of 3-azidopyridine will be examined as a route to diazepines and the resulting compounds screened for physiological activity. The break-up of thin-walled chemical munitions will be studied to determine parameters for optimum break-up. Research supporting the development of new smokes will be conducted by studying the light-scattering behavior of new highly efficient particle shapes, the optical constants of substances, methods for the physical and chemical characterization of aerosol particles, infrared emitting smoke and radiative transfer theory of target obscuration. Research will be expanded on the theory of light scattering by small nonspherical particles. This will include single particle scattering and radiative transfer through clouds. Work on cataloging and examining phenomena producing strong, broad extinction in the infrared will continue. Research on theory of light scattering by cylinders will also continue. Techniques will be developed for millimeter-wave spectroscopy. The data base on heat-producing reactions of aerosols will be extended including the development of aerosol calorimetry. A theory will be developed on multicomponent-drop evaporation. This will be combined with the FY81 coagulation code to produce a comprehensive model of the evolution of particle size distributions which include coagulation and competitive evaporation/condensation. Research will be initiated on theoretical approach to modeling instantaneous structure of a cloud growing by turbulent mixing with the atmosphere. An in-house library of computer programs will be implemented for optical inversion methods for determining size distribution of spherical particles.

4. (U) FY 1983 Planned Program: The FY83 program will continue the new initiatives established in FY82 in all areas. Workable models will be developed of electrolytic and heterogeneous catalytic processes and other alternatives to air purification in order to provide guidelines for determining decomposition sequences and reaction paths. Fundamental studies will be performed on aerosol transport and removal mechanisms. Research will continue on new concepts in residual life indicators identified previously. Models will be developed of the mechanics of physical removal of surface contamination by high-pressure jets and sprays. Simulants will be developed that mimic fundamental characteristics of agent-surface interactions. A physical-mathematical model will be completed of thickened liquid transfer mechanisms which account for cohesive and adhesive properties of thickened fluids. Experiments will be performed to validate computer simulation of removal mechanisms of viscous films. A parametric study will be completed of factors affecting solubility and reaction rates of chemical agents in microemulsions. A comprehensive review will be prepared on use of micellar solutions and microemulsions as approaches to decontamination methodology. Research on the chemistry of alumina and doped-alumina surfaces will be completed. Work will be performed on modeling the behavior of materials to chemical agents and tailoring properties of mate-

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rials through molecular structural control. Models will be developed of gas-solid reaction and interactions which could serve as a basis for design of detector coatings. Research will be extended as field ionization mass spectrometry and electro-optic phenomena. Work will be completed on microscale organic reactions for improved methods of chemical agent identification and analysis. Chemometrics analysis investigations will be extended to assist in design of new chemical training agents and simulants. Research will be continued on new concepts for biological detection, identification, and decontamination. Studies will be conducted of immunochemically changed light transmission of an antibody film as a result of reaction with antigen as a potential virus detection technique. Special emphasis in chemical deterrence will be placed on multifunctional organophosphorus compounds and fundamental relationships in the prediction of pharmalogical activity relative to molecular stereochemistry. Methodology will be developed for fragment size optimization that would consider both chemical incapacitation including dependence on drop size and incapacitation due to fragments. Research in aerosol science and in the mechanisms of target obscuration in support of the Army's requirements for improved obscurant agents will be continued. A solution will be initiated of the full radiative transfer problem including effect of infrared emission from particles and cooperative interactions between particles. Measurement of infrared optical constants of new obscurant materials will be continued and extended to include measurements of millimeter-wave optical constants. The study of nonspherical particles will be extended from small particles to cover all steps and will include the solution of electromagnetic scattering by wavey fibers and birdnests of fibers. Research will be performed on the effects of obscurants against directed energy weapons to understand nonlinear phenomena which will dominate the design of obscurants for this class of problems. Experiments will be continued on growth of particles and methods of altering smoke size distribution. Experiments will be conducted on dense aerosol plume behavior to test theory and explore predictions for improving plume performance. Additional basic research will be performed to identify new concepts in smoke elimination. Research will be performed on the dissemination of powders under steady state forces or high-energy loading, including physical influence of nonspherical particle shapes such as flakes and fibers. Research will be conducted on polarization conversion effects for characterizing nonspherical particles.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not Applicable.

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7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	1500	1948	7422	3100	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	1625	2200	2730	--	Continuing	Not Applicable

FY80 and FY81 decreases are due to minor reprograming into other research areas. The increased funding for FY82 will support research in new concepts in chemical and biological warfare defense equipment chemical deterrence, chemical defense training, and biological defense materiel. These tasks are critical to the development of an adequate defense against the chemical and biological warfare threat.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.21.05.A Title: Materials
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	12315	11394	11182	12557	Continuing	Not Applicable
AH84	Materials	12315	11394	11182	12557	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The work under this program is Exploratory Development of improved and advanced materials directed primarily toward four generic Army weapon systems, their mission, and support equipment: aircraft, armament, ground combat vehicles, and missiles. The remainder addresses special problems with varied requirements for materials technology. The objective of the program is to conduct Exploratory Development to produce improved materials and materials processing methods for use in the design, construction, and operation of Army weapon systems to satisfy superior tactical and strategic performance requirements and reduced life cycle costs. Specific Army need is reflected in the following examples: accelerated wear of helicopter gears and drive train components with resultant excessive vibration and costly maintenance requirements; excessive wear and erosion of gun tubes producing short barrel life, inaccurate ballistics performance, and high operational costs; increasing weight growth of ground combat vehicles along with growing needs for mobility and agility and advanced armor; high vulnerability of crew and personnel of ground combat vehicles to wide-angle backface spall generated by antiarmor munitions; limited capability of missile radome materials traveling at high mach numbers to withstand rain erosion and maintain good electromagnetic transmission properties; limited capability of current weapon system materials to provide adequate protection against battlefield laser threats; lack of acceptable levels of reproducibility to ballistics performance of high-density penetrator munitions due to inadequate advanced penetrator core materials and materials processing methods; and the unavailability of adequate high strength, lightweight mobile bridging materials.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Work will be conducted to overcome mission deficiencies and satisfy mission needs outlined in paragraph B and to exploit technological opportunities in advanced materials development. It will consist of the development of improved alloys and coatings for aircraft turbine engine components; development and evaluation of metal-matrix composite materials for helicopter drive-train systems to reduce by one-third the cost of overhaul; evaluation and improvement of the environmental durability and reliability of organic and composite materials used in critical components of Army helicopters; development of coating materials and processes for erosion and corrosion control for Army weapon systems and equipment; development of processing methods for improving mechanical, thermal, and fatigue properties of large gun barrels; development

Program Element: #6.21.05.A Title: Materials
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

of new materials formulations and designs to defeat combined fragmentation, blast loading and penetrator munition threats to Army ground combat vehicles; and evaluation of high modulus, lightweight materials to withstand high gravity forces of advanced missile systems. The overall objective will be to develop and characterize materials specimens to provide life-cycle cost reductions, needed improvements in weapon system performance and reliability, and significantly improved maintainability.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	12315	11394	11182	Continuing	Not Applicable
Funds (as shown in FY 1980 submission)	13601	12632	12703	Continuing	Not Applicable

The decrease in funding of $1286 thousand in FY 1980 is attributable to reprograming to higher priority Army technology base requirements. The funding level decrease of $1238 thousand in FY 1981 reflects the application of general Congressional reductions. The funding level decrease of $1521 thousand in FY 1982 reflects revised scope of program efforts based on Army budget formulation decisions to fund other higher priority Army technology base requirements.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.21.05.A Title: Materials
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The work in this program is part of a three-part Research, Exploratory Development, and Advanced Development program for materials. The goals of this Exploratory Development program are to produce new materials products, new materials specifications, and prototype specimens made of new materials. Exploratory Development is conducted in the following areas: metallurgical techniques and alloy improvements; organic materials, ceramic materials, composite materials, mechanics of materials, laser hardening of materials, failure analysis, and test evaluation methods. All of these projects are aimed at producing improved materials for use in the design, construction, or operation of Army materiel to satisfy superior performance requirements, to reduce costs of weapon systems acquisition and lifetime ownership cost of weapon systems.

G. (U) 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 the Office of the Deputy Secretary of Defense Annual Apportionment Reviews and meetings of the Office of the Deputy Under Secretary of Defense Research and Engineering Ad Hoc Services Materials Laboratories Council. Coordination with the nonmilitary 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 Material coordination meetings and the Department of Defense Biannual Materials and Structures Briefings for Industry. International coordination is effected through the Technical Cooperation Program with Australia, Canada, New Zealand, 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.

H. (U) WORK PERFORMED BY: Approximately 80% of the work will be accomplished in-house at the Army Materials and Mechanics Research Center, Watertown, MA; US Army Armament Research and Development Command, Dover, NJ; Natick Research and Development Command, Natick, MA; US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA; and the US Army Missile Command, Huntsville, AL. Primary contractors are: AVCO, Everett, MA; Massachusetts Institute of Technology, Cambridge, MA; MITCO, TRW, Cleveland, OH; Terra Tek, Salt Lake City, UT; Materials Research Lab., Glenwood, IL; Materials Concepts, Inc., Columbus, OH; Drexel University, Philadephia, PA; Vought Corp., Dallas, TX.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Completed baseline flight test of metal-matrix reinforcement plates for vibration, wear, and noise reduction of CH-47 helicopter forward transmission. Developed an advanced hardened carbon metal-bearing resin composite material capable of withstanding high-energy laser fluxes. Developed and evaluated a new aluminum/steel composite armor for hardening ground-launched cruise missile transporter-erector. Developed and evaluated a ballistic spall suppression liner system of laminated Kevlar for the M-113 armored personnel carrier. Designed and fabricated a selection of glass

Program Element: #6.21.05.A Title: Materials
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

compositions that provide superior resistance to continuous and pulsed high energy lasers. Developed a harder, more abrasion-resistant coating, general-purpose military Kevlar cable. Determined the causes of unacceptable variability of tungsten core kinetic energy munition and fabricated and tested improved cores.

2. (U) FY 1981 Program: Weapon systems structural work is focused on fabrication processes to exploit cost reductions, on evaluation of environmental effects on protective coating systems, and on development of improved adhesive bonding materials for advanced weapon systems. Work is in progress to correlate structural properties and component performance on military vehicle gear and bearing materials. New penetrator materials formulations of extruded uranium and tungsten alloys are being fabricated and tested. Fragmentation tests are being completed on cylinder materials machined for 105mm and 155mm projectiles. Thermal stresses and gaseous environments effects on crack initiation and crack propagation in large gun tubes are being investigated. Textured materials for armor application have been subjected to ballistic firings and analysis. Powder metallurgical processing with aluminum alloys and strain-hardenable aluminum-magnesium-lithium alloys for helicopters is in progress. Fire-barrier armor materials for ground combat systems are being developed and evaluated. Work will continue on microstructural analyses of fuzed silica, rain-erosion resistance of silicon nitride, fabrication techniques for missile nose cones, and the improvement of thermal battery materials. Effects of humidity and temperature on stress corrosion cracking of stored missiles are being determined for a series of steel and aluminum alloys. Bridging materials work is focused on fiber-reinforced organic composite materials, lightweight metallic components, and design of shafting, truss, and coupling members. Rapid-cure thermosetting resin-based composites, continuous fiber-reinforced thermo-plastics and improved lightweight impact-resistance structural foams components are being developed as part of a new thrust on improved lightweight tank track and suspension system materials. Effects of tropical environments on new lightweight magnesium alloys will be evaluated. The new major thrusts in metal-matrix composite and advanced formulation armor materials are continuing. Increased emphasis is being focused on materials processing research and development.

3. (U) FY 1982 Planned Program: Develop improved processing and quality control methods of composite materials to ensure greater reliability, reproducibility, and performance in helicopter rotor blades and flight critical structural components. Continue the development of multifunctional airframe materials offering improved structural properties and reduced radar cross-section, along with resistance to ballistic and laser weapon threats. Develop helicopter gear materials having improved strength, toughness and wear resistance using rapid solidification technology and advanced processing methods. Advance the development of improved high density armor penetrators through optimization of compositions, processing methods and use of high density composite materials containing tungsten and depleted uranium. Develop improved fragmentation shell materials having improved rough handling and launch survivability. Accelerate the development and demonstration of composite materials and components for lightweight combat and tactical vehicles for improved mobility, survivability, deliverability, and reduced fuel consumption. Focus the continuing development of metal-matrix composite materials technology on optimization of properties and

Program Element: #6.21.05.A Title: Materials
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

processing methods for improved productivity and cost reduction. Concentrate ceramic engine materials work on turboalternator and adiabatic diesel engines for field power, armored personnel vehicle and combat vehicle engine applications. Continue the development, evaluation, and demonstration of recently developed armor materials for the defeat of current and projected kinetic energy threats. Optimize the composition and processing parameters of advanced ceramic missile radome materials to achieve maximum erosion resistance and electromagnetic transmission properties. Continue work on compartmented armor materials major thrusts. Personnel supported: 83 professional; 79 support.

4. (U) FY 1983 Planned Program: Materials RDTE will continue to emphasize cost reduction and survivability (including reliability, maintenance, producibility). Efforts will be directed toward materials and processes leading to lower costs and increased system performance. Major areas of effort will include materials for radial turbines, gear materials, metal-matrix composites, corrosion reduction, improved ceramics, design factors, mechanics of materials and laser effects and hardening. Major program to develop new and improved processing techniques to include welding for armor materials, machining of gun tubes, wet winding and joining of composite structures, ion implantation to decrease wear and erosion, electroforming, staballoy conversion, and rapid solidification technology and processing of large ceramic shapes. Develop plastic laminates for protection against multiple threats; prevent and control degradation of missile guidance components; prototype ceramic components for adiabatic diesel engine; develop new adhesives and joining techniques for missile structures; and continue development of fuel resistant elastomers. Continue work on metal-matrix composites, compartmented armor, laser hardened materials and rapid solidification technology major thrusts.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.21.11.A
Title: Atmospheric Investigations
DOD Mission Area: #522 - Environmental and Life Sciences (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	5947	5711	6840	6900	Continuing	Not Applicable
AH71-A	Automatic Meteorological Technology	366	268	918	814	Continuing	Not Applicable
AH71-B	Atmospheric Effects on Electromagnetic Transmissions	0	0	230	255	Continuing	Not Applicable
AH71-C	Atmospheric Characterization	2718	2525	2679	2451	Continuing	Not Applicable
AH71-D	Remote Atmospheric Sensors	1049	926	727	1133	Continuing	Not Applicable
AH71-E	Atmosperic Models for Electro-Optical Systems	1012	1285	1436	1379	Continuing	Not Applicable
AH71-F	Meteorological Techniques for Artillery	802	707	850	868	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Mission needs respond to: (1) Requirements contained in Department of Defense DOD Atmospheric Transmission Plan, 15 Jul 80, which identifies Army responsibilities to all three services (Army, Navy, Air Force); (2) requirements from Deputy Under Secretary of Defense for Research and Engineering, 1 Feb 79, for the Army to take the lead providing meteorological support, both technology base (6.2) and meteorological operational support (6.5), to the DOD National

High Energy Laser Test Range at White Sands Missile Range, NM; (3) requirements contained in (U) Fire Support Mission Area Analysis, Phase I Report, 31 Jan 80, and from the United States Army Field Artillery School, 23 Jun 80, to provide improved long range artillery effectiveness; and (4) a requirement for the Army to provide its own weather support forward of Division for weapon systems, and for hydrologic and flood forecasting. This program addresses the urgent need to develop meteorological techniques and equipment essential in the planning and support of combat operations. The impact of weather and battlefield conditions (dirty battlefield) on sophisticated weapon systems employing electro-optical, millimeter and microwave devices must be determined. Adequate knowledge of meterological effects and adequate procedures and equipment to compensate for them are essential for artillery fire control accuracy and tactical operations. Near real-time weather intelligence is essential in planning combat operations and direct support of weapons systems. Remote wind sensors are required to increase the standoff range and survivability of battle tanks. Specific objectives are to: (1) develop meteorological techniques and equipment for direct and indirect support of electro-optical and target acquisitions systems, armor, smoke, high energy laser, and artillery precision guided munitions; (2) establish and correct deficiencies in existing capability to assess and simulate, through models, the effects of dirty battlefield environment on performance of current and future electro-optical and near millimeter wave weapon system; (3) provide quantification of potential battlefield environments at wavelengths from visible to near millimeter; and (4) develop remote atmospheric sensors to increase armor and artillery fire control accuracy increasing the probability of first round hits.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Complete, validate, and distribute advance Central European and Mideast obscuration models. These will give the Army well-documented, validated computer simulations of dirty battlefield environmental effects on the performance of electro-optical millimeter and microwave weapon systems for use by weapons designers, war gamers, testers, and tactical commanders. Develop techniques to predict transport and diffusion of toxic materials at the DOD High Energy Laser Systems Test Facility and validate models for predicting critical atmospheric conditions during field tests of high energy laser weapon systems. This provides essential knowledge of atmospheric interactions with high energy laser systems to aid in site selection for testing, system design, and operational support. Improve meteorological messages and extend artillery message to higher altitudes to increase long range artillery effectiveness. The improved AN/TMQ-31 antenna (improved low angle track and reduced weight/size) will transition to Product Improvement Program and the Global Positioning System- AN/TMQ-31 prototype will be fabricated to provide accurate wind data for the field artillery. Conduct field tests to investigate atmospheric effects on near millimeter wave propagation to assess the effects of realistic battlefield environments on near millimeter wave weapon systems.

Program Element: #6.21.11.A Title: Atmospheric Investigations
DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

D. (U) COMPARISON WITH FY 1981 RDTE REQUESTS: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Costs
RDTE					
Funds (Current Requirements)	5947	5711	6840	Continuing	Not Applicable
Funds (as shown on FY 1981 submission)	5947	6717	6853	Continuing	Not Applicable

AH71 - The decrease of $1,006 thousand in FY 81 is attributable to the application of general congressional reductions. Minor decrease in FY 82 ($13 thousand) results from reduction in efforts directed toward tactical weather intelligence.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.21.11.A Title: Atmospheric Investigations
DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Develop techniques and equipment for meteorological support of Army battlefield operations and for the design, development, operation and employment of: weapon systems that use electro-optical/millimeter/and microwave sensors, high energy lasers, artillery, smoke armor, target acquisition systems, precision guided munitions. Quantify battlefield obscuration conditions and effects for electro-optical systems under realistic battlefield atmospheric conditions for weapons designers and war gaming. Quantify propagation environment for millimeter/microwave propagation and the effects of realistic battlefield environments on millimeter/microwave systems to improve acquisition, tracking, and destruction of targets under low visibility battlefield conditions. Develop and evaluate new techniques to analyze/interpret/and predict critical atmospheric conditions and develop new measurement techniques applicable to field testing high energy laser weapon systems at the DOD High Energy Laser Systems Test Facility. Improve long range artillery effectiveness by improving quality and extending the range of atmospheric measurements, and by integrating modern equipment and techniques into user applications. Develop remote atmospheric sensors to increase armor and artillery fire control accuracy. Provide software for the weather intelligence function of Army's All Source Analysis System to include hydrology/mobility/and operations as influenced by tactical scale weather conditions. Develop high frequency direction finding techniques to improve location accuracy of high frequency sources based on increased understanding of atmospheric (ionospheric) effects leading to lessening of basic atmospheric constraints.

G. (U) RELATED ACTIVITIES: Program Elements 6.11.02.A, Atmospheric Sciences; 6.27.30.A, Cold Regions Engineering Technology; 6.37.41.B, Meteorological Equipment; and 6.57.02.A, Support of Development Testing. Work is coordinated within the Department of Defense (DOD) by the Under Secretary of Defense Research and Engineering (USDRE). Direct coordination is maintained with Project Manager, Smoke/Obscurants; Project Manager Control and Analysis Centers (CAC); Army Materiel Systems Analysis Activity; Harry Diamond Laboratory; High Energy Laser Systems Project Office/Missile Command; Test and Evaluation Command, White Sands Missile Range (WSMR); Dugway Proving Ground; US Army Training and Doctrine Command; Air Force; Navy; National Oceanographic and Atmospheric Agency; Environmental Protection Agency; Research Study Groups 6, 8, 14, and 15 of NATO Panel IV (Action Committee 243); Panel XII (Meteorology) of the NATO Army Armaments Group and the US Army European Mesometeorology Advisory Panel to exchange information and preclude duplication of effort.

H. (U) WORK PERFORMED BY: The Atmospheric Sciences Laboratory, White Sands Missile Range, NM, is the in-house developing organization responsible for the program. Of the $5.711M program in FY 1981, approximately 61% is in-house and 39% is contractual. Contracts totaling $1.364M exist with the following: Physical Science Laboratory, New Mexico State University, Las Cruces, NM; Optimetrica, Ann Arbor, MI; Science Applications, Inc., Ann Arbor, MI; Oregon Graduate Center, Beaverton, OR; National Research Council, Washington, DC; Kentron, Dallas, TX; University of Dayton, Dayton, OH; and Lockheed, Houston, TX. Additional contracts total $1.419M.

Program Element: #6.21.11.A Title: Atmospheric Investigations
DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

I. (U) PROGRAM ACCOMPLISHMENT AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Completed and validated Electro-Optical Systems Atmospheric Effects Library 80. This gives the Army a well documented, validated computer simulation of the dirty battlefield environmental effects on the performance of electro-optical and near millimeter wave weapon systems. These model results can be used for the design, analysis, and trade-off studies in one-on-one and force-on-force situations. Conducted field measurements for dust and smoke validation tests and infrared and near millimeter wave transmission through dust and smoke for weapon systems performance analysts and combat modelers. Provided measurements of aerosol characteristics, as a function of height for STINGER-POST at Greding, GE. Provided analysis and interpretation of critical atmospheric conditions for outlying high energy laser test sites in support of DOD National High Energy Laser Test Range. Exploratory development model of laser remote integrated path crosswind sensor for tanks partially completed. Utilized prototype visibility and cloud base sensor in tests to characterize visibility for electro-optical sensors. Successfully flight tested and utilized maneuverable atmospheric probe for electro-optical propagation studies and DOD high energy laser program. Customized electro-optical climate models and user weather scenarios (Europe) delivered to weapons designers and war gamers. Smoke munition expenditure model, called KWIK, used to calculate munition expenditures and impact separations in real time at Dugway Proving Ground, UT, and for real time support to PM Smoke during Smoke Week III. Completed interim complex terrain model for transport and diffusion of battlefield obscurants and model was implemented to generate realistic battlefield smoke scenarios. Additionally, completed a model to provide the instantaneous probability of target acquisition through obscurants generated from multiple smoke munitions. FY 80; In-house $3.923M, Contractual $2.024M.

2. (U) FY 1981 Program: Document and distribute Electro-Optical Systems Atmospheric Effects Library 80 for central Europe (over 35 known users). This provides the Army with a computer simulation of the dirty battlefield environmental effects on the performance of electro-optical/millimeter/and microwave weapon systems for weapons designers/war gamers. Conduct field tests to quantify battlefield obscuration effects on electro-optical and near millimeter wave weapon systems, for example, in support of Surveillance Target Acquisition Radar for Tank Location and Engagement (STARTLE) in dust/smoke/snow/fog/and rain. Provide atmospheric characterization for DOD High Energy Laser Systems Test Facility for site selection/system design/and operational support. Complete exploratory hardware for improved AN/TMQ-31 antenna to provide improved low angle tracking/reduced weight/and size (Artillery). Improve meteorology for field Artillery through integration of merged meteorological messages, wind shear, and sounding frequencies for improved long range artillery effectiveness. Develop atmospheric effects models and display techniques for battlefield application (emphasis on electro-optical/smoke/and aerosols). Field test/validate smoke munition expenditures models at infrared wavelengths utilizing inventory and candidate munitions. Identify main causes of High Frequency Direction Finding uncertainties due to the ionosphere. FY 1981: In-house $4.292M, Contractual $1.419M.

Program Element: #6.21.11.A Title: Atmospheric Investigations
DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

3. (U) FY 1982 Planned Program: Complete and validate new modules for snow, fire products, foreign and special smokes, and optical turbulence and provide this advanced capability to users through the Electro-Optical Systems Atmospheric Effects Library 82 for both the mideast and central European type environments. Deliver customized climate information and user scenarios for the Mideast. Modify radar performance model to permit evaluation of both near millimeter wave and infrared STARTLE concepts and assess atmospheric effects on both. Conduct cold region field measurements of optical/infrared transmission and other atmospheric properties to better quantify battlefield cold region obscuration. Adapt techniques for predicting transport and diffusion of toxic materials at DOD High Energy Laser Systems Test Facility. Improve met messages and extend artillery messages to higher altitudes for improved long range artillery effectiveness. Transition the improved AN/TMQ-31 antenna to Product Improvement Program and fabricate prototype Global Positioning System-AN/TMQ-31 (wind data for Artillery). Validate models for estimating precipitation as it affects mobility (Tactical Weather Intelligence). Initiate modification of ray retracing techniques for improved location determination (High Frequency Direction Finding). FY 1982: In-House $4.398M, Contractual $2.442M. Number of personnel supported: professional 35; support 26.

4. (U) FY 1983 Planned Program: Complete models to quantify battlefield obscuration effects on electro-optical systems and atmospheric limitations of near millimeter wave and infrared wavelengths. These results will support DARCOM and TRADOC program involving materiel development, testing, war gaming, and weapon employment. Investigate cold region battlefield obscuration effects on electro-optical and near millimeter wave systems through field tests. Determine critical atmospheric conditions for optimizing high energy laser performance in self-defense/self-support scenarios. Consolidate improvements to artillery meteorological message and apply to target area meteorology to improve long range artillery meteorological message and artillery effectiveness. Evaluate NATO smoke obscuration models. Evaluate prototype Global Positioning System/Navagational Aids for the AN/TMQ-31 radar to provide a passive wind finding technique for artillery fire support. Combine tactical smoke/CB/electro-optical models and displays for Army All Source Analysis System (Tactical Weather Intelligence). Develop techniques to improve location accuracy of High Frequency sources by a factor of two or better for ranges between 100 and 1000 kilometers. Fabricate prototype high altitude sounding system to provide upper air data (wind/temperature/pressure, etc.) for tactical artillery units. Add sensor to maneuverable atmospheric probe to measure dust and aerosol scattering coefficients for electro-optical atmospheric characterization. Using a multicolor lidar, determine spatial/temporal variability of smoke/dust. FY 83: In-house $4.248M; Contractual $2.652M.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.21.20.A Title: Nuclear Weapons Effects, Near Millimeter Wave, Fluidics
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	6787	5994	5840	9765	Continuing	Not Applicable
AH25	Nuclear Weapons Effects Research, Near Millimeter Wave Technology, Fluidics Technology	6787	5994	5840	9765	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Army urgently requires combat, combat support, and combat service support equipment which is survivable in a nuclear environment. The soldier can be effective in the battle even after being exposed to severe nuclear environments. Equipment must be as survivable as the soldier if the Army is to avoid the potentially disastrous situation of having soldiers who are willing and able to fight after surviving a nuclear attack but are unable to do so because combat systems fail to withstand the hostile nuclear environments. A Nuclear Weapons Effects research program is required to pursue advances in hardening technology that make possible the survivability of Army materiel during and after a nuclear exchange. Environmental definition, vulnerability assessment, development of hardening fixes, and evaluation of the nuclear survivability of operational forces are parts of the program. The approach is to develop, maintain, and transfer to the materiel developers the technology for balanced hardening of fielded and developmental systems. Near Millimeter Wave (NMMW) radars offer a potential way to see through the smoke and obscurants of the modern battlefield. This capability is critical to the Army when fighting outnumbered against forces heavily reliant on obscurants for cover in the attack. The NMMW Program provides a much needed data base on transmission and target background reflectivity in adverse environments and explores new systems technology. The fluidic technology program provides a coordinated, Army-wide program for the design, development, testing, and feasibility demonstration of fluidic activated control systems for use in Army materiel. Compared to electronic systems, fluidic systems offer the potential for greatly improved reliability, availability and maintainability, and reduced life-cycle costs while providing improved end item performance. This is a Single Program Element Fund (SPEF) wherein a single Army laboratory is funded in one Program Element (PE).

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Technology will be developed to insure that hardness is maintained during produc-

Program Element: #6.21.20.A Title: Nuclear Weapons Effects, Near Millimeter Wave, Fluidics
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

tion and fielding of systems. Vulnerability and hardness assessments of automatic data processing systems will be initiated. Electro-optical device vulnerability assessment will continue. In the Near Millimeter Wave (NMMW) program, equipment capable of operating in a limited visibility environment is to be designed, and target/background signatures, measurement techniques, radars, and collection receiver technology will be investigated for NMMW all-weather Army systems. The fluidics program will continue efforts to develop and demonstrate high-reliability control systems and environmental sensing devices.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	6787	5994	5840	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	6636	6505	9014	Continuing	Not Applicable

In FY 1980, an increase of $151 thousand was required to complete Exploratory Development of the urgently required communications-electronics hardened tactical shelters. The FY 1981 decrease of $511 thousand reflects the application of general Congressional reductions. Planned funds for FY 1982 have been decreased $3174 thousand because funds were more urgently needed in higher priority areas of the Army's technology base program.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.21.20.A Title: Nuclear Weapons Effects, Near Millimeter Wave, Fluidics
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION:

1. (U) The Nuclear Weapons Effects (NWE) research program is an integral part of the Army Nuclear Survivability Program. The NWE research program is structured to provide adequate environmental definition for all nuclear weapon effects, to develop appropriate hardening fixes, and to provide technology for including nuclear survivability hardening during design and testing of systems in development. This is the Army's only program to provide the technology that enables development of equipment that will be survivable on the tactical nuclear battlefield.

2. (U) Near Millimeter Wave (NMMW) systems can provide better resolution of military targets than longer wavelength microwave systems. They are less affected by smoke and fog than electro-optic systems. The NMMW Technology Program will fill existing data gaps, develop NMMW measurement standards, and investigate new NMMW all-weather systems.

3. (U) Fluidics offer low maintenance, high reliability, intrinsically safe control systems that can operate in harsher environments than other types of controls, and are adaptive particularly to controls for missiles and remotely piloted vehicles, gas turbine fuel controls, and turret stabilization systems for armored vehicles. This program explores the applicability of fluidics to candidate systems sufficiently to demonstrate the feasibility of transferring technology to system development as cost-effective improvements.

G. (U) RELATED ACTIVITIES: Nuclear weapon effects research is part of a tri-Service effort in coordination with the Defense Nuclear Agency. It is a vital and essential part of the Army Nuclear Survivability Program. It is related to Program Element (PE) 6.36.04.A, Advanced Weapons Effects and Nuclear Munitions, which provides for technological assistance to materiel development agencies. All appropriate programs for missiles, combat vehicles, communication systems, and battlefield intelligence systems are supported by these efforts. The NMMW technology program is coordinated with research activities in PE 6.11.02.A, Defense Research Sciences, and other US Army Electronics Research and Development Command programs. Fluidic technology follows up on research in PE 6.11.02.A, Research in Fluidics, Nuclear Effects, and Ordnance Electronics.

H. (U) WORK PERFORMED BY: Harry Diamond Laboratories, Adelphi, MD; Ballistic Research Laboratory, Aberdeen Proving Ground, MD; US Army Electronics Research and Development Command, Fort Monmouth, NJ; US Army Missile Command, Redstone Arsenal, AL; White Sands Missile Range, NM; Air Mobility Research and Development Laboratory; Fort Eustis, VA; US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA. Contractors include General Electric, Schenectady, NY; University of Florida, Gainsville, FL; Shock Hydrodynamics, Ventura, CA; Physics International, San Leandro, CA; GTE Sylvania, Needham, MA; Science Applications, La Jolla, CA; Kaman Sciences Corporation, Colorado Springs, CO; Mission Research Corporation, San Diego, CA; Kaman Avidyne, Boston, MA; Braddock, Dunn and McDonald, Albuquerque, NM; Unidynamics, Phoenix, AZ; Northrop

Program Element: #6.21.20.A Title: Nuclear Weapons Effects, Near Millimeter Wave, Fluidics
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Corporation, Hawthorne, CA; Denver Research Institute, Denver, CO; Lovelace Foundation, Albuquerque, NM; AiResearch Manufacturing Company, Phoenix, AZ; TriTec, Inc., Columbia, MD; and Applied Physics Laboratory, Laurel, MD.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments:

a. (U) A comprehensive electromagnetic pulse (EMP) program was continued under which survivability levels are being established for Army single- and multi-channel radios, repeaters, and telephone terminals. Product improvement proposals to incorporate increased levels of EMP survivability into hardware have been initiated in cooperation with appropriate project managers. The High-Altitude EMP (HAEMP) vulnerability assessment of Selected Tactical Fire Control System (TACFIRE) equipment was completed. HAEMP hardening was developed for AN/TRC-138 and AN/TRC-112/121 multichannel communication equipment. Vulnerability assessment of the AN/VRC-12 and AN/PRC-77 radios was completed. Balanced effects vulnerability analyses of TACFIRE and communications mobile electric power units were advanced. The first successful low-altitude EMP simulation coupling test was completed using a bounded wave transmission line in the Aurora test cell. This test confirmed the response prediction for the AN/PRC-77 radio. The near-surface-burst EMP environments code production runs were made for Pershing and a Soviet-type warhead. An internal shock spectrum simulator was fabricated, and nuclear-blast-generated shock spectra were obtained for several communication devices. A selective shielding approach was demonstrated to reduce radiation vulnerability of armored vehicles by some 40 percent. A method was developed to harden fiber optic cables against blast and thermal effects.

b. (U) The design and construction contract of the NMMW Mobile Measurement Facility (MMF) with the Georgia Institute of Technology continued, and the 140 gigahertz (GHz) portion of the system was completed. The Mobile measurement facility will be used to characterize target and background signatures in realistic battlefield environments at 94, 140, and 225 GHz. Measurement procedures were formulated, and a detailed test plan for the Mobile Measurement Facility was developed. The system parameters and configuration of a lightweight handheld ground surveillance radar were defined. Multipath measurements at 94 GHz were made over water, gravel, and grassy terrains.

c. (U) Fluidic stabilization on helicopters and tank turrets, fluidic control of shock absorbers in automotive suspensions, and fluidic gas turbine fuel controls have been successfully demonstrated. In FY80, fluidic rate sensor/amplifier (rate gyro) circuits demonstrated superior accuracies. These circuits are being developed for heading reference units for navigation systems and as rate gyros for missile and remotely piloted vehicle controls. Temperature sensor hardware was installed at an Army plant for long-term evaluation. Technology coordination continued to be emphasized.

Program Element: #6.21.20.A Title: Nuclear Weapons Effects, Near Millimeter Wave, Fluidics
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

2. (U) FY 1981 Program:

a. (U) High-altitude electromagnetic pulse hardening and balanced vulnerability analyses will be initiated on the Intelligence Surveillance Target Acquisition (ISTA) and the Air Defense Command and Control systems. Balanced hardening fixes will be developed for low-, medium-, and high-capacity multichannel communications systems. The vulnerability analysis and hardening of a mobile electric power unit for selected communications systems will be continued. An effort to harden large computer vans will be initiated. A feasibility study will be completed for the large-area combined blast/thermal nuclear weapons effect simulator. A program will be initiated to predict the incidence, distribution, and the resulting damage to military units of tree blow-down and fires in forests as the result of a nuclear explosion and the resulting damage to military units. A program will be initiated to develop techniques for hardness assurance during manufacture and hardness maintenance of systems in the field.

b. (U) The basic near-millimeter wave mobile measurement facility for operation at 94, 140, and 220 gigahertz (GHz) will be completed. Transmission and target and clutter/background measurements in adverse environments will be made in Vermont, Western Europe, and other locations. A breadboard model of a very lightweight handheld 94 gigahertz (GHz) ground surveillance radar will be made. A prototype near-millimeter wave collection receiver will be designed; multipath measurements will be continued at 94 GHz. NMMW antenna technology will be investigated.

c. (U) Fluidic rate gyros for missiles and heading reference units will continue. Development of a no-moving-parts servovalve will begin. Work on an optical-to-fluidic interface will advance from research into exploratory development. Work will continue on a dual-channel fuel controller for increased survivability of armored vehicles. Technology coordination will continue.

3. (U) FY 1982 Planned Program:

a. (U) The program to develop techniques to predict the incidence and distribution of tree blow-down and fires in forests as the result of a nuclear explosion will continue. Source region Electromagnetic Pulse (EMP) studies will be completed. General technology efforts will continue with emphasis on vulnerability and hardening and identification of electro-optical device vulnerabilities. Development of hardness assurance and maintenance techniques will continue. Vulnerability and hardness assessments of automatic data processing systems will be initiated.

b. (U) The US Army Harry Diamond Laboratories (HDL) NMMW Mobile Measurement Facility (MMF) will be used to make measurements of transmission and of target and clutter background signatures in adverse environments in the United States.

Program Element: #6.21.20.A Title: Nuclear Weapons Effects, Near Millimeter Wave, Fluidics
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Modification of the MMF 140 gigahertz (GHz) transceiver for coherent operation will be initiated. Improved antenna and processor requirements will be determined for the very lightweight handheld ground surveillance radar. A NMMW (Near Millimeter Wave) collection receiver system will be designed and built. Multipath measurements will be made at 94, 140, and 220 GHz with the Mobile Measurement Facility (MMF) for various terrains and conditions of tactical interest. NMMW antenna technology for tactical application will be investigated.

c. (U) Development of a fluidic rate gyro for missiles will be completed, and heading reference units will continue. Work on a no-moving-arts servovalve, a backup fuel controller, and an optical-to-fluidic interface will be completed. Development of fluidic laminar proportional amplifiers will begin. Technology coordination will continue.

d. (U) The reduced funding in FY82 has curtailed hardening efforts for automatic data processing and key communications and target acquisition systems, and has deferred initiation of a vulnerability assessment for the Improved Hawk and Patriot air defense systems. Target background measurements utilizing the mobile measurement facility have been deferred. Development of the fluidic-optical transducer and fluidic fuel controller has been deferred.

e. (U) This program employs a total of 66 personnel, of which 58 are professionals and 8 are support.

4. (U) FY 1983 Planned Program:

a. (U) Experimental techniques for testing Army systems to the effects of low-altitude Electromagnetic Pulse (EMP) will be developed. Efforts to develop the technology to predict system vulnerability to the combined effects of blast and thermal will be continued. Efforts to define the tree blow-down forest fire environment will continue. Radiation and EMP vulnerability of emerging semiconductor technologies will be determined. The design for a large-area blast/thermal simulator will be completed. Vulnerability assessment of Intelligence Surveillance Target Acquisition (ISTA) and air defense systems will be initiated. A program to develop hardening techniques for the Low-Altitude Defense System will be initiated. Development of hardness assurance and maintenance techniques will continue. Vulnerability and hardening assessments of ISTA, Air Defense, and data processing systems will continue.

b. (U) The NMMW Mobile Measurement Facility (MMF) will continue to be used for measurements of background characteristics of expected tactical environments. The conversion to coherence of the 140 GHz system will be completed, and measurements of coherent clutter signatures will begin. The prototype lightweight 94 GHz ground surveillance radar demonstrator will be completed and tested in tactical environments. The NMMW collection receiver will be completed and tested; NMMW measurements standards will be investigated. Investigation of NMMW antiradiation weapon sensors will be initiated. NMMW antennas will be designed and tested for tactical application.

Program Element: #6.21.20.A Title: Nuclear Weapons Effects, Near Millimeter Wave, Fluidics
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

c. (U) Development of fluidic rate gyros for heading reference units and remotely piloted vehicles will be completed. Work on increased bandwidth laminar amplifiers will continue. Work on the no-moving-parts servovalve will be completed. The optical-to-fluidic transducer will be environmentally evaluated. Technology coordination will continue.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.22.01.A
Title: Aircraft Weapons Technology
DOD Mission Area: #523 - Engineering Technology (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	1901	1666	2290	2955	Continuing	Not Applicable
D1196	Aircraft Weapons Technology	1901	1666	2290	2955	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program generates concepts and demonstrates the technical feasibility for application of advanced armament techniques and weapons on Army aircraft for delivering ordnance to destroy, neutralize, or suppress enemy targets in the conduct of the land combat campaign. The objective is to provide the greatest possible weapons effectiveness at affordable costs in order to multiply the value of a single system through technology and compatibility with other systems.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Investigation of new concepts to improve the mission effectiveness of armed Army aircraft, initiated in FY 1981, will be continued and hardware developed. Areas to be addressed include target-sensing munitions to enable helicopter weapon subsystem to defeat point targets at extended ranges; self-defense air-to-air fire control to expand present helicopter air-to-ground capability to include defense from airborne threats; passive range-finding to improve effectiveness of automatic target; magneto-electric turret controllers which provide to potential of lighter weight and more accurate weapon turret system; interferometer technology to enable rapid and accurate acquisition of radar-directed defense systems.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

Program Element: #6.22.01.A Title: Aircraft Weapons Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	1901	1666	2290	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	2101	1808	2704	Continuing	Not Applicable

FY 1980 amount reduced due to reprograming to higher priority technology program. The FY 1981 decrease reflects the application of general Congressional reductions. FY 1982 decrease imposed by the Office of the Secretary of Defense (OSD) as partial offset for higher priority exploratory engineering programs.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.22.01.A Title: Aircraft Weapons Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Development efforts are directed toward strengthening the technology base of aircraft weaponry to provide the Army with advanced aircraft weapons and improved munitions. Effort is directed towards generating concepts and advancing technology necessary for improved performance and extended life. There are four areas of research and development: weapons system concepts, fire control, aerial munitions, and aerial rockets.

G. (U) 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 and to minimize duplication of effort. 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.

H. (U) WORK PERFORMED BY: Aviation Research and Development Command (AVRADCOM), St. Louis, MO; Armament Research and Development Command (ARRADCOM), Dover, NJ; US Army Missile Command (MICOM), Huntsville, AL; US Army Materiel Systems Analysis Activity (AMSAA), Aberdeen, MD. Contractors: General Electric, Binghampton, NY; Westinghouse, Baltimore, MD; Firestone, Akron, OH; Aerojet General, Downey, CA; Boeing Aerospace, Seattle, WA; and Texas A&M University, College Station, TX.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: High Impulse Gun Airborne Demonstration (HIGAD) project was completed. This project showed the feasibility of mounting a high-impulse weapon system on an Army helicopter. Included in this effort was the integration of new technology fire control features such as constant recoil, closed-loop fire control, improved stabilization, and precision aiming. Processing schemes have been formulated for millimeter wave radar to allow acquisition and tracking of fixed ground targets in a clutter environment. Tower testing is underway to verify fixed target detection. This evaluation established the ground rules regarding radar use on rotary-wing aircraft for both air-to-air and air-to-ground application. Optical sight model validation was performed which established a basis for comparison of advanced target acquisition methods with known optical capabilities. Analysis of helicopter air-to-air ballistic dynamics was completed. A firing test using the Multiweapon Fire Control System (MWFCS) with a dual-rate-of-fire turreted 20mm weapon was completed at Fort Bliss. Four contenders for a second-generation area weapon were evaluated and the Xm230, 30mm chain gun was selected. Studies were conducted to determine aerial weapon system 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.

Program Element: #6.22.01.A Title: Aircraft Weapons Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

Additionally concepts for a helicopter-launched antiradiation missile were evaluated. Fire control parameter analyses related to extending the range capabilities of ballistic and rocket weapons, remote control (drone) delivery systems, and night/all-weather systems were conducted. Firing tests with turreted and wing-mounted guns on the AH-1G attack helicopter were conducted to identify the different variables contributing to total firing error and magnitude of each error source. The spin insensitivity and penetration potential of a shallow cone-shaped charge warhead were also demonstrated. Firing tests of 2.75-inch rockets with submunition warheads were conducted to investigate the sensitivity of submunitions deployment variations in rocket trajectory. Design efforts for mass focus fragmentation and secondary trajectory stabilization for a submunitions and a fuze wave shaper for small caliber ammunition were initiated. Automatic target-cueing methodology was evaluated for television and FLIR (Forward Looking Infrared) sensors. A prototype autotarget-cueing system to provide a target detection capability for use with remote view imaging sensors was fabricated and flight testing planned. This effort establishes the basis for the fabrication of a fully operational airborne autotarget-cueing system. Initial work on smoothbore concepts for the high-impulse gun, capable of defeating enemy armor, was initiated. A precision point fire weapon concept using armed Remotely Piloted Vehicles in providing long-range standoff capability against enemy armor and hostile aircraft was pursued. A feasibility demonstration of low-cost radio frequency (RF) target marking system to allow integrated use of cannon and rockets on selected targets was initiated.

2. (U) FY 1981 Program: An investigation will be initiated to determine the possible use of Magneto-Electric effect to produce lightweight precision direction of aircraft weapons. A passive approach is represented in the design. An active forcing function approach will be addressed. The payoff is expected to be a lightweight, simplistic, more reliable system. Target-sensing armament will be investigated. The objective is to provide the Army aircraft the ability to deliver accurate munitions with a short time of flight. Air target concepts will be addressed. Present fire control systems on Army aircraft are designed primarily for engaging ground targets. The air target concepts will allow for successful engagement options to be defined which will allow for multiple weapon application. At present, the exploratory research program is culminating automatic target-cueing in a flyable breadboard design. Additional capabilities such as a passive range-finding and target handoff appear possible. The advanced Automatic Target Cueing research effort will be oriented toward providing these adjunct capabilities to the existing designs. .

3. (U) FY 1982 Planned Program: Efforts initiated in FY 1981 will be continued in FY 1982. Magneto-Electric breadboard hardware will be procured and test initiated. Hardware will be fabricated for the precision armament system and target sensing armament system. Computational algorithms, engagement strategies, ballistics motion, target lock-on functions and predictor techniques will be addressed for air targeting concepts.

4. (U) FY 1983 Planned Program: Efforts will be undertaken to address weapon system precision performance concepts. These efforts include such tasks as precision fire control, closed-loop fire control analysis and integration with man both

Program Element: #6.22.01.A Title: Aircraft Weapons Technology
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in and out of the loop, and automatic in-flight boresighting of all on-board armament and fire control subsystems. Continuing analyses of air-to-air fire control and munitions will be undertaken. Low-cost smart projectile concepts will be developed by the US Army Armament Research and Development Command (ARRADCOM), and Missile Command (MICOM) for rotary-wing aircraft utilization.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.22.02.A
Title: Aircraft Avionics Technology
DOD Mission Area: #521 - Electronic & Physical Science (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	6741	5598	6507	8155	Continuing	Not Applicable
AH85	Aircraft Avionics	6741	5598	6507	8155	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides the exploratory development technology base for Army avionics and related equipment in air-to-air and air-to-ground communications, environmental sensing, improvement of the helicopter man-machine interface, digital avionics, nap-of-the-earth navigation, air traffic management, and tactical instrument approaches. Future Army aircraft must have the flexibility to perform a variety of missions against a numerically superior enemy.

In addition, the increasing lethality and number of Warsaw Pact antihelicopter systems require enhanced survivability measures in new Army aviation systems. One key to providing this survivability and flexibility is implementation of a standard interface (defined now as MIL-STD-1553) and design of a modular, integrated, digital avionics system. These improvements will allow use of integrated controls and displays, plus automation of routine functions to allow aircrews to concentrate on tactical needs. Finally, lower cost and weight should result from these developments to provide benefits in improved aircraft performance and lowered life cycle costs.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: The FY82 program will concentrate on exploratory development for cockpit modernization, improved man-machine interfaces, improved airborne sensors, digital avionics, improved navigation and instrument approaches to landing at night and in adverse weather. Emphasis will be placed on readying new subsystems and techniques for demonstration in the UH-60A BLACK HAWK helicopter.

Program Element: #6.22.02.A
DOD Mission Area: #521 - Electronic & Physical Science (ED)

Title: Aircraft Avionics Technology
Budget Activity: #1 - Technology Base

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in Thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	6741	5598	6507	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	6322	6178	7739	Continuing	Not Applicable

The FY 1980 increase was the result of internal Army adjustments of $419 thousand to fund previously deferred work on aircraft antennas. FY 1981 and FY 1982 programs were reduced from previous estimates in order to fund higher priorities with reductions primarily in air traffic management work.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.22.02.A Title: Aircraft Avionics Technology
DOD Mission Area: #521 - Electronic & Physical Science (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This program explores new ideas, concepts, and techniques in aviation electronics. The objective of the program element is to determine the feasibility of applying new aviation electronics technology to Army aircraft and related ground equipment. Particular emphasis is placed on helicopter operations and crew workload at night, in adverse weather, and at low-level/nap-of-the-earth (NOE) altitudes.

G. (U) RELATED ACTIVITIES: An interservice Memorandum of Agreement was signed on 5 December 1980 to insure triservice participation, whenever appropriate, for new avionics developments. Related programs of the other services, the National Aeronautics and Space Administration and the Federal Aviation Administration are monitored to avoid duplication of development efforts. Resources are concentrated on problems which are Army-unique or not addressed by other development activities. This program element leads to developments in Program Elements 6.32.07.A, Aircraft Avionics Equipment, and 6.42.01.A, Aircraft Avionics.

H. (U) WORK PERFORMED BY: US Army Avionics Research and Development Activity, Fort Monmouth, NJ. Contractors include: American Electronic Laboratory, Wall, NJ and Colmar, PA; Raycomm, Freehold, NJ; RCA Corporation, Camden, NJ; Airborne Instrument Laboratory, Farmingdale, NJ, Sperry Rand, New York, NY and Phoenix, AZ; Singer/Kearfott, NJ; Litton Guidance/Control, Hawthorne, CA; Lear Siegler, Grand Rapids, MI; United Technology Research Center, East Hartford, CT; Analytical Sciences Corp., Reading, MA; General Electric, Binghamton, NY; Hazeltine, Greenlawn, NY; MITRE Corp., Washington, DC; Draper Labs, Cambridge, MA; Harris Corp., Melbourne, FL.

I. (U) PROGRAM ACCMMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Digital Avionics - In FY79 the US Army initiated an exploratory development program with the goal of applying digital system architecture to an entire aircraft system. This system of the future is called ADAS (Army Digital Avionic System). Sperry Flight Systems was competitively selected to develop the hardware for ADAS. The exploratory program for digital avionics has four phases. During the now-completed first phase, Sperry completely defined and characterized the ADAS (with assistance from Bell Helicopter). During this first phase, a system architecture was developed for the UH-60A STAR (System Testbed for Avionics Research) based upon the output of the Bell human factors engineering effort and a detailed analysis of the electronic sensors and subsystems on board the aircraft. Multiplex data bus controller hardware was designed, fabricated, and delivered along with appropriate software support in order to obtain an early start on the development of operational bus controller software for a bench verification phase and the aircraft demonstration phase. The ADAS control/display subsystem will provide fully integrated control and display capabilities for both pilots of the UH-60A STAR. The Night Navigation/Pilotage System (NNPS) effort was continued; hardware and software were supplied for initial flight evaluation of the terrain-aided AN/ASN-128 doppler navigation system (Phase 2). A contract for development of

Program Element: #6.22.02.A Title: Aircraft Avionics Technology
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the digital map generator portion of the NNPS was initiated with the Harris Corporation. Installation and operational tests of a cockpit simulator using conventional instruments driven off a data bus were completed. An Avionics System Engineering investigation for the Advanced Scout Helicopter was completed, and an investigation into the system engineering of the Light Experimental Helicopter was initiated. Aviation Communications - The objective of the Aviation Communications effort is to formulate requirements and demonstrate feasibility of future communications systems capable of reducing pilot workload, increasing mission effectiveness, and enhancing interoperability. Toward this end, during FY 1980 a contract with the MITRE Corporation, a federal contract research center, was initiated to examine the Army Aviation Command and Control requirement in relation to the Army-wide need and to formulate future communications requirements. In addition, development of an integrated bus-structured Digital Multiplexed Audio System was initiated. Environment Sensing - The primary thrust in this area is centered on providing a multifunction CO2 nap-of-the-earth sensor to simultaneously perform wire detection, terrain sensing, and three-axes doppler velocity sensing. This program consists of a two-phase effort, with Phase I begun in FY 1979. During 1980, the Multifunction CO2 Sensor Phase I design was completed, and a contract was awarded for Phase II hardware to explore tactical target descrimination and other nap-of-the-earth tasks. Hardware delivery is currently scheduled for FY 1981. Controls and Displays - There are three areas in this task: The Electronic Master Monitor Advisory Display System (EMMADS), Thin Film Electroluminescent Display, and the Integrated Mission Management System. During FY 1980, the EMMADS effort was continued. The Thin Film Electroluminescent Display and the Integrated Mission Management System will be FY 1982 starts. Improved Navigation - Three separate areas are continued in this effort; these are Navigation Systems, Navigation Sensors, and Navigation Hybrid/Position update. Navigation - Accomplishments to date include Special Electronic Mission Aircraft Navigation Analysis, Heading Reference Self-Calibration/Improved Dynamic Accuracy, Dead Reckoning Position Update Analysis, and two NAVSTAR/Doppler Patent Applications. Air Traffic Control - Incorporated advanced features into the experimental Very Lightweight Air Traffic Management Equipment and conducted quantitative system accuracy flight tests using the FAA Technical Center's measurement range. Landing - Applied in-house technical expertise by participation in USMC flight tests of scanning beam landing system and in FAA's Helicopter Flight Research Program. Prepared in-house simulator for investigation of the unique problem involving very close spacings of helicopters performing decelerated instrument landings.

2. (U) FY 1981 Program: The Army Digital Avionics System (ADAS) hardware fabrication will be completed. A sensor/controller simulator will also be integrated into the hot bench. A data base simulation computer program will be developed to provide a capability to simulate multiplex data base operation. Software programs will be converted from Phase II of the Night Navigation Pilotage Program to the Phase III configuration. This results in the integration of the following Night Navigation Pilotage functions: terrain correlation navigation update, high-speed digitally generated topographic map, and pilot and copilot symbology. The Light Experimental Helicopter (LHX) system architecture definition will be completed. Complete design and test of Single-Channel Ground and Airborne Radio System (SINCGARS V) Antenna. Hardware delivery of Phase I Multifunction

Program Element: #6.22.02.A Title: Aircraft Avionics Technology
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CO2 Nap-of-the-Earth sensor system. Advanced display techniques efforts will continue with emphasis on solid state display modules employing thin-film transistor on silicon circuitry and a solid state display medium. Complete flight test/data reduction for four state-of-the-art Advanced Heading and Reference Systems (AHRS); prepare a helicopter AHRS parametric specification. Complete test of NAVSTAR/Doppler Hybrid; document new processor requirements. Test new provisions for low airspeed in the lightweight doppler navigation system. Continue Doppler Position Location Reporting System hybrid. A prototype of a position/navigation system for Advanced Airborne Signals Intelligence Electronic Warfare system will be configured and flight tested. Complete and prepare a report of the Joint Tactical Information Distribution System/Doppler Hybrid Navigation experimental configuration. Continue attitude heading reference system efforts aimed at a solid state system for increased ruggedness and reliability. Continue emphasis on user dialogue to define the equipment for an Air Traffic Control Base. Define new air traffic control concepts using study results of multimode, ground passive, secondary radar techniques. Conduct flight research with FAA and initiate multiple helicopter decelerated landing simulation.

3. (U) FY 1982 Planned Program: During FY82 (Phase III) the Army Digital Avionics System (ADAS) will be evaluated on a digital hot bench to insure that all functions required can be easily performed. Also, the hot bench facility will be used for pilot familiarization. Due to the flexibility of the ADAS architecture any changes required as a result of the hot bench phase will be incorporated by software modification. At the end of the hot bench evaluation (approximately one year) the Army will begin the installation of ADAS into the UH-60A System Testbed for Avionics Research (STAR) (see DB97). Development of the Night Navigation Pilotage System (NNPS) will continue with emphasis on improved navigation algorithms. Design and fabrication of the Phase IV NNPS will be undertaken and advanced communication system analysis continued. A feasibility model of the Electronic Master Monitor Advisory Display System will be evaluated and a user/developer letter of agreement initiated. Based on FY80 Laser Advanced Heading Reference System (AHRS) study, a Procurement Work Directive for consignment/test of several laser AHRS candidates will be prepared. The Position/Navigation error budget analysis for late-80's helicopter scout/attack missions will be completed. Contract for and test Position Location Reporting System/Doppler position-up data link. Contract for strapdown magnetic compass. Complete study on applying Air Traffic Control technology and disciplines to the Army Aviation Command and Control problem. Initiate landing flight research in actual Instrument Meteorological Conditions with FAA and NASA.

Program Element: #6.22.02.A
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Title: Aircraft Avionics Technology
Budget Activity: #1 - Technology Base

4. (U) FY 1983 Planned Program: During FY83 the Phase IV Army Digital Avionics System (ADAS) will be flight tested in the UH-60A Systems Testbed for Avionics Research (STAR). This vehicle will provide Army pilots an opportunity to fly an integrated digital aircraft and provide valuable feedback. This vehicle will also provide a valuable system integration tool. Through its bus-oriented architecture, ADAS possesses a flexibility which promises major benefits to Army operational aircraft avionics systems. In addition, simulator experiments will be completed on a hot bench to assess the efficiency of display formats. Development of the full-capability Night Navigation and Pilotage System now including both airborne and ground elements will be started. System architecture efforts will incorporate new technologies (e.g., fiber optic data busses into Army avionics systems). Initiate program for development of the Integrated Mission Management System. Initiate breadboarding of critical design elements defined by advanced communications system analysis. Investigate antenna techniques for electronic counter-countermeasures for all aircraft communication bands. Initiate hybrid multispectral millimeter wave/CO2 earth multifunction system design. Prepare integrated system design of current and emerging communications and navigation systems with secondary radar techniques to enhance Air Traffic Control and Command and Control capabilities. Based on analysis and simulation results, develop experimental hardware for flight research on the multiple aircraft decelerating landing problem. Analyze error-budget for Doppler Altimeter/Inertial/NAVSTAR/Barometric Terrain Trend Determination. Breadboard/test microwave radiometric ground velocity measuring device and derivation of aircraft heading from Hybrid navigation equipment. Initiate Magnetic Map Navigation System development to achieve self-contained nap-of-the-earth position/navigation under all adverse conditions.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.22.09.A
Title: Aeronautical Technology
DOD Mission Area: #523 - Engineering Technology (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	16925	19572	18886	25585	Continuing	Not Applicable
AH76-A	Aerodynamics	2642	2653	2629	3562	Continuing	Not Applicable
AH76-B	Structures	2593	2232	2435	3299	Continuing	Not Applicable
AH76-C	Propulsion	2991	3086	3039	4117	Continuing	Not Applicable
AH76-D	Reliability & Maintainability	1383	1558	1567	2123	Continuing	Not Applicable
AH76-E	Safety & Survivability	2478	3003	2940	3982	Continuing	Not Applicable
AH76-F	Mission Support	964	1144	412	559	Continuing	Not Applicable
AH76-G	Aircraft Systems Synthesis	946	1948	2095	2838	Continuing	Not Applicable
AH76-H	Aircraft Subsystems	556	822	506	68[illegible]	Continuing	Not Applicable
AH76-J	Helicopter Analysis	1082	1429	1353	1833	Continuing	Not Applicable
AH76-K	R&D Flight Simulation	767	872	831	1125	Continuing	Not Applicable
AH76-M	Man-Machine Integration	523	486	642	870	Continuing	Not Applicable
AH76-N	Research Aircraft Systems	0	339	437	592	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The work performed under this program element is essential to permit Army aviation to maintain a technology advantage and to sustain the operational effectiveness and mission capability of future Army aviation systems integral to the conduct of land battle. The objective of this program is to conduct exploratory development and expand scientific knowledge in the field of aeronautical technology. Further, to exploit this knowledge within the various technical areas/disciplines to: increase operational effectiveness, reduce life-cycle costs, decrease dependence on mechanical components, and improve helicopter analysis, system integration and flight simulation capabilities, using both in-house and contract research efforts. Technical areas are as indicated above.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: The FY 1982 program provides for the continuing development of the aeronautical technology base with particular emphasis directed toward filling technological voids or deficiencies in aerodynamics,

Program Element: #6.22.09.A Title: Aeronautical Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

structures, and propulsion technology; specifically the areas of rotor flow fields, dynamic stall, helicopter drag, rotor/fuselage interaction, influence of ground effects on helicopter dynamics, dynamics of advanced rotors, vibration reduction, stability, control, handling qualities, design criteria, advanced structural materials (composites) for rotors and airframes, and small gas turbine engine components. Additional areas of effort will include in reliability and maintainability, development of diagnostic condition-monitoring capabilities; in safety and survivability, reduction of visual, acoustic, radar, and infrared signatures utilizing Stealth Technology; development of high-energy laser protection concepts; improved ballistic tolerance and crashworthiness. Under remaining tasks, 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 helicopter ground movement system; development of R&D simulators with analytical analysis capability; and reduced pilot workload through research in man-machine integration.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	16925	19572	18886	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	17128	21648	24028	Continuing	Not Applicable

The decrease in funding, $203 thousand in FY 1980, reflects transfer of funds to higher priority Army programs. The decrease in funding, $2076 thousand in FY 1981, is attributal to the application of general Congressional reductions and reductions for increased efficiency. The decrease of $5142 thousand in FY 1982 is to fund higher priority Army programs.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.22.09.A Title: Aeronautical Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The purpose of this program is to ensure a sound technical base for advanced and engineering development programs leading to improvements of the operational effectiveness and mission capability of Army aviation systems. This is necessary so that a technology advantage can be maintained for the US Army. Areas of investigation within the technology disciplines previously indicated 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 thermodynamics 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, flight simulation, and aviation human engineering. These technologies will be developed for application to all Army aircraft systems of the future, including the Advanced Helicopter Improvement Program (AHIP), the UH-60A BLACK HAWK Helicopter, the CH-47 Medium Lift Helicopter, and product improvement programs of other aviation systems.

G. (U) RELATED ACTIVITIES: Related programs are performed by the National Aeronautics and Space Administration (Low Speed Aircraft Research and Technology - 505-42-XX), Navy (Program Element # 6.22.41.N - Aircraft Technology), Air Force (Program Element # 6.22.01.F - Flight Dynamics), and the Federal Aviation Agency (FAA) of the Department of Transportation. Coordination to eliminate unnecessary duplication is accomplished by: joint program review, exchange of program data sheets, research and technology resumes, 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 lead into Advanced Development under Program Elements 6.32.01.A, Aircraft Power Plants and Propulsion; 6.37.11.A, Aircraft Electronic Warfare Self-Protection Equipment; 6.32.09.A, Air Mobility Support; and 6.32.11.A, Rotary Wing Controls, Rotors, Structures.

H. (U) WORK PERFORMED BY: The in-house portion of this program is accomplished at the US Army Research and Technology Laboratories, Moffett Field, CA; through the Aeromechanics Laboratory, Moffett Field, CA; Applied Technology Laboratory, Fort Eustis, VA; Structures Laboratory, Langley Research Center, VA; and Propulsion Laboratory, Lewis Research Center, OH. For FY 1982, fourty-four percent, or approximately seven million dollars, of the budget for this program is contracted. The principal contractors are Boeing Vertol Company, Philadelphia, PA; Sikorsky Aircraft, Stratford, CT; Pratt and Whitney Aircraft, West Palm Beach, FL; Bell Helicopter Textron, Fort Worth, TX; AiResearch Manufacturing Company, Torrance, CA; Detroit Diesel Allison, Indianapolis, IN; Hughes Helicopter, Culver City, CA. At least twelve other contractors will share in this program. Many contracts are still open and will be awarded on a competitive basis.

Program Element: #6.22.09.A
DOD Mission Area: #523 - Engineering Technology (ED)

Title: Aeronautical Technology
Budget Activity: #1 - Technology Base

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: A simulator study of helicopter symbology/control interaction was performed; as a result, it may be possible to improve Attack Helicopter hover/pop-up mission performance. A contracted effort to design and test the major joints and attachments on an all-composite helicopter was completed. The feasibility of turbulence intensity measurements in the combustor exit plane using laser doppler anemometry was demonstrated. A superhard transparent coating was developed and flight-tested under operational conditions. An aerosol program established the feasibility of a helicopter-mounted smoke/aerosol system to countermeasure the visual rangefinder/designator threat. Design and fabrication of a hook/beam external load flight demonstration hardware for simplified cargo handling were completed. Over 2000 Advance Helicopter Improved Program (AHIP) new design concepts were generated and evaluated for application to future AHIP efforts. Laboratory testing concentrated on compatibility of ice phobic coatings with rotor blade materials in conjunction with the Army Cold Regions R&D Laboratory. Second-Generation Comprehensive Helicopter Analysis System (2GCHAS) Project Office was formed. Development continued of SPURS-A, a hybrid analog computer and program for rotor mathematical modeling. Advanced software for display format research was also developed.

2. (U) FY 1981 Program: Results of the Improved Main Rotor Blade (IMRB) ogee tip tests will be documented. A study of composite helicopter crash characteristics will be completed. A study to demonstrate performance potential of a 10:1 centrifugal compressor stage will be initiated. Abrasion-resistant coatings of windshields will be tested in an operational environment. Protective armor kits for crew protection against 7.62mm and 12.7mm armor-piercing rounds will be designed incorporating latest lightweight armor technology. The tandem cargo hook breadboard hardware evaluation will be initiated through a coordinated flight program. Ice phobic coating, subjected to flight testing during FY 1980, will be evaluated under actual field conditions. The Second Generation Helicopter Analysis (2GCHAS) system design will be completed, and a design review government/industry working group will be held. Flight simulation development support will include engineering analysis and contract continuation. Pilot performance and workload measurement will also be continued.

3. (U) FY 1982 Planned Program: An empirically modified prescribed wake program will be evaluated using flight data from several full-scale and model tests. A rotor hub program for reducing weight and cost of helicopter rotor hubs while improving their integrity and maintenance requirements will be emphasized. Based on the T-700 engine core, three different fan/shaft engines will be characterized. Additionally, assessment of combat maintenance and repair requirements will provide a basis for changes in current maintenance policies. Fabrication of a ballistic-damage-tolerant flight control system, will be undertaken. Means to service and display Army aircraft in forward austere sites in a high-threat environment will be developed. Development, verification, and application of advanced concepts and designs of aircraft subsystem components, assemblies, and systems will continue. Development of executive and technology modules for Second Generation Helicopter

Program Element: #6.22.09.A Title: Aeronautical Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

Analysis System (2GCHAS) will continue; integration of completed modules will be initiated. At present, 281 civilian professionals and 19 military personnel will be involved in supporting this Program Element.

4. (U) FY 1983 Planned Program: Specific efforts planned include: Advanced rotor/airfoil combinations will continue to be developed. Advanced propulsion system components will be developed for fuel efficiency. Advanced hybrid composite components will be developed for minimum cost and weight; highly maintainable and repairable concepts will be emphasized. Systems survivable to sophisticated enemy threat will be developed. Ground support for forward area mobility will be emphasized. First level release of the Second Generation Helicopter Analysis System (2GCHAS) is planned.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: # 6.22.10.A
Title: Airdrop Technology
DOD Mission Area: #523 - Engineering Technology (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	1170	1467	1543	2009	Continuing	Not Applicable
D283	Airdrop Technology	1170	1467	1543	2009	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This Program Element supports basic airdrop technology. The technological output is critical in fielding new airdrop systems and equipment that provide and upgrade the US capability to employ and rapidly resupply airborne and conventional combat units. The feasibility of new airdrop concepts is evaluated which have potential for increasing mission capabilities of airdrop/airlift operations and for reducing the costs of acquisition, use, and logistics support of airdrop systems and equipment. The Airdrop Technology project consists of thirteen different technology efforts which support all of the military services and are the bases for the two related airdrop projects in advanced and engineering development.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Continue exploratory development efforts in the areas of Gliding Decelerator Technology, Rigging Technology, High-Level Airdrop Technology, Airdrop Simulation, High-Speed Airdrop Technology, Developmental Air Force Aircraft Engineering Support, Advanced Airdrop Technology, and Design Criteria for Airdrop Aircraft. Initiate exploratory work in Parachute Technology.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST ($ in thousands):

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	1170	1467	1543	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	1327	1882	2001	Continuing	Not Applicable

Program Element: # 6.22.10.A
DOD Mission Area: #523 - Engineering Technology (ED)

Title: Airdrop Technology
Budget Activity: #1 - Technology Base

The decrease of $157 thousand in FY 1980 is the result of general reprograming during execution and a decrease in the scope of work plannend. The decrease in FY 1981 reflects the application of general Congressional reductions and reductions for increased efficiency. The $458 thousand decrease in 1982 reflects the transfer of funds to priority efforts in other technology areas.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: # 6.22.10.A
DOD Mission Area: #523 - Engineering Technology (ED)

Title: Airdrop Technology
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Major areas of program effort are: (1) the study of concepts for the airdrop of personnel at low altitudes for mass tactical assault; (2) the development of criteria for the design and use of airdrop air transport aircraft; (3) exploring feasibility of airdrop at higher aircraft speeds and altitudes; (4) the development of practical concepts for the guidance/control of airdrop systems for supplies and equipment; (5) the development of new airdrop rigging concepts to lessen logistics and training burdens; (6) the development of computer and physical simulations to reduce development costs and to enable evaluations of airdrop systems under extreme and unsafe conditions; (7) the study of retrorocket and airbag impact-attenuating systems; (8) updating of parachute technology for all airdrop applications, particularly for heavy outsize loads, high rates of descent, and high aircraft drop speeds; (9) preliminary design of a system to airdrop a squad-size unit in a single module with individual and squad equipment. The specific objectives are to increase airdrop operational capabilities at all altitudes, at higher air speeds and in all weather and geographical environments, increase airdrop accuracy, reduce drop-zone dispersion, provide the technology base for advanced airdrop systems, eliminate technical barriers hindering attainment of new airdrop capabilities, and reduce the costs of developing and maintaining airdrop components and systems.

G. (U) RELATED ACTIVITIES: Program Elements 6.32.18.A, Airdrop Equipment and Techniques, and 6.42.18.A, Airdrop Equipment Development; Joint Technical Coordinating Group/Airdrop; North Atlantic Treaty Organization, and Air Standardization Coordinating Committee (ASCC/WP44); Mutual Weapons Data Exchange Agreements with France, Germany, and Korea; United States/Germany nonmajor items meetings. International and interservice agreements and boards are used to exchange information on gains in airdrop technology, to avoid duplication of effort through joint and combined efforts, and to promote and attain the objectives of US Rationalization, Standardization, and Interoperability (RSI) policies and programs.

H. (U) WORK PERFORMED BY: Arthur D. Little, Inc., Cambridge, MA; AAI Corporation, Baltimore, MD; Irvin Industries Ltd., Canada, Canada; Pioneer Parachute Co., Manchester, CT; Bertin & Cie, Plaiser, France; US Army Yuma Proving Ground, AZ; University of Minnesota, Minneapolis, MN; and US Army Natick Research and Development Command (NARADCOM), Natick, MA.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Completed tests of new materials for three-gallon Free-Drop Water Container. Evaluated contractor concepts for Drop Zone Assembly Aids (Visual) and awarded contract to test feasibility of near-term capability. Published a technical report on the use of retrorockets for soft landing cargo airdrop system and initiated testing of a French airbag platform energy dissipator system as an alternative concept for an airdrop soft landing system. Initiated in-house evaluations of various deployment concepts to prevent line twists of personnel parachutes. Initiated fab-

Program Element: # 6.22.10.A Title: Airdrop Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

rication of parachute models and completed simulation analyses in preparation for wind tunnel tests to solve problems of extraction parachute performance. Completed trajectory computer simulations of various 200-knot airdrop system concepts and designed a system to demonstrate a 200-knot capability using standard components. Completed nineteen flight tests of a high-level platform airdrop system prototype employing a two-stage recovery system and initial radio-controlled flight tests of a small-capacity gliding decelerator. Fabricated and wind-tunnel-tested three different 31-square-meter gliding canopy designs and awarded contract for guidance and control hardware system. Completed vehicle Roll-on/Roll-of rigging feasibility study. Initiated study of Test Operations Procedure to simulate airdrop testing of weapons and individual equipment jumped by parachutists. Developed a statistical model to simulate the aircraft roller-airdrop platform load interface, and completed literature search related to the use of physical scale modeling to simulate airdrop loading environments. The FY80 reduction in funds resulted in the cancellation or reduction in efforts planned for high-speed airdrop, procurement of guidance hardware for glider decelerators, the design of a medium-capacity glider, and evaluation of the French airbag platform system.

2. (U) FY 1981 Program: Complete materials evaluation, select new material for the Free-Drop Water Container and obtain Surgeon General's approval. Complete tests of French airbags and evaluate their potential for achieving a soft landing airdrop system. Develop new personnel canopy designs and deployment methods to improve turn rate, and conduct dummy airdrop tests of breadboard designs. Complete airdrop test report on C-141B aircraft and identify related Army airdrop developments to take advantage of enhanced airdrop aircraft capabilities. Complete preparation for and conduct wind tunnel tests to determine extraction parachute behavior behind model airdrop aircraft. Optimize High-Level Platform System design and initiate feasibility flight tests. Complete contract effort for on-board guidance and control hardware for gliding canopies. Complete evaluation of 225-kg-capacity gliding canopy designs and procure selected design(s) for a 1000-kg-capacity system. Refine and finalize statistical model to simulate the aircraft roller-airdrop platform load interface. Initiate studies to develop feasible concepts for airdrop on water drop zones and airdrop of large containerized loads; e.g., MILVANS and Sea Land-type containers.

3. (U) FY 1982 Planned Program: Continue exploration of new airdrop concepts and the development of advanced airdrop technology. Optimize design configurations for new tactical mass assault troop-type parachute. Continue to provide airdrop engineering support to developers of Air Force airdrop aircraft. Analyze wind tunnel test results of model extraction parachutes deployed behind model airdrop aircraft. Design prototype components of High-Speed Airdrop System to upgrade grade maximum airdrop speed to 250 knots and develop flight test plan. Complete feasibility test program of High-Level Platform Airdrop System and transition to advanced development. Test and evaluate alternative guidance and control schemes and initiate flight testing of 1000-kg-capacity gliding canopy. Define a Cargo Offset High-Glide Airdrop System and transition to advanced development. Initiate design concepts for rapid packaging and unpacking (rig/derig) of heavy drop platform

Program Element: # 6.22.10.A Title: Airdrop Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

loads. Continue study to simulate airdrop tests of weapons and individual equipment jumped by parachutists. Conduct in-house studies to determine techniques to scale airdrop systems and to simulate airdrop loadings and events and initiate scale model tests of airdrop systems and components. Update theoretical work in parachute technology and conduct related experimental tests. Continue to define airdrop systems usable on water drop zones and to study the feasibility of airdropping large containerized loads; e.g., MILVANS and Sea Land-type containers. Ten professional and five support personnel are involved in the program. Any reduction in funding will directly result in a decrease in the only DOD airdrop technology program. A reduction of $140 thousand or more will also result in a reduction in personnel.

4. (U) FY 1983 Planned Program: Continue exploratory efforts on: Advanced Airdrop Concepts; Developmental Aircraft Airdrop Engineering Support; Design Criteria for Airdrop Aircraft; High-Speed and High-Level Airdrop Technology; Gliding Decelerators; Rigging Technology; Airdrop Simulations; Soft Landing Concepts; and Parachute Technology. Initiate Free-Drop Technology effort, Soft-Landing Concepts, and Concepts for a Personnel Module Airdrop System.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.23.03.A
Title: Missile Technology
DOD Mission Area: #523 - Engineering Technology (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	28509	26288	30634	42075	Continuing	Not Applicable
A214-01	Sensors Technology	4934	4433	4528	6100	Continuing	Not Applicable
A214-02	Guidance and Control Technology	4503	3335	4080	5150	Continuing	Not Applicable
A214-03	Terminal Guidance Technology	2503	3525	3470	5116	Continuing	Not Applicable
A214-4	Digital Technology	1218	1400	0	0	Continuing	Not Applicable
A214-05	Simulation Research Technology	2148	1995	2549	3150	Continuing	Not Applicable
A216-06	Technology Demonstrations	3205	2400	4876	6556	Continuing	Not Applicable
A214-07	Aerodynamics Technology	2950	2675	2549	4800	Continuing	Not Applicable
A214-08	Propulsion Technology	3498	2885	3333	4700	Continuing	Not Applicable
A214-09	Ground Support Equipment Technology	1314	1550	1706	2500	Continuing	Not Applicable
A214-10	Structures Technology	855	840	490	1700	Continuing	Not Applicable
A214-11	Technology Integration	576	800	867	983	Continuing	Not Applicable
A214-12	Missile Technology Applications and Analysis	445	450	2186	700	Continuing	Not Applicable
A214-13	High-G Terminal Homing Technology	360	0	0	620	Continuing	Not Applicable

Program Element: #6.23.03.A Title: Missile Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This Program provides the Army exploratory development work leading to improvement in fielded Army missile and rocket components and technical options for use in future tactical missile systems in response to user prioritized science and technology (S&T) objectives. These S&T objectives are addressed through work in applied research, laboratory hardware development and limited technology demonstrations in the S&T areas of Close Combat, Fire Support, and Air Defense. This program is needed to protect US technological leads in tactical missile and rocket technology and provides the Army a critical capability to: (1) maintain expertise to be a smart buyer and provide the Army the best missile/rocket systems at the least life cycle costs; (2) provide for technological advancement in areas where there is little or no industry incentive due to lack of commercial applications; (3) provide a quick response capability in time of crisis; and (4) to preclude technological surprises by potential enemies. This program supports the DOD Guidance and Control Information Analysis Center both technically and fiscally.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: This request is for continuation of exploratory development in the application of the growth potential of electronic devices, sensors, and materials in missiles and rockets and will allow for the impact of inflation, and provide an increased investment in the user's highest air defense priority (defense against tactical missiles). Principal products under investigation are: an Active RF seeker for both close combat and air defense roles, RF active target simulation techniques, guidance algorithms for fire-and-forget seekers in close combat roles, adverse environment guidance techniques, dual-mode lightweight air defense suppression seeker, adaptive beam forming quiet radar for air defense, antitactical ballistic missile system synthesis, analysis techniques for submissile dispersion, strapdown inertial guidance components, low-signature launching and propulsion, kinetic energy rockets, composite missile structures, dynamically aimed free rockets, launch noise reduction, over-armor fly-by destruction technology demonstration, and an integrated terminal homing weapon system simulation.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	28509	26288	30634	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	27807	30368	34604	Continuing	Not Applicable

Program Element: #6.23.03.A Title: Missile Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

The change in the FY 1981 funding is due to a Congressional funding decrease. The decrease in FY 1982 is due to adjustments to the technical base in compliance with guidance for reductions for efficiencies and inflation.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.23.03.A Title: Missile Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This program provides for the integration of domestic and foreign technological innovations and advancements into Army missile and rocket components. Principal products under investigation emphasize true fire-and-forget missile technology, cost reduction techniques, missile operation in adverse natural and artificial environments, survivability enhancements, man-weapon interoperability improvements, and the exploitation of technological opportunities which may counter new threats and improve the force multiplier ratio of Army combat forces. The broad objectives of the program are to: (1) develop guidance and control and terminal homing systems having multimode and fire-and-forget characteristics, reduced vulnerability to antiradiation missiles, and the capability for operation in adverse weather and countermeasures environment; (2) develop minimum signature propulsion systems and low-cost missile/rocket components with improved service life; (3) reduce development costs through simulation/tactical software; (4) reduce risk in new system development. These objectives involve most of the scientific and engineering disciplines related to missile and rocket development. The program consists of 13 technology areas (corresponding to the project numbers listed in paragraph A). Work areas contained within the technology areas are: Sensors - advanced radar acoustic/infrared sensing and signal processing; optical command and beamrider; millimeter guidance; infrared homing; radio frequency (RF) guidance; sensor design and signal processing. Guidance and Control - advanced guidance systems; modular guidance; automatic tracking and integrated fire control; inertial components; laser designator/weapon systems simulation; advanced analysis for future missile guidance control. Terminal Guidance - guidance system integration and verification; optical homing; System application of sensors; laser guidance and designators; terminal homing measures. Digital - missile tactical software; missile imbedded computer hardware. Simulation Research - RF simulation technology; infrared/electro-optical simulation technology; hybrid computer technology; millimeter simulation. Technology Demonstrations - Air Defense weapons, infantry weapons, small craft weaponization; aircraft weapons; artillery systems. Aerodynamics - flow interference phenomena affecting tactical missiles; advanced missile interceptor aerodynamics; submissile aeroballistics; verification of hypervelocity antiarmor concepts; dynamically aimed free flight rocket concept; elastic airframe effects on missile performance; low-cost multiple rocket system aerodynamics. Propulsion - low exhaust signature propulsion; cost reduction; advanced concepts (for example, exploit laser-induced chemistry to overcome a propellant burning rate barrier for more effective future close support weapons and reduce impulse noise for advanced shoulder-fired weapons). Ground Support Equipment - launching techniques; airborne support equipment technology; launcher control systems; auxiliary systems technology. Structures - missile system structures; structures analysis; environmental effects (including advanced ablative radomes). Missile Technology Applications and Analysis - conduct antitactical ballistic missile system concept definition analysis; generate concepts for affordable future missile systems which can defeat the threat. High-G Terminal Homing - develop/assess strapdown IR and RF (active/passive) seeker; develop high-g gyros and gimbals in 155 mm and 8-inch sizes; aerodynamic response.

Program Element: #6.23.03.A Title: Missile Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

G. (U) RELATED ACTIVITIES: Efforts in this program relate closely to science and technology programs conducted by the Defense Advanced Research Projects Agency (DARPA) (PE #6.27.11.E, Tactical Technology), the US Navy (PE #6.23.32.N, Strike Warfare Weaponry Technology), the US Air Force (PE #6.26.02F, Conventional Munitions, and 6.36.01.F, Conventional Weapons) as well as to other programs within the Army (PE #6.33.06.A, Terminally Guided Projectiles). Duplication is precluded by active participation by laboratory personnel in interagency working groups, liaison visits to agencies/activities involved in missile-related science and technology work, the free exchange of information among agencies, via the Defense Technical Information Center and the National Technical Information Service, and deliberate structuring of the program to concentrate on the Army's unique needs in tactical missiles. Where areas of potential unwarranted duplication have been identified, appropriate agreements have been effected with the command/agency concerned. Membership exists in working groups of the Joint Services Guidance and Control Committee (JSGCC), The Joint (tri-Service) Technical Coordinating Group for Munitions Development (Missiles and Rockets), Joint Army/Navy/National Air Force Interagency Propulsion Committee, and North Atlantic Treaty Organization Panels. JSGCC working groups are structured in the areas of millimeter guidance, midcourse guidance, active/passive RF guidance, infrared guidance, and countermeasures/counter-countermeasures.

H. (U) WORK PERFORMED BY: The US Army Missile Command (MICOM), Redstone Arsenal, AL, has primary responsibility for execution of this program. Approximately 50 percent of the dollars are contracted out to more than 50 contractors and universities. Major contractors include Hughes Aircraft Corporation, Fullerton, CA; Battelle Memorial Institute, Columbus, OH; Texas Instruments Incorporated, Dallas, TX; and Martin Marietta, Orlando, FL. Universities include Georgia Institute of Technology, Atlanta, GA; Auburn University, Auburn, AL; University of Alabama, Huntsville, AL; University of Alabama, Tuscaloosa, AL; Tennessee Technological University, Cookeville, TN.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Completed development of an ultra low sidelobe antenna for the Quiet Radar. Demonstrated feasibility of millimeter differential guidance for antitank roles via ten successful guided flights. Demonstrated feasibility of a dual-mission (air defense/land combat) active radio frequency (RF) seeker. Completed multifrequency RF measurements to quantify target polarization signature effect. Developed an advanced signal processor for high angle of attack, indirect fire millimeter seekers. This effort was unique to the Army by joint agreement with the US Air Force. Evaluated available sensor technology for application to the field Army's antitactical ballistic missile (ATBM) role--effort interfaced with the US Army Ballistic Missile Advanced Technology Center via a formal, standing committee. Proved feasibility of liquid-discharge-eject, low-signature launching technique for missile shoulder-firing from enclosures

Program Element: #6.23.03.A Title: Missile Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

in urban conflict. Developed a realtime, closed-loop RF clutter simulation which was used for IHAWK evaluation. RF simulation support provided to the Joint Cruise Missile Project and the Joint Navy/AF Advanced Medium Range Air-to-Air Missile (AMRAAM) program. Completed a simplified inertial guidance demonstration (SIG-D) program with all objectives met or exceeded. Completed testing the Hemispheric Coverage Antenna (HCA), which is being considered for the field Army ATBM program. Established feasibility of a bidirectional fiber optics data link between a missile and a ground station. Developed a baseline minimum signature propellant which is committed to production for Chaparral and a TOW product improvement. Developed and distributed to government and industry the initial version of the Joint Army, Navy, NASA, Air Force (JANNAF) standardized plume flow field code. This is a jointly funded, coordinated program. Developed a family of low-cost microprocessor-based missile computers employing a jointly developed (USAF) communications data buss.

2. (U) FY 1981 Program: Complete the track-while-scan quiet radar and begin development of a short-range air defense digital beam-forming radar. Establish optimal design of an active RF air defense seeker with close combat capability. Evaluate ground target radar discriminants. Fabricate and test dual-mode, lightweight RF/infrared imaging seeker hardware for air defense suppression application. Conduct critical experiments for over-armor, fly-by missile sensors. Develop multispectrum imaging algorithms for autonomous Target Acquisition. Demonstrate minimum signature rocket motor for HELLFIRE application. Demonstrate an advanced, boost-sustain rocket motor with a 10-percent performance increase compared to IHAWK. Investigate intradifferential method of predicting aerodynamic forces for a high-angle-of-attack missile. Demonstrate the utility of a single penetrator, kinetic energy (SPIKE) rocket concept in an antiarmor role. Complete design of next-generation hybrid simulation processor and specification for a land combat RF simulator. Develop advanced guidance laws for close combat missiles. Develop inertial devices for tactical surface-to-surface missiles - microoptics gyroscope development is joint program with USAF. Expand baseline tools for missile software validation and verification. Develop analytic methods for design of composite missile structures. Demonstrate techniques for improving accuracy of short-range Military Operations in Urban Terrain (MOUT)/ASSAULT weapons.

3. (U) FY 1982 Planned Program: Demonstrate the quiet radar in a threat environment. Develop system concepts and architecture for a digital beam-forming antenna for air defense and antitactical ballistic missile (ATBM) applications. Fabricate a body-fixed, low-cost infrared seeker for direct fire use. Evaluate active array technology for direct hit capability of dual mission, small, RF missiles. Develop advanced image processing circuitry. Complete design of millimeter classification and guidance sensor for a high-rate-of-fire, direct fire guidance sensor. Demonstrate infrared (IR) strapdown sensor operation in a high-g environment. Develop a programable radio frequency signal processor compatible with very high speed integrated circuits/very large scale integrated (VHSIC/VLSI) devices. Develop breadboard model of a lightweight RF/IR

Program Element: #6.23.03.A Title: Missile Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

seeker for air defense suppression use. Select optimum guidance techniques for a field army antitactical ballistic missile. Continue assessment of adverse environments on developmental sensors and characterization of threat target signatures. Develop autonomous missile acquisition flight test hardware using previously developed algorithms. Validate the JANNAF plume model standardization code. Demonstrate low-cost, antiarmor and tactical surface-to-surface missile computer. Develop 3-degree-of-freedom generic antitactical ballistic missile systems simulation. Develop automatic missile loaders for ground and heliborne weapon systems. Improve target tracking accuracy in under-armor environments. Demonstrate technique to reduce propulsion noise levels to close combat gunners. Begin technology demonstration of a dynamically aimed free-flight rocket.

4. (U) FY 1983 Planned Program: Complete definition of the digital beam-forming radio frequency (RF) signal processor architecture, complete algorithm development, and develop a solid state module using very high speed integrated circuitry (VHSIC) technology. Complete evaluation of a lock-on-after-launch infrared imaging seeker for indirect fire and the long wavelength infrared rosette land combat seeker. Complete field tests on dual-mission RF Active Seeker. Validate RF target classification and signature analysis data. Begin fabrication of a breadboard millimeter target classification and guidance sensor for high-rate-of-fire, direct fire guidance. Evaluate error sources for direct fire guidance in the millimeter and laser regions. Demonstrate a minimum signature motor for Short-Range Air Defense System (SHORADS) application. Develop initial hardware for an RF land combat target simulator. Develop heliborne multiple target-to-seeker handoff techniques. Validate submissile deployment dynamics methodology. Extend advanced air defense interceptor methodology to hypersonic regime. Develop design and fabrication techniques for advanced matrix composite missile structures. Begin feasibility demonstration of the spinning plug nozzle guidance concept for close combat missile use. Complete demonstration of the single penetrator kinetic energy (SPIKE); solid propellant, advanced ramjet, kinetic energy (SPARK); and dynamically aimed free-flight rocket concepts.

5. (U) Program to Completion: This is a continuing program. Following areas will be emphasized: (a) reduction of air defense vulnerability to antiradiation missiles; (b) all-weather, countermeasure hardened, fire-and-forget seekers with multimode capability; (c) millimeter wave seekers and beamrider guidance concepts; (d) low-cost inertial guidance; (e) minimum signature propulsion, improved service life; (f) simulation; (g) digital technology for small tactical missiles; (h) low signature launching techniques; (i) more accurate under-armor tracking systems; (j) application of composite structures for reduced weight, higher performance, and reduced cost in missile/rocket systems; (k) improved efficiency in structure analysis; (l) automatic tracking algorithms; (m) improved aerodynamic designs to enhance missile performance and effectiveness; (n) development of automatic self-test techniques for missile systems.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: # 6.23.07.A
Title: Laser Weapons Technology
DOD Mission Area: #521 - Electronics and Physical Sciences (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	1320	18759	24956	32077	Continuing	Not Applicable
A139	Laser Weapons Technology	1320	18759	24956	32077	Continuing	Not Applicable

B. BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Army needs rapid fire laser weapons systems for employment against the large quantities of used on the weapons and support systems of potential enemies. The laser weapons technology program explores the potential weapon system uses of the laser and concurrently advances the technology base toward future application to Army missions. Emphasis is being placed on improvements and advancements in laser components and subsystems, concept development and demonstration, and lethality verifications. Laser weapon systems, with their large magazines, low cost per shot, and instant delivery, can have significant, possibly unique, capabilities against the target-rich environment of large numbers of sophisticated weapons and sensors of future battlefields. Potential Army mission applications include the attack of critical components of ground targets in the close combat role,

This program is needed to provide the Army a critical capability to: (1) establish and maintain expertise to be a smart buyer; (2) provide for technological advancement in areas where there is little or no industry incentive due to a lack of commercial markets; (3) provide a quick response in time of crisis; and (4) preclude technological surprises by potential enemies.

Program Element: # 6.23.07.A
DOD Mission Area: #521 - Electronics and Physical Sciences (ED)

Title: Laser Weapons Technology
Budget Activity: #1 - Technology Base

C. BASIS FOR FY 1982 RDTE REQUEST: Effort will be performed in FY82 on the Forward Area Laser Weapon Demonstrator (FALW-D), the laser weapon brassboard (ROADRUNNER), and the technology of laser components and new laser sources.

FALW-D.
forward area laser weapon technology brassboard to demonstrate the potential of

It is planned to maintain multiple competitive contractors at least through the Preliminary Design Review in late

ROADRUNNER.
laser weapon brassboard for the
field environment demonstration of the potential of compact, lightweight, laser weapons for use on
Army combat vehicles to that the enemy seeks to
employ in the close combat area. It is planned to compete two contractors up to the Critical Design Review late in when
a single contractor will be selected to continue the program.

(U) High Energy Laser Technology. Advancement of the technology base will be continued through the development of laser energy-generating mechanisms such as the pulsed electric and chemical lasers, the development of large rugged optics to survive on the battlefield while withstanding high energy densities, the expansion of the laser effects and vulnerability data bases, and the pursuit of aggressive acquisition and fire control programs.

D. COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	1320	18759	24956	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	20500	20387	22468	Continuing	Not Applicable

Program Element: # 6.23.07.A
DOD Mission Area: #521 - Electronics and Physical Sciences (ED)

Title: Laser Weapons Technology
Budget Activity: #1 - Technology Base

There were programmatic changes between the FY 1981 and FY 1982 Summaries due to an Army decision in FY 1980 to emphasize near-term High Energy Laser applications. The Army/Air Force Joint Short-Range Test, was discontinued in favor of, activities to develop and field test brassboard technology demonstrator systems for a Forward Area Laser Weapon (FALW-D), and for an close combat laser weapon (ROADRUNNER). In addition, increased Army involvement in the Navy SEALITE lethality verification program is planned. The decrease of FY 1981 funds reflects the Laser Weapons Technology program portion of general Congressional reductions resulting in delay to the pulsed chemical laser technology and deletion of ROADRUNNER risk reduction efforts. The increase in FY 1982 funds will increase the effort toward pulsed chemical laser technology and increased risk reduction efforts for FALW-D and ROADRUNNER providing acceleration to the demonstration schedules.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: # 6.23.07.A
DOD Mission Area: #521 - Electronics and Physical Sciences (ED)

Title: Laser Weapons Technology
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The objectives of the Army High Energy Laser program are to develop the laser weapons technology base to permit future laser weapon system developments, develop laser weapon system concepts for viable Army missions, demonstrate the lethality capabilities of laser systems, and explore the possible utility of unconventional beam technologies. As a result of the Army Laser Weapon Technology Assessment (ALAWTA) conducted between May 1979 and January 1980, this program has been redirected to concentrate on concepts and technology that will provide near-term payoff. This program now consists of two medium-power laser weapons demonstration efforts along with the technology base development. A laser has several unique features which could make it a highly effective weapon in a target-rich environment: instant delivery; agile beam; short engagement time; large target-handling capabilities; low cost per shot and capabilities of causing mission abort, short of a hard kill. Laser weapons technology areas supporting eventual weapon system development include: laser devices and components; acquisition/beam control/fire control; propagation/effects/vulnerability; and concept development/validation. The Army's laser weapons technology program concentrates on developments in these areas for the two leading candidate laser approaches, continuous-wave chemical laser and repetitively pulsed electric laser, as well as further developing other emerging laser approaches and concepts which show promise for radiation weaponry.

G. (U) RELATED ACTIVITIES: In FY 1980, the Army High Energy Laser (HEL) program was funded $20,320,000: $1,320,000 in Program Element (P.E.) #6.23.07.A, High Energy Laser Technology, and $19,000,000 in P.E. #6.33.14.A, High Energy Laser Components. In FY 1978 and FY 1979, exploratory development of HEL was conducted as a task in P.E. #6.23.03.A, Missile Technology. From FY 1975 through FY 1979, nonsystems advanced development of HEL was conducted under P.E. #6.33.14.A, High Energy Laser Components. From FY 1977, research in HEL has been conducted under P.E. #6.11.02.A, Defense Research Sciences. Other HEL development is being accomplished by the Navy (P.E. #6.27.35.N, High Energy Laser, and P.E. #6.27.68.N, Directed Energy), the Air Force (P.E. #6.36.05.F, Advanced Radiation Technology, and P.E. #6.26.01.F, Advanced Weapons), and the Defense Advanced Research Projects Agency (P.E. #6.27.11.E, Experimental Evaluation of Major Innovative Technologies, and P.E. 6.23.01.E, Strategic Technology). Different battle environments and system platform requirements for the different Services require significantly different High Energy Laser technology approaches for each. The Service programs are closely coordinated by the Office of the Under Secretary of Defense (Research and Engineering) to preclude duplication of effort. A number of work efforts in the Department of Defense High Energy Laser program are jointly funded and performed. In years prior to FY 1975, Army High Energy Laser development was funded under a series of Program Elements - P.E. #6.21.39.01.A, High Energy Laser Research, P.E. #6.23.03.A, High Energy Laser Research, P.E. #6.26.03.A, High Energy Laser Research, P.E. #6.26.09.A, Project EIGHTH CARD, P.E. #6.26.12.A, Project EIGHTH CARD, P.E. #6.27.03.A, High Energy Laser Research, P.E. #6.27.05.A, High Energy Laser Research, P.E. #6.26.21.A, Laser Technology and Applications, and P.E. #6.36.11.A, High Energy Laser Developoment, Advanced Laser Development, and Project EIGHTH CARD.

Program Element: # 6.23.07.A
DOD Mission Area: #521 - Electronics and Physical Sciences (ED)

Title: Laser Weapons Technology
Budget Activity: #1 - Technology Base

H. (U) WORK PERFORMED BY: The top five contractors are: Rockwell International, Anaheim, CA; Lockheed, Sunnyvale, CA; AVCO Everett Research Laboratories, Everett, MA; TRW, Inc., Defense and Space Systems Group, Redondo Beach, CA; and W. J. Schafer Associates, Wakefield, MA, with an estimated contract value of $9.0 million in FY 1981. There are 30 additional contractors with an estimated total contract value of $5.0 million in FY81. The principal government organization conducting this technology program is the Directed Energy Directorate, Army Missile Laboratory, US Army Missile Command, Redstone Arsenal, AL. Other government organizations performing tasks under this project are: US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA; US Army Electronics Research and Development Command, Adelphi, MD; the White Sands Missile Range, NM; Naval Research Laboratory, Washington, DC; Naval Sea Systems Command, Washington, DC; and the national laboratories at Los Alamos, NM, and Livermore, CA.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1980 and Prior Accomplishments: Technologies necessary for Army High Energy Laser (HEL) weapon system applications have been identified and partially developed through research, subscale demonstrations, and selected scaling experiments. Both Repetitively Pulsed (RP) CO_2 electric discharge and continuous wave (CW) DF chemical laser devices are being developed as well as components and subsystems required for acquisition, beam control, and fire control in close combat and air defense scenarios. Integrated tests of the Modular Army Demonstration System (MADS) chemical laser device were completed, demonstrating exhaust-free operation in a duty cycle at power output. A fire control simulator was designed which will permit in a cost-effective manner the solving of interface/integration problems associated with the various subsystems of the laser weapon system. Test planning for the Joint Army/Navy hotspot tracking field test program (HOST II), using an Army-developed advanced brassboard tracker, was initiated. Solid window materials for chemical lasers were successfully tested; these windows This milestone was a significant step toward reducing the complexity of laser weapons and demonstrating their eventual fieldability. The Army Laser Weapon Technology Assessment (ALAWTA) was completed, and technically and tactically viable near-term laser weapon applications were identified. The tactical applications include

This assessment resulted in a redirection of the Army HEL Program toward nearer term, lower risk systems with potential payoffs that were attractive to the Army.

2. FY 1981 Program: One of the major thrusts of this program is to design and develop a technology brassboard system (Forward Area Laser Weapon-Demonstrator, FALW-D) to prove the utility of high-energy lasers in the Close Combat and Forward Area Air Defense mission areas. Concept formulation is being accomplished for a brassboard system (ROADRUNNER) to

demonstrate the ability of currently available, lighter weight lasers for

The expansion of the HEL technology base to make laser weapons affordable, efficient, and reliable is an essential input to these demonstrators. Emerging repetitively pulsed chemical laser device technology is being evaluated for future air defense weapons roles, both in the forward areas and in vital asset defense. Increased reliability of electric lasers through ultraviolet (UV) preionization techniques will be investigated. A Solid Oxidizer fluid supply subsystem will be demonstrated in scale hardware to show the logistic supportability of chemical lasers. The digital computer simulation of a laser fire control will be developed with hardware in the loop capability to aid in identifying subsystem integration opportunities or problems and to forewarn of any technology shortfalls.

3. FY 1982 Planned Program: The Preliminary Designs of the competing concepts for the Forward Area Laser-Demonstrator will be evaluated, and the best technical approach will be selected for detailed design in FY 1983. Based on additional battlefield effectiveness modeling and sensor vulnerability testing, the design for ROADRUNNER will be completed and test plans developed for fabrication and testing in Technology development thrusts will include testing and evaluation of the upgraded continuous wave (CW) chemical laser module previously developed with improved nozzles, resonators, chemical pumps, and solid reactant fuel supply subsystems. Pulsed chemical laser technology developments will be expanded to determine scalability for Army applications. Compact, lightweight prime power and power conditioning subsystems for electric lasers compatible with FALW-D will be completed. The Joint Army/Navy HOST II Program will be completed, thereby establishing the value of hotspot tracking for Army close combat and air defense missions.

The data base of laser beam interactions with aerosols, such as battlefield dust and smokes, will be expanded through controlled field tests, and laser propagation codes will be modified to better include "dirty battlefield" effects.

4. FY 1983 Planned Program: The overall thrust of the program is to advance the state of the art so that, at the completion of the FALW-D and ROADRUNNER demonstrations, the technology will support fabrication of full-up prototypes. Continued improvements in chemical and electric laser technology will be pursued to develop higher efficiency, lower operating cost, field supportability, and reduced volume and weight. Methods for realtime kill assessment for laser air defense weapons will be tested and integrated into the fire control subsystem. The fire control simulator to include hardware-in-the-loop capabilities will continue to be expanded to permit evaluation of laser weapon system components and subsystems. The HEL Integration Tracker subsystem will be completed and its performance capabilities evaluated through beam control field tests. System definition studies will be conducted to establish mission requirements for the beam control

field tests. System definition studies will be conducted to establish mission requirements for the High-Energy Laser Vital Asset Defense System to defend airfields, nuclear delivery units, and other key tactical installations against Army decisions on combat vehicles to carry the ROADRUNNER and FALW, operational and organizational concepts, and the laser weapon mix/interaction with other combat systems, will be sought based on initial cost and operational effectiveness analysis.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.26.01.A Title: Tank and Automotive Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	12152	12909	15785	19362	Continuing	Not Applicable
AH91	Tank and Automotive Technology	12152	12909	15785	19362	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The purpose of this program is: (1) to advance the state-of-the-art of tank and automotive technology to allow development of Combat/Tactical systems which can defeat the anticipated threat in a battlefield environment; (2) to conduct product line planning and develop technology to improve the cost and combat effectiveness of tank-automotive systems; (3) to improve mobility through the development of improved engine, transmission, and supporting tank-automotive components; (4) to conceive, design, and evaluate total system concepts to meet user needs both explicit and implied; and (5) to enhance vehicle survivability against current and anticipated threats through the integration of vehicle design, active and passive countermeasures, and composite materials.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Supports continuation of over fifteen tasks begun in prior years and the initiation of several new tasks including some that were delayed due to the general Congressional reduction to this program in FY 1981. All tasks for which funds are requested offer significant potential improvements in the performance of ground combat and tactical vehicles; objectives include improved fuel economy, increased track and suspension life, improved fire detection and suppression, a better quality of ride, and enhanced diagnostic techniques, among others. A more detailed discussion of the basis for the FY82 request can be found in paragraph I3.

Program Element: #6.26.01.A Title: Tank and Automotive Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	12152	12909	15785	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	11487	15571	19791	Continuing	Not Applicable

FY80 increase of $665 thousand was utilized to fund radial turbine effort, advanced suspension effort, and advanced fuels work. FY81 decrease attributed to a general reduction for inflation and a $2 million Congressional reduction resulting in reduction in scope of several ongoing tasks and cancellation of some initiatives. FY82 decrease due to change in scope and support for higher priority Army near-term readiness goals.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.26.01.A Title: Tank and Automotive Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DISCRIPTION: This Program Element provides funds to advance the state-of-the-art in tank and automotive technology, eventually leading to the development of ground combat and tactical vehicle systems and componentry which improve the Army's ability to operate against the anticipated threat. The program is divided into four areas: mobility, systems integration, survivability, and support. The Mobility effort provides for exploratory development of improved propulsion systems, track and suspension systems, structures/chassis, and components/materials. Systems Integration explores development of advanced concepts for future ground combat and tactical vehicle systems, methodologies for optimizing total system designs, and examination of new techniques to assist the designer in creating an optimized design. Survivability addresses the means by which a vehicle and its crew can best be protected from enemy detection and, if detected, measures to be taken to improve survivability and armor/hardening. The Support area addresses human factors engineering, reliability, availability, and maintainability, training, and integrated logistics support.

G. (U) RELATED ACTIVITIES: Specific programs related to the technical areas of this program element are: PE 6.11.02.A, Defense Research Sciences; PE 6.21.05.A, Materials; PE 6.26.03.A, Large Caliber and Nuclear Technology; 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, Combat Vehicle Propulsion Systems PE 6.36.31.A, Combat Vehicle Turret and Chassis; PE 6.36.24.A, Mobility; PE 6.23.79.A, Test Measurement and Diagnostic Equipment; PE 6.36.02.A, Advanced Land Mobility Systems Concepts; and PE 2.37.35.A, Combat Vehicle Improvement Program. A close relationship is maintained with other services and government agencies through regular conferences and coordination meetings to preclude duplication of effort. Research and development information concerning information concerning respective allied tank-automotive technology is being shared via data exchange agreements.

H. (U) WORK PERFORMED: US Army Tank-Automotive Command, Warren, MI, has the responsibility for the implementation of this program. Other Army in-house organizations that support this program are: US Army Armament Research and Development Command, Dover, NJ; Waterways Experimental Station, Vicksburg, MS; and Cold Regions Research and Engineering Laboratory, Hanover, NH. Major contractors participating in the program are: Stevens Institute of Technology, Hoboken, NJ; Garrett Corp, Phoenix, AZ; Northrup Corp, Ventura, CA; Hamilton Instruments, Houston, TX; Optimetrics Inc, Ann Arbor, MI; Keweenaw Research Center, Houghton, MI; Environmental Research Institute, Ann Arbor, MI; and Battelle Laboratory, Columbus, OH.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Established the Tank Science and Technology Base Program as the framework for future tank development efforts. Completed initial systems-level concept design for an advanced main battle tank. Completed development of the survivability optimization model and initiated its use as a concept analysis tool. Completed a

Program Element: #6.26.01.A Title: Tank and Automotive Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

feasibility study of an adiabatic diesel engine, advanced turbine components, mine-resistant track system, nonmetallic composites for components, protection from overhead submunitions and run-flat bonded tire. Verified the feasibility of 10-ton heavy expanded mobility tactical trucks based on commercial components.

2. (U) FY 1981 Program: (1) Advanced Adiabatic Components-Exploratory Investigations of various friction-reduction techniques will continue to be explored using various high-temperature ceramic materials and designs; work will involve single-cylinder engine demonstration; (2) Advanced turbine-combustor components will be designed and evaluated to determine fuel system management techniques, compatibility of alternate fuels against petroleum baseline for performance, lubrication/wear, efficiency impact on durability and reliability emissions and signature; (3) Advanced engine intake air filtration self-cleaning systems will be evaluated; this approach promises to reduce maintenance and increase filter life; also, the Tank-Automotive Command will evaluate dust detector technology with the idea of providing a signal when excessive dust is being ingested by an engine; (4) advanced transmission concepts for future engines will be initiated to include final configuration layouts along with some testing at the component level; this effort will be followed by an evaluation of major subassemblies leading to the building and evaluation of complete transmissions; TACOM will perform studies and analyses of functions of various transmission component areas including hydrostatic systems, steering systems, increased shaft and gear speeds and alternate materials; (5) specific concepts of a bidirectional suspension system will be analyzed for operational and cost effectiveness; the selected concept will be pursued to incorporate desired modification in a specific design; (6) track-rubber processing techniques to improve quality and reduce cutting/chunking in the field will be investigated; (7) competitive contracts with industrial teams will examine concepts for the post-1985 timeframe.

3. (U) FY 1982 Planned Program: (1) Continue development and refinement of friction-reduction techniques to improve performance of high-temperature diesel engines. Component development will be initiated to include hardware fabrication testing for application in future advanced turbine engines; (2) characteristics of candidate high-energy power systems will be evaluated, and a breadboard system will be developed; (3) alternate fuel work will continue to determine design changes required to enable efficient operation of selected fuels; (4) the Tank-Automotive Command will investigate state-of-the-art equipment, formulate concepts, and establish technical requirements for available auxiliary power systems; (5) TACOM will also initiate evaluation of electrostatic repulsion of dust from engine intake system as well as dust separator technology and advanced inertial separator concepts; (6) TACOM will continue to develop new track/rubber processed compounds and the bidirectional suspension unit, complete analysis of track retention and control systems and prepare data for a prototype fixed-pitch positive guided system. Efforts will include initiation of concept design for a terrain complaint suspension system; (7) analysis of future close combat vehicle design concepts will be completed and promising concepts prepared for demonstration; (8) a third iteration of signature reduction countermeasures techniques will be executed in GE with USAF and NATO participation; (9) participation in lightweight combat vehicles design and analysis will continue; (10) system integra-

Program Element: #6.26.01.A Title: Tank and Automotive Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

tion analysis will be performed concerning missile applications for close combat vehicles; (11) development of magnetic bea ing indicators will continue; (12) a brassboard pneumatic gyro rate sensor will be integrated into a technology demonstrator, and an all-pneumatic stabilization system prototype will be developed; (13) modification of thermal sources on ground combat vehicles for alteration of image cues in target selection will be undertaken; (14) track and engine silencing techniques and components will be integrated and evaluated for effectiveness; (15) control of vehicle-generated dust will be achieved by design of necessary components; (16) total vehicle lighting system will be modified to enhance security against image intensifiers; (17) sensitive components will be evaluated for susceptibility to laser damage; (18) evaluation of ammunition fire suppression systems through large-scale ballistic tests will be made, signatures of penetrating rounds will be obtained, and fire-suppressant toxicity will be determined; (19) laboratory evaluations of methods for using vehicle engine air filters and primary dust separators for crew nuclear, biological, and chemical protection will be made.

4. (U) FY 1983 Planned Program: (1) continue development of advanced adiabatic components, turbine engine components, concept work for alternate fuels, advanced air filtration systems, long-life track and NBC-tolerant rubber for roadwheels; final work will result in minimum friction, adiabatic diesel engine incorporated into future generation of highly efficient high-temperature diesel engines; (2) perform transmission component redesign; (3) conduct analysis of track retention and fixed-pitch track and coordinate bidirectional and adaptive data into terrain-compliant suspension; (4) explore new technology in area of fire-resistant materials; (5) evaluate new extinguishing agents; (6) investigate integration of previous test set functions into current vehicle diagnostic equipment; (7) continue development of NBC materials and techniques; (8) explore technology to develop high-energy power sources in burst power concept and conduct fuel tolerance investigations to widen spectrum of fuels for use in advanced engines.

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

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.26.03.A
DOD Mission Area: #523 - Engineering Technology (ED)

Title: Large Caliber and Nuclear Technology
Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	26330	24646			Continuing	Not Applicable
AH18	Large Caliber and Nuclear Technology	26330	24646			Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The objective of this program is to establish and maintain a technology base upon which advanced and engineering development of major caliber weapon systems and munitions can be initiated and sustained. The effort conceptualizes revolutionary systems and defines ways of product-improving the current systems. The program scope embraces munition systems for armor, infantry, field artillery, air defense, aviation, and combat engineering. Technology areas include human factors, energetic materials, explosives, propellants, and pyrotechnics, weapons, conventional munitions, fuzing, training munitions, and weapon/munition interfaces.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: This program will support the continued exploratory development and maintain each of the medium and large caliber weapon systems, infantry armanent systems, and combat engineer armament support systems. This base also encompasses the exploratory development of technological opportunities in the areas related to propellant and explosive charges/fillers, cannons, projectiles, ammunition fuzes, and other types of munitions.

Program Element: #6.26.03.A Title: Large Caliber and Nuclear Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

D. COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	26330	24646		Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	24482	30291		Continuing	Not Applicable

The increase in current requirements over funds requested in the FY81 submission for FY 1980 was due to expanded efforts within the areas of target acquisition munitions, infantry armament systems, artillery armament systems, munitions technology, and munition and propulsion interface technology. The FY 1981 decrease reflects the application of a specific reduction by Congress and general Congressional reduction for inflation and technology base studies and analyses. The FY82 decrease has resulted from reorientation of Army priorities, and as a result of the amended budget submission, which will cause a constrained level of effort within nonsystem-related exploratory development programs.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.26.03.A Title: Large Caliber and Nuclear Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION. This program element provides the advanced technology and exploratory development thrusts for improved major caliber nonnuclear and nuclear weapon systems. The program is divided into two major categories: technical areas dedicated specifically to systems that will enhance the capabilities of the Army branches that comprise the combat arms structure; i.e. armor, infantry, artillery, air defense, combat aviation and combat engineers; and generic (application nonspecific) basic technologies of energetic materials, munitions, weapons, weapon-munition interface, and nuclear munitions. Of paramount importance in structuring the program is the requirement for responsiveness to the objectives set forth in the Science and Technology Objectives Guide (STOG), and the recognition that only those Exploratory Development exports which offer the highest potential payoff, and which will clearly meet Army needs are transitioned to Advanced Development. Construction of the program evisioned the required efforts to support the need, the high priority of critical tasks commensurate with the austere program necessary to meet funding constraints.

G. (U) RELATED ACTIVITIES: Related technology efforts conducted in this program were formerly addressed in Program Element 6.26.03 A/AH78, Armament Technology; 6.26.17 A/AH79, Munitions Technology; 6.26.15A/AH 74, Nuclear Munitions; and 6.26.A/AH 77, Fuze Technology; 6.26.20, Fuze Nuclear Weapon Effects, Fluidics. Technical areas of this program for FY 1982 are in consonance with Program Element 6.26.18, Ballistics Technology. To preclude duplication of effort, coordination of the efforts conducted by the other services/agencies is promoted by visits of technical personnel, interagency meetings, triservice reviews and workshops to encourage cross-fertilization.

H. (U) WORK PERFORMED BY: In-house efforts are conducted at the US Army Armament Research and Development Command facilities located at Dover, NJ, Aberdeen, MD, and Edgewood, MD. Contract support is provided by Motorola Government Electronics Division, Scottsdale, AZ; Florida University, Gainsville, FL; Honeywell, Minneapolis, MN, Norden Systems, Norwalk, CN; Firestone Tire & Rubber, Akron, OH; Maremont, McGregor, OK; Westinghouse Electric Corporation, Pittsburgh, PA; Chemetal Ind, Los Angeles, CA; McDonnell Douglas, Titusville, FL; and numerous other small contractors.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Initiated conceptual evaluations for the next generation armored fighting vehicle with emphasis on an integrated plan which includes fire control, armament and weapon and ammunition interface for the vehicle. The planned concept encompasses the establishment of a moving target algorithm necessary to develop a true fire-on-the-move capability and improved probability of hit. Precision firings were conducted from the meduim caliber antiarmor systems and demonstrated with single and burst rate fire the capability to defeat conventional tank armor. Target acquisition top attack munitions and components were designed, fabricated and successfully ballistically tested, and showed potential for significantly increased probability of hit. A prototype infantry armament system was fabricated and success-

Program Element: #6.26.03.A Title: Large Caliber and Nuclear Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

fully demonstrated. The design features low noise levels, smokeless and flashless recoilless system and is capable of being utilized in military operations on urbanized terrain (MOUT). Artillery registration and adjustment system (ARADS) components and system designs were completed. Efforts were initiated to fabricate demonstration test hardware toward the next generation 155mm howitzer system. The output from these efforts will enable decisions to be made regarding options to pursue, either a new-generation self-propelled artillery weapon system or sufficient product improvements to make an M109A2/A3 capable of defeating the threat in the 1990's. Continued exploratory development efforts were conducted in energetic materials (propellants/fillers/initiating devices) to include characterization, formulations, and testing. The thrust of these efforts is to reduce the wear characteristics of cannon/gun tubes, increase performance, and reduce vulnerability. Investigations to date have revealed benefits from propellant additives, plating and alternate materials for rotating bands. Design concepts were established for a multioption fuze for artillery ammunition. The concept will provide all functions (proximity, point-detonating, delay-after-impact, and time) required for effective utilization of high-explosive ammunition. The overall system concept for an extended-range, ramjet-powered projectile was defined, and the preliminary design which incorporates the ramjet, seeker, and payload was completed. In past years (FY 1977-79 timeframe), among the most significant technological efforts are included the cannon-launched beamrider projectile components which were fabricated, successfully tested, and showed promise of significantly increasing the probability of hit. Techniques which can significantly reduce propellant ignition delay and variance were demonstrated. Alternative explosive fills for all high-use munitions were developed and qualified for use during mobilization. The design fabrication and installation of an automated gun laying system was completed in an M109A1 howitzer. Terminal ballistic performance testing of high-velocity, medium caliber kinetic energy projectiles was completed. Laser link guidance was successfully demonstrated under blast, smoke, and haze environments for the Cannon-Launched Beamrider Projectile (CLBRP). 155mm projectiles were successfully fired with nonmetallic rotating bands. Millimeter wave radiometer tests confirmed feasibility of a sensor for the SADARM (Search and Destroy Armor) artillery projectile. Studies of radio frequency (RF), optical and electrostatic fuze concepts were conducted for application to weapon systems.

2. (U) FY 1981 Program: Highlights of the program include a concept feasibility demonstration of the artillery registration and adjustment system; planning and technological efforts for DOD Insensitive High-Explosive and Propellant program; continuation efforts for comparison of the Howitzer Testbed III with the 155mm self-propelled howitzer and foreign systems; continuation of exploratory development for next-generation armored fighting vehicles via the integrated plan for fire control, armaments, and weapon and ammunition interface for the vehicle. Complete technology efforts on medium caliber (75mm) armament system by exploring data collected from testing experimental hardware and testbed firings. This data will be used to predict optimum design approaches for further advanced development. Conduct feasibility firings of the recoilless infantry armament system for use in military operations in urbanized terrain (MOUT). Continue efforts to develop and characterize explosive, propellant, and pyrotechnic formulations for various classes of ammunition. Continue efforts that will provide

Program Element: #6.26.03.A Title: Large Caliber and Nuclear Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

new concepts in cannon, cannon mounts, and recoil systems. Improvement goals include greater muzzle energy and firing rates per unit weight, better accuracy and precision, and longer weapon life. Continue technology efforts in support of standard and future munition systems encompassing technology related to munitions, munitions and propulsion interface, nuclear munitions, and ammunition fuzes.

3. (U) FY 1982 Planned Program: Technology base efforts required to provide the highest probability of kill against armored vehicles and secondary targets, through establishing significant improvements in firepower capability. Investigations to determine the future threats and define the future battlefield of the 1990's will be conducted and the results incorporatd into the program as appropriate. Advance the technology base in warheads, target acquisition, and aerodynamic devices by supporting evaluations concerned with system analysis target vulnerability and countermeasures to optimize munition performance in the combat environment. Continue to develop the technology and/or explore evolving technologies to provide the basis for design of lighter weight, more effective infantry armament systems. Continue efforts to provide the technology base required to enhance the firepower capabilities needed to achieve improved artillery systems. The attack and neutralization of targets both in close proximity to the forward edge of battle area (FEBA) and these in assembly or second-echelon areas out of direct observation range is the primary thrust. Continue the technology to provide new innovative subsystems and component technology into advanced artillery testbeds. Included will be innovation techniques for automatic ammunition handling and loading, recoil mechanisms, new cannon and breech mechanisms, cased propellant charges, automated weapon loading and position location and azimuth referencing subsystems that permit more autonomous operations. Conduct exploratory development to evolve new concepts, apply new materials, and investigate specific techniques that have potential for providing to the user more cost-effective, more countermeasure-resistant, and more rapidly emplaced mine systems. Technology base efforts will continue for nonsystem-related development programs at a constrained level of effort which results from reduced funding in FY 1982. Programs affected include: energetic materials, human factors considerations, weapons technology, munitions technology, munition/propulsion interface technology, nuclear munitions technology, ammunition fuze technology, and training munitions for application to future munitions systems. The conduct of these exploratory developments requires 310 professional and 100 technical support personnel.

4. (U) FY 1983 Planned Program: Continuation of the efforts through the final phase of the program involving an analysis and conclusions pertinent to a conceptional version for the next generation fighting vehicle. Development efforts will be continued toward the evolution of target acquisition components incorporating countermeasures resistance and optimun performance in a tactical environment. Continue technology which will permit significant reduction in blast/signature of direct and indirect fire weapon systems. Testbed design, fabrication, and demonstrations of advanced artillery systems and subsystems will be pursued. Efforts will continue to develop new technologies to improve power sources, countermeasures resistance of scatterable mines, mine delivery/emplacement techniques, and mine target locators. Continued technology efforts will be

Program Element: #6.26.03.A Title: Large Caliber and Nuclear Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

pursued in the areas of energetic materials, weapons technology, munitions technology, munition/propulsion interfaces technology, nuclear munitions component technology, ammunition fuze technology, and training munitions technology for application to future weapon/ammunition systems.

5. (U) Program to Completion: This continuing technology program will demonstrate innovative munition concepts and define ways of product-improving the current systems to extend their useful life. Continuation of exploratory development efforts for artillery components and techniques for existing and future munition systems.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.26.17.A
Title: Small Caliber & Fire Control Technology
DOD Mission Area: #523 - Engineering Technology (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	8957	12477	9316	10980	Continuing	Not Applicable
AH19A	Joint Services Small Arms Program	2707	4589	966	0	Continuing	Not Applicable
AH19B	Combat Vehicle Armament	1725	1600	1600	1920	Continuing	Not Applicable
AH19C	Aircraft Armament	570	600	600	1350	Continuing	Not Applicable
AH19E	Short-Range Air Defense	800	1188	1100	1960	Continuing	Not Applicable
AH19F	Fire Control Technology	1180	2100	2350	2900	Continuing	Not Applicable
AH19G	Armaments Technology	1285	1400	1600	1650	Continuing	Not Applicable
AH19H	Application for Materials	690	1000	1100	1200	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: There is a major need to improve the accuracy of hitting enemy targets on the first round and successive rounds, as well as increasing the effectiveness of small caliber ammunition. Fire control components for gun systems offer a significant potential for improving gun accuracy through the application of advancements in electronic devices and new sensors. There has also been a longstanding need to consolidate Department of Defense research and development efforts in small arms. Since small caliber ammunition and guns are high-volume items, there is a continuing need in the areas of cost reduction, reduced logistic burden, and improved weapon system producibility and useful life. This program is to develop the technology base, exploit new findings and conceptualize and demonstrate innovative improvements in fire control, automatic cannon weapons, and small arms weapons and munitions systems to meet the mission need. Material applications and processes for improving current systems producibility and useful life, reducing logistic burden, and improving weapon features such as reducing weight and cost are a significant portion of this effort. The scope of the program emphasizes the system-oriented areas of combat vehicles, aircraft, infantry and short-range air defense armaments, as well as developing the basic technology areas of fire control, armaments, and material applications. The specific investigations develop both hardware and analytic tools necessary to assess system performance, identify problem areas, and address resolution of these problems. The resulting data base forms the foundation for all subsequent fire control and small caliber weapon and munition advanced and engineering developments.

Program Element: #6.26.17.A
Title: Small Caliber & Fire Control Technology
DOD Mission Area: #523 - Engineering Technology (ED)
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The objective is to develop and maintain a technology base upon which advanced development of fire control for all gun systems, future automatic cannons, and future small arms for all the services, improved small caliber munitions, and innovative materials applications for gun systems can be initiated to improve existing weapon systems and/or to develop new systems. Current emphasis includes improving infantry effectiveness through the Joint Service Small Arms Program projects, improved infantry fighting vehicle armament, lightweight armament for rapid deployment capability, lightweight air defense gun systems, all-weather fire control, improved helicopter armament for survivability and standoff, and tank fire control for improved hit probability. A primary goal is to improve effectiveness and to resolve critical problems in fire control, automatic cannon weapon systems, and small arms. The approach is to assure effective operation, while seeking to improve reliability, maintainability, and durability. In addition, program objectives emphasize cost reduction processes, new material applications, alternatives for critical materials, and solution of production and field problems for all calibers of gun armament systems. The approach is an integrated program of analysis, experimentation, and test demonstration that advances the state-of-the-art and leads to concept validation.

G. (U) RELATED ACTIVITIES: The technical areas in this program are related to the following program elements: 6.26.03. A, Large Caliber and Nuclear Technology (AH18); 6.26.18A, Ballistic Technology (AH80); 6.22.03.A, Aircraft Weapons Technology (DH96); 6/21/05.A, Materials Technology (AH84); and numerous other advanced and engineering development projects. The coordination of similar efforts conducted by the Air Force and the Navy is accomplished by interagency meetings and triservice reviews and workshops to encourage information exchange and preclude unnecessary duplication. A Joint Services Small Arms Program has been chartered with membership from the Army, Navy, Air Force, Marine Corps, and Coast Guard, to coordinate development of all small arms weapons. The Laboratory director chairs the Army fire control technology base planning group which includes active members from all development and readiness commands to assure full coordination and prioritization of activity and the most effective utilization of resources. The Laboratory director also chairs the Joint Services Working Party for Guns which reviews, assesses, and coordinates all gun activities, principally automatic cannons, for all the services. In close cooperation with the US Army Aviation Research and Development Command, a fully integrated helicopter armament technical base program has been developed.

H. (U) WORK PERFORMED BY: The in-house work is conducted at the US Army Armament Research and Development Command facilities located at Dover, NJ. The five largest contractors are the Raytheon Corp., Waltham, MA; the Hughes Aircraft Corp., Culver City, CA; AAI Corp., Cockeysville, MD; Baird Corp., Bedford, MA; and Analytic Sciences, Redding, MA. In addition, there are small contracts with 14 other vendors with a total value of $806,000.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

Program Element: #6.26.17.A Title: Small Caliber & Fire Control Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

C. (U) BASIS FOR FY 1982 RDTE REQUEST: The funds will support the development and maintenance of a small caliber and fire control technology base encompassing the technical areas related to armament and fire control for combat vehicles, aircraft, light weapons, and air defense, and to further investigate the broad areas of fire control and small caliber armaments. It will support the harmonization of all services' small arms requirements and developments under the Joint Service Small Arms Program.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	8957	12477	9316	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	8511	10347	11514	Continuing	Not Applicable

FY80: Net increase of $446K results from increase of $596K reprogramed primarily for the Army share of the Joint Service Small Arms Program and a reduction of $150K reprogramed into the Chemical Systems Laboratory protective mask project (PE 6.27.06).

FY81: Net increase of $2130K will be used to increase the activities in small arms development under the Joint Service Small Arms Program and emphasize fire control technology for innovative improvements in gun system hit probability at extended ranges.

FY82: The net decrease of $2198K will result in a decrease in support of the Joint Service Small Arms Program and a reduction in efforts for the Lightweight Air Defense Gun for the Rapid Deployment Force, and delays of efforts in aircraft armament systems and combat vehicle armaments.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.26.17.A
DOD Mission Area: #523 - Engineering Technology (ED)

Title: Small Caliber & Fire Control Technology
Budget Activity: #1 - Technology Base

1. (U) FY 1980 and Prior Accomplishments: For infantry, light vehicle, and tank secondary armament, a general-purpose heavy machine gun changeable from caliber .50 to 20mm was designed, tested and four weapons prototyped for user concept evaluation. Demonstrations of an extremely lightweight, 10-shot semiautomatic grenade launcher for infantry use were completed. Design and prototype of an inexpensive, compact 9mm submachine gun was completed. A handgun assessment study and trade-off analyses were accomplished. A low-cost, more accurate fire control improvement for the M60A1 tank was demonstrated. In comparison to this baseline, potential further fire control improvements were tested with troops in conjunction with the Human Engineering Laboratory and the Tank-Automotive Research and Development Command to define fire control configurations that offer significant increases in hit probability. An autotracker component was begun for the next phase. In cooperation with the Aviation Research and Development Command, an air-to-air self-defense capability for helicopters was demonstrated in flight test, an acoustic sensor feasibility was demonstrated, a mast-mounted sight was demonstrated, an airborne fire control radar was designed, a precise servo turret control was designed and tested, and a capability to fire high-impulse automatic cannon (Air Force GAU-8 type) from a helicopter with the constant recoil turret design was demonstrated. Low-drag air defense projectile configurations for low time of flight and resulting higher hit probabilities were defined end demonstrated. A vapor-deposited coating for solving the tank ammunition corrosion problem was demonstrated. Thin-film optical filter design to permit normal viewing while protecting the viewer's eye or soft components from laser radiation has been designed, demonstrated, and a product improvement proposal submitted. The potential of a 25mm long-rod projectile for the Infantry Fighting Vehicle was successfully demonstrated. Significant manufacturing cost savings for fuze and small caliber gun components by the definition and application of powdered metallurgy techniques were demonstrated and documented.

2. (U) FY 1981 Program: The user concept evaluation tests of the heavy machgine gun and the 9mm submachine gun will be completed. Results will define refinements which will be completed in this fiscal year. Strong user interest in the heavy machine gun indicates a significant potential to replace the M2 machine gun with a weapon having significantly lower cost, reduced weight, smaller number of parts, and options of caliber and selectivity of ammunition feed. A Congressionally directed assessment of a future infantry rifle will be completed and system approaches identified. The potential of caseless small arms ammunition offering revolutionary changes to infantry weapons is a major part of the Joint Service Program. The Congressional funding increase for the Joint Service Small Arms Program will allow completion of a handgun silencer and an advanced ammunition design study; development of concepts for a universal grenade launcher system with reduced time-of-flight projectile; determination of methods best suited for improving man/weapon system interface for a sniper rifle; and development of a near-term multipurpose individual weapon system alternative and its transition into advanced development (6.3). In developing fire control systems for ground and airborne combat vehicles, emphasis is placed on simplicity of operation and maintenance and on reducing the rapidly escalating costs of new systems through multifunctional use of instruments and exploitation of advances in electronics, devices, and new sensors. Design and firing simulation tests of the airborne high-impulse precision armament system with the six-degree-of-freedom simulator will be completed. Performance trade-offs

Program Element: #6.26.17.A Title: Small Caliber & Fire Control Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

and feasible alternatives for the Rapid Deployment Force Lightweight Air Defense will be completed. As part of a cooperative effort with Israel, a simulation and system definition of a terminal round adjusting miss sensor will be made to determine miss distance, sensing, tracking, control, and other parameters. Autotracker verification tests begun in FY80 will be completed. The 25mm heavy metal penetrator defined in FY80 will be demonstrated at extended ranges. A new enzymatic deterring technique to increase stability and reduce cost of small arms propellant manufacturing will be exploited. Complete ballistic testing of unalloyed depleted uranium penetrators.

3. (U) FY 1982 Planned Program: The general-purpose heavy machine gun will be transitioned to advanced development (6.3). Evaluation of a lightweight medium support weapon against extended range light armor and personnel threats will be initiated, but completion will be delayed until FY83. Advances in penetrator design for 7.62mm and caliber .50 ammunition will provide a capability of engaging light armor threats. The system trade-offs and design options for armament and fire control systems for a future light combat vehicle will be completed. The initial design layout for the airborne High-Impulse Precisions Armament System will be completed but the completion of production models will be deferred until FY83. Trade-offs and options to meet the requirement for both the advanced attack and new light helicoptor will be completed. Data from flight tests of an acoustic sensor and processing system will be evaluated to determine potential of this technique for extended range acquisition of threat vehicles in ground clutter or while in defilade. Use of these passive sensors could provide low-cost acquisition and tracking assistance and greatly enhance system survivability. A digital turret pointing system will be integrated into an XM-97 turret mounted on a Cobra helicopter for weapon firing tests. The ability of this system to provide accurate weapon pointing and extend effective range will be evaluated. Evaluation of techniques to provide low probability of intercept radars will be initiated. Performance feasibility of a very high velocity air defense projectile will be demonstrated. Complete thin-film blocking filter design environmental tests and transition to a product improvement for fire control systems. Complete hardware fabrication and software development for a multifunctional fire control processor for tank systems. Complete formulation for higher energy solid propellant and a predictive weapon design model for caseless ammunition. The potential of rapid solidification techniques for achieving major improvements in material properties and the resulting increased performance of weapon systems will be evaluated. The development of ultrasonic-assisted manufacturing processes will be completed. Tests have shown that significant cost savings can be achieved by this technique since barrel drilling times can be reduced by 250%. This involves 85 professional and 22 support personnel.

4. (U) FY 1983 Planned Program: The Joint Service Small Arms Program (JSSAP) will be funded under a new separate Program Element commencing in FY83. The demonstration of a conceptual armament system for a future light combat vehicle will be completed. This will provide a future infantry fighting vehicle with the capability to outshoot the projected 1990 threat. The airborne acoustic sensor system breadboard will be updated, and through additional flight tests, a set of system

Program Element: #6.26.17.A
DOD Mission Area: #523 - Engineering Technology (ED)

Title: Small Caliber & Fire Control Technology
Budget Activity: #1 - Technology Base

specifications developed. The prediction models for the high impulse precision armament system will be completed. A dual-role gun armament system will be tested to generate data on air-to-ground and air-to-air capabilities to obtain trade-off data for a possible need in FY84 to product-improve the AH-64 helicopter. The subcaliber short-time-of-flight ammunition for the divisional air defense gun will be transitioned. Complete evaluation of low probability of intercept radar techniques. The design criteria for a gun-launched maneuvering air defense munition will be finalized. The terminal round adjusting miss system will be integrated into an M60 tank for a field evaluation. The improvement in hit probability achieved will significantly increase the ability of main battle tanks to service an increasing number of targets. An initial experimental fixture for a liquid propellant automatic cannon system will be completed. In the past, such efforts have been hampered by an inadequate theoretical understanding; however, a technique using neutron radiography has been developed which will overcome this problem. The development of the plasma arc melting technique for the production of tungsten and tungsten alloy penetrators will be completed. Development of nickel alloy alternate materials to eliminate the need for cobalt liners in current machine guns will be completed.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.26.18.A
Title: Ballistics Technology
DOD Mission: #523 - Engineering Technology
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY1983 Estimate	Additional To Completion	Total Estimated Costs
	Total For Program Element	18176	17733	23912	28790	Continuing	Not Applicable
AH80	Ballistics Technology	18176	17733	23912	28790	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The efforts within the ten technical areas of this program element are dedicated to satisfaction of specific objectives in the Army Science and Technology Objectives Guide, which serves as the basis for structuring research and development programs at the entry level of the materiel development cycle. The Guide formulates and prioritizes user-oriented requirements for the Army's mid- to long-range planning periods. The results from Ballistic Technology work are used in the development of weapon systems or other materiel to provide Army-required capabilities in close combat, fire support, other combat support, and air defense.. Hardware constructed within this program is limited to proof-of-concept laboratory prototypes. The program is needed as a primary source of technological innovations and improvements providing initial definitions of concepts which can be exploited in system development under advanced development (6.3) and engineering development (6.4).

C. BASIS FOR FY 1982 RDTE REQUEST: Funds are needed to support a long-range ballistics technology program responsive to long-range combat capabilities of the Army. During FY82, increased emphasis will be placed upon exploratory development efforts in Interior Ballistics, Launch and Flight Dynamics, Warhead Mechanics, Terminal Effects and Armor Dynamics, and Vulnerability Methodology. Specific efforts in those technical areas will focus on on high-impetus propellants for use in traveling charge hypervelocity gun concepts, reduction of muzzle blast overpressures and signatures from modern high-performance artillery firing at high charge zones, techniques to desensitize ammunition against the effects of fire and shock,

Program Element: #6.26.18.A
DOD Mission: #523 - Engineering Technology

Title: Ballistics Technology
Budget Activity: #1 - Technology Base

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	18176	17733	23912	*Continuing*	Not Applicable
Funds (as shown in FY 1981 submission)	16304	19589	23780	Continuing	Not Applicable

(U) The decrease in FY 1981 is attributable to the application of Congressional general reductions. The increase in FY 1982 is partially consistent with the application of higher indices for inflation, fuel, and civilian pay than were applied last year. The increase in requirements over funds requested in the FY 1981 submission for FY 1980 is due to expanded efforts within the areas of interior ballistics, warhead mechanics, terminal effects, and armor dynamics.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.26.18.A
DOD Mission: #523 - Engineering Technology

Title: Ballistics Technology
Budget Activity: #1 - Technology Base

P. (U) DETAILED BACKGROUND AND DESCRIPTION: The objective of this program element is to develop and maintain ballistic technology which insures a solid foundation upon which advanced and engineering development of weapon systems can be initiated and sustained. The Ballistics Technology Program focuses on describing closed system ignition and combustion processes (propulsion dynamics); interactions between high-pressure gases with the atmosphere (propulsion dynamics and launch and flight dynamics), dynamics of projectile flight (launch and flight dynamics), and the delivery of projectile energy to a target (warhead mechanics and terminal effects and armor dynamics). The capability to comprehensively describe ballistic phenomena is critically important to the successful prosecution of advanced and engineering development of weapon systems. Through that capability, state-of-the-art concepts can be identified, developed, and evaluated with a minimum of costly and time-consuming trial and error experiments. In addition, the Ballistics Technology Program develops vulnerability assessment techniques which are used Army-wide by development and analysis agencies to identify system weaknesses and appropriate design changes before production. This formalized vulnerability assessment/reduction effort has improved survivability of recently developed Army materiel. Equally important, the effort pinpoints and quantifies weaknesses in enemy equipment, weaknesses that can be exploited by weapons designers and military doctrine analysts.

G. (U) RELATED ACTIVITIES: These Ballistic Technology efforts are related to development activity in Large Caliber and Nuclear Technology, 6.26.03.A; Small Caliber and Fire Control Technology, 6.26.17.A; and Tank and Automotive Technology, 6.26.01.A. Also, Ballistics Technology efforts are related to similar efforts conducted by the Air Force and the Navy. Visits by other service technical personnel and interagency transfers of knowledge preclude unnecessary duplication of efforts.

H. (U) WORK PERFORMED BY: Approximately 75 percent of the work will be performed in-house at the US Army Armament Development Command facilities at the Ballistic Research Laboratory, Aberdeen Proving Ground, Maryland. Other participating Army facilities include major system commands of the Development and Readiness Command, among which the Test and Evaluation Command, Aberdeen Proving Ground, Maryland, will be the major participant. Major contract support will be provided by the New Mexico Institute of Mining and Technology, Socorro, New Mexico.

Program Element: #6.26.18.A
DOD Mission: #523 - Engineering Technology

Title: Ballistics Technology
Budget Activity: #1 - Technology Base

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1980 and Prior Accomplishments: Demonstrated that Low Vulnerability Ammunition (LOVA) propellants impart muzzle velocities to kinetic energy projectiles equal to velocities given identical projectiles by standard M30 propellants; the implication is that safer LOVA propellants can be used without sacrificing performance. Devised special graphical firing table technique so that two standard artillery rounds can be used as registration projectiles for a nuclear projectile; this technique gives added flexibility to a battery commander.

Results of artillery system analyses show a possibility for reducing an artillery logistics burden by a factor of five, while performing the mission with a fifty-percent increase in effectiveness and survivability. Made first-time-ever instrumented tests of fuze performance during flight of a major caliber shell; results showed that some shells would have been duds or would have detonated only upon impact; thus instrumented fuze can be a valuable tool. Produced 79 Firing/Graphical Tables and other publications containing aiming data.

2. (U) FY 1981 Program: Select best low-vulnerability ammunition propellant candidate for expanded production and application to product improvement program; concurrently analyze interior ballistic performance and assess vulnerability of the candidate propellant. Provide ammunition developers with computer codes which will enable them to derive projectile aerodynamic coefficients and in-flight heat transfer data solely from the projectile design. Produce firing tables and other ballistic data for US land combat weapons and supply ballistic data for field computers and, as needed, for NATO interoperability goals. Provide advanced shaped charge technology for use in an Improved TOW and and Improved Medium Antiarmor Weapon System. Through one-quarter-scale tests, development of scaling laws, and computational simulation, advance several armor technologies and consequently armor design. Complete initial version of advanced component-level method for assessing lethality of antiarmor weapons. Evaluate lethality and vulnerability of tanks and light armor vehicles. Develop selection techniques for materials predicted to increase survivability of tanks. Develop the Army Command Experiment, an interactive, multiplayer, realtime computer model to simulate tactical artillery operations. Complete design of a 60 GHz sensor for use in a smart air defense bullet.

3. (U) FY 1982 Planned Program: Evaluate pilot lots of superburning-rate propellants for use in a traveling charge hypervelocity gun concept. Analyze spectral structure of weapon muzzle blast and flash to characterize pressure propagation, electromagnetic signature, and damage mechanisms. Produce firing tables for all US land combat weapons and provide ballistic

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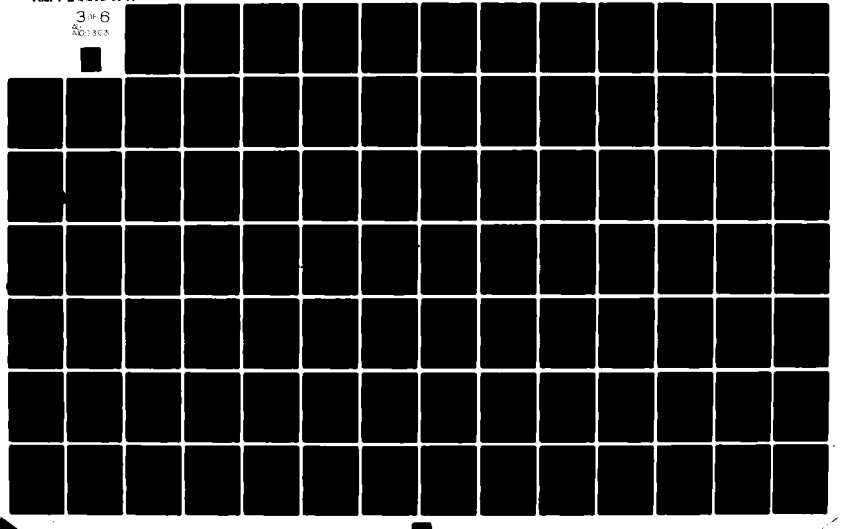

Program Element: #6.26.18.A
DOD Mission: #523 - Engineering Technology

Title: Ballistics Technology
Budget Activity: #1 - Technology Base

data for use in field artillery computers and the NATO interoperability program. Perform limited number of full-scale tests of multi-hit-resistant armor and test sub-scale prototypes to demonstrate the proof-of-the-principle of various armor techniques to defeat antiarmor weapons. Develop improved shaped charge techniques for use in man-portable or crew-served antitank systems. Improve methods for assessing aircraft vulnerability by introducing engine and electronics component simulation models. Verify lethality predictions for ammunition intended for use in Military Operations in Builtup Terrain. Provide realtime target evaluations by combining vulnerability models with upgraded computerized target descriptions and interactive computer graphics. Identify materials with potential for providing optimum protection against conventional/nuclear threats to tanks. Initiate first phase of the construction of the Artillery Command Experiment Model and apply the model to the analyses of tactical artillery scenarios. Make a 60 GHz millimeter wave sensor for use onboard an air defense smart bullet. Work requires 155 professional and 140 support personnel.

4. (U) FY 1983 Planned Program: Demonstrate traveling charge propulsion concept in laboratory device and start development of an experimental prototype gun. Design and make a full-scale proof-of-principle prototype 155mm muzzle brake which uses low-blast/moderate-recoil concepts. Produce firing tables for all US land combat weapons. Exploit understanding of munitions structural response and explosives sensitivity characteristics to formulate, test, and evaluate munitions hardening techniques. Complete development of methods to assess vulnerability of aircraft engines and electronic systems. Generate quick-response and midlevel-response analyses for helicopter vulnerability. Develop and publish parametric analyses of the effects of munitions against tanks and infantry fighting vehicles to guide weapon development decisions. Through full-scale tests, assess effectiveness of combined threat armor designs for improving survivability of armored vehicles. With Artillery School, begin modification of first Artillery Command Experiment model to a comprehensive model by incorporating C^3 equipment. Evaluate low-angle tracking capability of 94 GHz, low-probability of intercept radar for helicopter targets.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.26.22.A Title: Chemical Munitions and Chemical Combat Support
DOD Mission Area: #522 - Environmental & Life Sciences (ED) Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	6015	5280	20528	7012	Continuing	Not Applicable
A554	Chemical Munitions and Chemical Combat Support	6015	5280	20528	7012	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Union of Soviet Socialist Republics (USSR) has developed and continues to improve upon its formidable chemical warfare capabilities. These capabilities represent a threat to the survival of United States (US) and North Atlantic Treaty Organization (NATO) Forces. The US needs a program to counter/deter that threat by exploitation of state-of-the-art concepts and creation of a broad technology base to support chemical munitions (binary lethal and incapacitating) and chemical combat support materiel (smoke and civil disturbance/tactical irritant) development. Specifically, this project applies the results of basic research to the exploratory development of previously mentioned chemical munitions and chemical combat support weapons systems in meeting stated Army requirements. Additionally, the Army has been designated the Executive Agent for RDTE of chemical weapons and chemical-biological defense materiel for the Department of Defense (DOD). As such, there is a need for a project to support DOD-wide requirements in chemical weapon systems development. This project provides the only source for such support.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: The funding level of this program for FY 1982 has been increased by $14 million to bring to fruition an expanded technology base upon which to build a deterrent chemical warfare capability to offset Soviet and Warsaw Pact offensive capability. The FY 1982 program will significantly expand and accelerate exploratory development on Intermediate Volatility Agent (IVA) and Munitions Concepts on a family of Chemical Munitions required to provide a credible deterrent/retaliatory capability. Munitions systems investigated will include artillery projectiles, missile and rocket warheads, and bombs. Proportionate increases in funding will be programed in FY 1983 and subsequent years to maintain and complete efforts initiated in FY 1982. Additionally, multispectral screening concepts will be applied to deep target and artillery delivery systems. Toxicology evaluation of candidate infrared and multispectral obscurant agents will be continued. Technical support of munitions development efforts will continue to insure low-risk/efficient munition designs and scaleup parameters for the weaponization of intermediate volatility or other highly persistent agents. Efforts will continue to

Program Element: #6.26.22.A Title: Chemical Munitions and Chemical Combat Support
DOD Mission Area: #522 - Environmental & Life Sciences (ED) Budget Activity: #1 - Technology Base

develop the data base on new candidate obscurants with emphasis on environmental effects, optical characteristics, elimination techniques, and toxicology. Work will also continue on the development of new incapacitation and civil disturbance agents which are effective by both inhalation and absorption through the skin. New and improved methods and models for estimating the probability of incapacitating trauma from penetrating and blunt impacts will be developed.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional to Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	6015	5280	20528	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	6615	5751	7131	Continuing	Not Applicable

(U) The decrease of $600 thousand in FY 1980 is the result of reprograming to higher priority Army requirements. The funding decrease of $471 thousand in FY 1981 reflects the application of general Congressional reductions. The $13,397 thousand increase in FY 1982 is the result of an Army commitment to provide increased funding to support a critically needed expansion of the chemical warfare deterrent/retaliatory technological base.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.26.22.A Title: Chemical Munitions and Chemical Combat Support
DOD Mission Area: #522 - Environmental & Life Sciences (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This program supports the entire Department of Defense (DOD) chemical technology 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 munition types with a resultant capability for air or ground delivery using standard and advanced weapons systems; and 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; developing effective means for exploitation of these agents; and identifying the physical and chemical characteristics of these agents; (3) Chemical Combat Support Systems: Includes accelerated search for improved multispectral smoke/obscurant screening materials and delivery systems to cover visual through microwave regions of the electromagnetic spectrum; and provides for large-area screening capability with minimum logistics burden. Also included are the development and evaluation of new chemical compounds for civil disturbance control and tactical irritant agents, development of concepts for their use, and the establishment of feasibility responsive munitions.

G. (U) RELATED ACTIVITIES: In executing the Army's executive agent responsibilities as assigned by DOD Directive 5160.5, investigations under this project provide the essential exploratory effort in lethal, incapacitating, and civil disturbance control agents and munitions, smoke and multispectral obscurant 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. Related technical investigations are conducted under PE 6.27.06.A, CB (Chemical-Biological) Defense and General Investigations. The projects provide direct technical support to Program Elements 6.36.15.A, Lethal Chemical Munitions Concepts; 6.36.27.A, Combat Support Munitions, 6.36.14.A, Incapacitating Chemical Munitions Concepts; 6.46.10.A, Lethal Chemical Munitions; 6.46.09.A, Combat Support Systems; and 6.46.13.A, Incapacitating Chemical Munitions.

H. (U) WORK PERFORMED BY: Contractors - ASH Stevens, Inc., Detroit; MI; Batelle, Columbus, OH; Foxboro Analytical, South Norwalk, CT; Brunswick Inc., Marion, VA; Southern Research Institute International, Birmingham, AL; Barnes Engineering, Stanford, CT; Aerodyne Research, Burlington, MA; R&D Associates, Santa Monica, CA; Rahtech, Madison, WI; American Histological Laboratories, Bethesda, MD; Stanford Research, Menlow Park, CA; In-house developing organization is the US Army Chemical Systems Laboratory, Aberdeen Proving Ground, MD.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

Program Element: #6.26.22.A Title: Chemical Munitions and Chemical Combat Support
DOD Mission Area: #522 - Environmental & Life Sciences (ED) Budget Activity: #1 - Technology Base

1. (U) FY 1980 and Prior Accomplishments: Over the past 20 years, a variety of flame and incendiary, lethal chemical, tactical riot control, and civil disturbance control agent munition systems have been developed and fielded. To enhance safety and security, the binary concept has been successfully applied to the development of two artillery chemical projectiles. This concept is also being applied to the search for new dual-purpose agents having enhanced percutaneous and inhalation effectiveness and in the design of extended-range artillery projectiles, rocket warheads, and aerial-delivered munitions. A continuous effort is being made in the search for new intermediate volatility incapacitating agents which are effective by both inhalation and absorption through the skin. Based on an assessment of the expected threat, a high urgency was placed on the development of new multispectral large-area smoke/obscurant systems. A five-year program was initiated in FY 1976 and FY 1977. All US standard smoke formulations and numerous foreign formulations have been characterized for their screening capabilities. The search for and testing and evaluation of new candidate materials are continuous efforts. Field characterization and evaluation of candidate materials is accomplished during an annually scheduled Smoke Week where both electro-optical devices and smoke/obscurant systems are employed in a simulated realistic battlefield environment. Smoke programs have in the past utilized approximately 75 percent of the dollars allocated to the Program Element. This trend will be reversed in FY82, and a near equal distribution will occur in subsequent outyears. Accomplishments during FY 1979 included: (1) completion of exploratory development on the manportable large-area screening system, (2) continued development on two infrared screening agents which showed good potential in Smoke Week II, (3) demonstrated that the approved training agent polyethylene glycol 200 will produce a good smoke screen in the large-area screening system, (4) characterized several candidate obscurants and battle-induced dust for spectral attenuation properties, particle size distribution and chemical composition, (5) added methodology for munitions expenditure requirements to the Smoke Obscuration Model, (6) completed construction of full-scale 8-inch projectile reactant chamber and conducted tests to evaluate reaction kinetics, temperature, and stoichiometry of binary reactions. Results of the chamber tests helped resolve the cause of malfunctions of simulant-filled XM736 binary projectiles. During FY 1980 the program accomplished the following: (1) completed technology support for the XM736 Binary VX Projectile; (2) selected and evaluated binary warhead concepts for the Multiple Launch Rocket System, 81mm binary mortar cartridge, and 4.2-inch binary mortar cartridge; (3) initiated toxicology studies for binary intermediates; (4) continued bulk mixing studies and developed standards for new binary intermediates for better munition evaluation and quality control and starting materials; (5) initiated remotely piloted vehicle binary concept evaluation; (7) finalized the design of high flow generation for large-area screening with multispectral smoke agents; (7) completed modifications to the Large-Scale Decontamination Device (Jet Exhaust) to add rapid, large-area smoke generating capability; this dual capability will reduce logistic burden and provide protective cover for decontamination operations; (8) sixty candidate smoke agents have been characterized and nine have been recommended for use in 6.3 developments; and EA 5752 filled XM76 Infrared Smoke Grenade demonstrated design feasibility of that concept at Smoke Week III. Additionally, technology base investigations continued on dual effect incapacitating agents and potential weaponization, civil disturbance munitions, methods and modeling for estimating incapacitating trauma from penetrating and blunt impacts, process technology studies for

production and environmental control of lethal and incapacitating agents and binary constituents, and process technology studies of new smoke and obscurant agents.

2. (U) FY 1981 Program: Exploratory development on binary concepts for the 155mm and 8-inch intermediate volatility agent (IVA) projectiles will be completed. Potential dual-purpose (inhalation and skin penetration) chemical agents will be evaluated with an emphasis on their adaptability to the binary mode for several candidate munition systems (e.g., missile and rocket warheads, drones, and modular munitions). A search will continue for safe reactive simulants for binary agents and practical means for field assessment of these simulants in lieu of open-air testing of toxic agents. New improved multispectral screening compounds and compatible dissemination systems will be investigated. Smoke aerosol characterization studies will continue on candidate materials. Concept formulation for improved infrared screening munitions and the initiation of concept studies for battlefeld smoke elimination will be accomplished. Toxicity evaluations for candidate smoke materials and an evaluation of EA 4923 as a potential civil disturbance and tactical irritant will be conducted. Studies will continue to evaluate the effectiveness of EA 1834 as an effective percutaneous incapacitating agent. New and improved methods and models for estimating the probability of incapacitating trauma from penetrating and blunt impacts will be developed.

3. (U) FY 1982 Planned Program: Exploratory development will be completed on the binary concept for a chemical warhead for the Corps Support Weapon System and a lightweight mobile binary lethal agent munition system. Evaluation of potential dual-purpose lethal agents (IVA) adaptable to the binary mode of delivery will be expanded and accelerated. Application of the IVA technology to a family of ground, missile, rockets and aerial-delivered munition concepts will be investigated. Manufacturing processes for both lethal and incapacitating chemical agents will be investigated. Efforts will continue to expand the data base on candidate smoke/obscurant materials with special emphasis on environmental studies for potential incapacitating and disturbance agents will be conducted. The program employs a total of 77 personnel: 65 professional and 12 support.

4. (U) FY 1983 Planned Program: Efforts will continue to provide technology support to the Advanced Development (6.3) and Engineering Development (6.4) programs to insure effective safe munitions design. Investigations will evaluate potential dual-purpose lethal agents adaptable to binary delivery, weaponization concepts for remotely piloted vehicles, air-deliverable mines, Ground-Launched Cruise Missile, lightweight and long-range mortar systems, lightweight portable rocket warheads, and extended range artillery projectiles. Evaluation of chemical agent manufacturing processes and environmental control mechanisms will continue. Weaponization concepts, toxicology, and use scenarios for potential incapacitating agents will be studied. Technology base studies will continue to evaluate candidate multispectral obscurant materials with an emphasis on environmental effects, toxicology, elimination techniques, and optical characteristics. New methods and models

Program Element: #6.26.22.A Title: Chemical Munitions and Chemical Combat Support
DOD Mission Area: #522 - Environmental & Life Sciences (ED) Budget Activity: #1 - Technology Base

for estimating the probability of incapacitating trauma from penetrating and blunt impacts will be developed.

5. (U) Program to Completion: *This is a continuing program.*

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FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.01.A
Title: Communication/Technology
DOD Mission: #521 - Electronics & Physical Sciences (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	10461	8504	8162	8975	Continuing	Not Applicable
AH92-01	Multichannel Communication Technology	3820	2841	2100	3215	Continuing	Not Applicable
AH92-02	Battlefield Information Distribution (BID)	2435	1845	1688	1297	Continuing	Not Applicable
AH92-03	Tactical Net Radio Communications	1287	750	1302	1300	Continuing	Not Applicable
AH92-04	System Structures, Design Concepts & Optimization	1315	520	500	550	Continuing	Not Applicable
AH92-05	Survivability Enhancements & Assessments	372	515	180	290	Continuing	Not Applicable
AH92-06	Spectrum Management & Optimization Concepts	375	1130	1082	1100	Continuing	Not Applicable
AH92-07	System Modularity & Integration Concepts	200	335	350	350	Continuing	Not Applicable
AH92-08	Propogation/Electromagnetic Compatibility (EMC)	657	274	438	658	Continuing	Not Applicable
AH92-09	Digital Processing Technology	--	294	522	215	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program supports development of the communications-electronics (CE) technology base required to meet the mission needs of the next generation of tactical communications systems. The evolving weapons and fire control systems require communication capabilities which the current inventory of communications-electronics cannot provide. The heavy emphasis on digital and mixed analog/digital data in these systems creates serious problems in the areas of information distribution, signal processing, electromagnetic compatibility (EMC),

Program Element: #6.27.01.A Title: Communication/Technology
DOD Mission: #521 - Electronics & Physical Sciences (ED) Budget Activity: #1 - Technology Base

signal quality, propagation, spectrum management and system interoperability. Only the application of new technologies such as fiber optics, millimeter-wave, and Very High Speed Integrated circuits (VHSIC) will begin to solve these problems. In addition, exploratory work in Command, Control and Communication systems is essential to develop advanced concepts required to effectively use evolving high-technology systems.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Demonstrate, Test and Evaluate Battlefield Information Distribution (BID) System extension to Brigade forward communications. Start work on microprocessor-controlled antennas and investigate high-speed and low-probability-of-intercept modems for HF radios. Develop design plan to incorporate all local Communications Research and Development Command (CORADCOM) communications resources into the communications systems design center; test for system interfaces and investigate technology insertion opportunities. Complete the 40-300 GHz EMC measurements test and instrumentation contract. Complete tactical C^3 Army data network models in preparation for assessing new distributed C^3 architectures planned for future Army employment; extend the survivability assessment methodology developed in FY81 to incorporate physical and nuclear attack models. Continue the architecture development of integrated spectrum management (SM methods and techniques) and techniques for storage and distribution of Communication-Electronic Operating Instructions (CEOI). Complete development of a secure fiber optic (FO) link for data distribution and a an FO cable system for the military computer family. Start FO longer wavelength component development. Receive and test adaptively tuned millimeter wave (MMW) radio systems and start contract to develop the MMW wireless Low-Probability-of-Intercept command post. Prepare technical data to develop the Digital Microwave Radio (DMR) to provide needed ECCM capability and receive delivery of exploratory components for the DMR. Complete the development of land warfare spectrum models and assessment methodologies for electromagnetic compatibility and vulnerability.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirement)	10461	8504	8112	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	5185	9985	9585	Continuing	Not Applicable

Program Element: #6.27.01.A Title: Communication/Technology
DOD Mission: #521 - Electronics & Physical Sciences (ED) Budget Activity: #1 - Technology Base

(U) $5.276 million were programed into this program element to accomplish exploratory development for the military computer family in the areas of software and intelligent terminals. This action will be transferred to another P.E. in late FY81.

(U) The decrease in FY81 is attributable to the application of general Congressional reductions. The FY 1982 budget shows a decrease from the FY 1981 submission. This decrease was borne by the Multichannel Communication Area and the components of the Digital Processing Areas as offsets to higher priority programs.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.27.01.A Title: Communication/Technology
DOD Mission: #521 - Electronics & Physical Sciences (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Automation and Communication are rapidly becoming significant facets of almost every Army Defense System. The project goals are to provide technologies that will reduce the cost of development and support of tactical automation and communication functions and to accelerate the fielding and improve the survivability of all Army systems in which automation and communication play major roles. Present communications technology does not meet today's Army needs. Problems of excess weight, size, power drain, cross-talk, Electromagnetic Pulse (EM and Electronic Countermeasures (ECM) threat, both passive and active reliability and low channel capacity, require application of advanced technology. The approach to solving these problems is to develop new methods and techniques needed for future Army Communication-Electronic (C-E) systems. This effort requires exploration of the following: fiber optic and Millimeter Wave (MMW) communication; radio wave generation, amplification, and modulation for line of sight and troposcatter; techniques for handling, multiplexing, and storing information; electromagnetic compatibility; system technology, net communications to exploit the latest state of the art with emphasis on antennas and HF communications; packet radio and related technologies for the evolving Army Digital Distribution System (ADDS); switching technology; spectrum optimization; and information acquisitiond processing (speech, print, picture). These techniques will form the basis for system and subsystem design for effective integration and transition planning.

G. (U) RELATED ACTIVITIES: This program provides the exploratory development needed to support the following: Program Element 6.37.07.A, Tactical Communications Development; Program Element 6.37.22.A, Tactical Operation System; Program Element 2.80.10.A, Joint Communications Program, (TRI-TAC); Program Element 6.32.07.A, Aviation Electronics (Avionics), Program Element 6.47.02.A, Communication Engineering Development, Program Element 6.47.12.A, Tactical Data System (TDS Interoperability), Program Element 6.47.79.A, Joint Interoperability of Tactical Command and Control System (JINTACS); Program Element 6.37.23.A, Tactical Automation. Other related research and studies performed by the Air Force and Navy are also considered. Coordination and avoidance of duplication is accomplished by reviews conducted by the Department of Defense through the exchange of technical reports and attendance at scientific meetings and conferences. Program element 6.11.02.A, Defense Research Sciences, provides the basic research support for the project. Cooperation is accomplished with DARPA/TRADOC and XVIII Airborne Corps for concept formulation of an Army BID System using currently available packet radio technology.

H. (U) WORK PERFORMED BY: Georgia Tech, Atlanta, GA; Hughes, Fullerton, CA; Norden, Norwalk, CT; ITT, Nutley, NJ; Rockwell International, Dallas, TX. Jet Propulsion Laboratory, Pasadena, CA; MITRE Corp, McLean, VA; Lincoln Laboratory, Bedford, MA; SRI International, Manlo Park, CA. Twenty-one (21) other contracts will be awarded during FY 1982 with a total value of $2,960,000. In-house developing organizations are US Army Communications R&D Command (CORADCOM), Ft Monmouth, NJ; and DOD Electromagnetic Compatibility Analysis Center (ECAC), Annapolis, MD.

Program Element: #6.27.01.A Title: Communication/Technology
DOD Mission: #521 - Electronics & Physical Sciences (ED) Budget Activity: #1 - Technology Base

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Completed first phase of Secure Fiber Optic (FO) Communications System and took delivery of components. The Long Haul FO system transitioned into engineering development. The FO missile payout system moved into advanced development. Completed US Army Europe test on Millimeter Wave (MMW) Command post radios, and the program moved into advanced development. Completed foliage tests with MMW radios. Started program to develop adaptive techniques for line-of-sight microwave radio. Integrated packet radios into the BID corps-level testbed to provide field/mobile operation. Completed first phase of wideband propagation measurement program and conducted preliminary measurements of spread spectrum EMC with tactical narrowband radios. Completed evaluation of Intra-System EMC analysis program for application to the XM1 Tank. Provided EMC guidance to project managers and continued work on EMC standards. Started programs in tactical antenna development. The HF Radio contract determined that advances in digital technology will allow for high data rate transmission at HF and optimum channel selection. Completed the top-level descriptive version of the Command Control Information Utility generic model with detailed definitions and characterization of its elements. Completed the specification of the Mobile Subscriber Equipment (MSE) Radio. Initiated the development of a comparative rationale for survivability assessment. Performed initial investigations of adaptive spread spectum applications in hostile environments. Developed initial conceptualization of space distributed approach to anti-DF strategies. Completed initial study of Communications Electronics Operating Instructions (CEOI) automated preparation, distribution, storage, and integration with other management functions and facilities. Completed the plan for the integration of Battlefield Spectrum Management Facilities with Satellite Automated Frequency Engineering System (SATFES). Performed initial studies of integration with NATO and ABCA spectrum management concepts. Developed the initial algorithms and software for an improved frequency assignment capability. Initiated efforts on Electronic Warfare analysis and high-frequency pool management. Performed the initial studies to define the requirements for modeling each functional segment of the Command Control Subordinate System (C2S2). Completed first studies of partitioning and standard recovery sets. Completed the communications R&D portions of the INTACS update. Completed the initial evaluation of feasibility of a new concept for Command, Control Communications (C^3) data insertion via voiced commands. Completed initial planning for the development of a standard Army survivability assessment methodology for C^3 tactical systems.

2. (U) FY 1981 Program: Start fiber optic developments on a family of optical multiplexers, components, optical cable splicing methods and tools, and start interface tests of secure FO cable. Apply fiber optics to the Military Computer Family (MCF). Start analysis of MMW wireless command post system and continue contracts on MMW adaptively tuned radios. Start contracts to develop adaptive techniques for the Digital Microwave Radio. Demonstrate use of packet radio to provide data distribution in a static artillery scenario at Ft Sill, OK, and use packet radio to provide data distribution for HELSAT-8 exercise at Ft Sill. Start to integrate advanced net management techniques into BID concepts. Start contract in support of tes-

Program Element: #6.27.01.A Title: Communication/Technology
DOD Mission: #521 - Electronics & Physical Sciences (ED) Budget Activity: #1 - Technology Base

tbed activity for additional user system/BID interface/integration. Complete phase I analysis and start procurement of wideband characterization system. Develop ground network communication modeling capability. Start study of vehicular HF Antennas for Nap-of-the-earch links and develop an antenna system data base using a numerical electromagnetic code. Determine optimum electronic counter-countermeasures (ECCM) for use with near-term HF radio. Continue contract to develop EMC instrumentation for 40-300 GHz. Start investigation of microprocessor susceptibility to electromagnetic interference (EMI) and investigate propagation characteristics of spread spectrum systems. Award contract to investigate suitable bandwidth compression techniques for facsimile. Start exploratory planning for a Communication System Design Center and for switching technology. Formulate the conceptual architecture for the Command Control Information Utility model. Begin the characterization of the far-term C^3 system technical objectives. Complete survivability assessments of the top level and the functional segments of the baseline system specifications. Formulation adaptive concepts for antijam and antiintercept in context of the Command Control Information Utility structure. Formulate the conceptual architecture for Army Battlefield Spectrum Management. Develop automatic techniques (algorithms) for the generation of Very High Frequency (VHF) and High Frequency (HF) Communication Electronic Operating Instructions at Corps and Division. Develop initial automated techniques (algorithms) for circuit routing and multichannel frequency assignments for the Army Tactical Frequency Engineering pilot system. Establish analytic models which relate missions and (technical) functions for each Command Control Subordinate System functional segment. Evaluate the capability of a proposed voice-data entry device for Army tactical Command and Control (C2) applications. Establish an overall Army-oriented methodology for the assessment of survivability of proposed functional segment and operational subsystem designs. Develop the NATO land warfare spectrum model as the instrument for evaluation concepts and algorithms under which, as Army standard assessment models, the electromagnetic compatibility and vulnerability of proposed C^3 systems and subsystems can be assessed and rank ordered.

3. (U) FY 1982 Planned Program: Start development of Secure Fiber Optic link for data distribution system while continuing improvements on secure local distribution voice terminals. Start contract on optical cable system for the military computer family (MCF) and continue work on FO components (Optical Multiplexer and expanded beam connector). Perform extensive field tests of millimeter wave radios, including multiplexer interfacing. Start Millimeter Wave wireless command post contract which will include a module approach using previously developed mobile intercept secure radios (MISR) as a baseline. Receive delivery of exploratory components such as C-band Spread Spectrum modem, steerable null antenna, and coder/decoder. These items will be used as baseline technology for advanced development of the Digital Microwave Radio (DMR). Complete development and testing of wideband propagation measurement system and complete planning to start field measurements. Start design and development of UHF wideband channel emulator; continue integration of advanced net management concepts into BID testbed to include secure-like operation of the packet radio deployment. Demonstrate BID extension to Brigade Forward using VHF-FM radios. Start work on microprocessor-controlled antennas and continue work on vehicular HF nap-of-the-earth antenna. Investigate HF modem technology for high speed (up to 2.4 Kilobits/sec) and low probability of intercept and detection

Program Element: #6.27.01.A Title: Communication/Technology
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(LPI/LPD) for use in covert operation to resist enemy countermeasures and direction-finding. Develop design plan to coordinate the phased incorporation of all local CORADCOM communications resources into the communications system design center. Test the results of nodal parameters analysis for system independence and categorize the results by degree of system interaction. Continue investigation of bandwidth compression techniques for facsimile. Complete the 40-300 GHz EMZ measurements test and instrumentation requirements contract and decide need for follow-on exploratory hardware development. Continue Electromagnetic Compatibility (EMC) analysis modeling, EMC standards work, and EMC design support to project managers and other agencies. Complete the definition of the Command Control Information Utility Model architecture. Develop characterizations of survivability enhancements for the C^3 systems which are selected to form the baseline configurations. Formulate the Army Battlefield Spectrum Management and Engineering Architecture so that it accommodates the Satellite Frequency Engineering System requirements and integration with TRI-TAC system control and management elements. Investigate techniques for the electronic storage and electronic distribution of Communications Electronics Operating Instructions. Validate the initial algorithms developed for the Army Tactical Frequency Engineering System and expand them to include additional required spectrum management functions as indicated by the Steering Group. Define the tasks and interactions for each operational function in each Command Control procedure and equipment. Establish a detailed Army-oriented methodology under which system survivability under nuclear and physical attack can be assessed. Complete the development of the NATO land warfare spectrum model for system optimization studies. Complete the development of evaluation concepts and algorithms for electromagnetic compatibility and vulnerability assessments.

4. (U) FY 1983 Planned Program: Start investigation of optical routing methods which together with the multiwavelength coupler will form the basis of a wavelength division multiplex FO Communications system for incorporation into the TRI-TAC system. The contract for Millimeter Wave (MMW) wireless command post system will deliver initial radios for concept and development testing. A letter of agreement action will start to transition the wireless command post to advanced development. Exploratory work will start on a microwave radio performance monitor to indicate the source of system failure such as jamming and noise and to provide corrective action. An alternative approach for a phased array null steering antenna to provide electronic counter-countermeasures (ECCM) techniques for the digital microwave radio will start. Other exploratory starts will cover ECCM capability for TRI-TAC multiplexers in Ultra High Frequency (UHF) applications, null steering antenna for the AN/GRC-103 radio and digital UHF ECCM techniques applicable to replacement of the AN/GRC-103. Start field portion of wideband propagation measurement program which will also include overseas measurements (OCONUS). Start contract to Battlefield Information Distribution (BID)/Packet Radio testbed. Complete the BID system extension to Brigade Forward communication demonstration, testing, and evaluation using VHF-FM net radio. Complete investigation of vehicular HF nap-of-the-earth antennas and start study of a symmetrical base-isolated broadband whip antenna. Redirect the antenna program to incorporate relevant results of technology assessment. Start development of HF frequency management automation technology. Start preparation of CORADCOM building facilities to accommodate the local communications resources and begin to

Program Element: #6.27.01.A Title: Communication/Technology
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house or interface all available fielded and developing equipment in the communications system design center. Design, test, and fabricate an exploratory model of an integrated circuit switch and technical control facility. Select bandwidth compression techniques and demonstrate by computer simulation. Start those exploratory hardware/component developments as/if necessary to prove feasibility of EMC measurement, test, and instrumentation in the 40-300 GHz range. Start interference reduction investigation and continue microprocessor EMI susceptibility evaluation. Provide EMC design guidance and support. Begin the evaluation of alternative distributed communications network designs utilizing the Command and Control Information Utility model. Identify the C^3 survivability enhancements for operational (Army TOE) subsystems. Formulate the Army Battlefield Spectrum Management & Engineering architecture which is required for High Frequency Spectrum Management utilizing CHIRP sounding. Investigate methods for automatic production of Communications Electronic Operating Instructions (CEOI) for Demand Assigned High Frequency and Spread Spectrum Systems. Expand the Army tactical Frequency Engineering System pilot algorithms to include updated requirements derived from latest results, as defined by the Steering Group. Analyze and evaluate candidate allocations and partitioning of operational/technical functions among the Command Control Subordinate System functional segments. Evaluate alternative technical proposals for automated and semiautomated decision-aiding in tactical command centers. Establish the detailed Army methodology by which system survivability against chemical and electronic attack will be assessed. Expand the spectrum optimization model to incorporate systems employing frequency hopping and other spread spectrum techniques. Assess the vulnerability of baseline designs for the operational subsystems of C^3 architecture, utilizing the compatibility/vulnerability model.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.03.A

Title: Combat Surveillance, Target Acquisition and Identification

DOD Mission Area: #521 - Electronics and Physical Science (ED)

Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	3425	3588	2617	4590	Continuing	Not Applicable
DH93	Combat Surveillance, Target Acquisition and Identification	3425	3588	2617	4590	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides the technology base for new concepts and advanced systems for the solution of presently unsolved surveillance, target acquisition, and identification requirements. These include developing modular radar componentry to reduce size and cost and to increase performance and reliability; noncooperative battlefield identification friend or foe; radar techniques to identify stationary and moving targets, penetrate foliage, and provide an all-weather capability; passive acoustic techniques to rapidly locate hostile artillery; and integrating surveillance and target acquisition sensors to provide fused output. It also identifies the most promising alternatives to fill existing operational gaps in the Army's integrated surveillance, target acquisition, and identification capability. Exploratory development is performed in the following technological areas: personnel and vehicle detection; identification; data transmission; weapons location; detection and measurement of nuclear radiation and bursts; and the integration of surveillance and target acquisition sensors.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Lightweight, modular, low probability of intercept (LPI) radar componentry will be integrated into a testbed remotely piloted vehicle radar system for flight testing. Work will continue on multistatic radar techniques; foliage penetrating radar concepts; stationary and moving target detection and identification; noncooperative battlefield identification; electronically steerable multiple beam antenna technology for intelligence, surveillance, and target acquisition sensor data transmission; and the detection and measurements of nuclear radiation. Fabrication of prototypes for a wideband adaptive ground antenna system and the dosimeter section of a miniature, multipurpose radiac device will be initiated. Testing of low-cost prototype radiation dosimeters and radiacmeters will continue.

Program Element: #6.27.03.4 Title: Combat Surveillance, Target Acquisition and Identification

DOD Mission Area: #521 - Electronics and Physical Science (ED) Budget Activity: #1 - Technology Base

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (Current Requirements)	3425	3588	2617	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	3615	4420	4994	Continuing	Not Applicable

The FY 1980 decrease is the result of reprograming to higher priority Army requirements. The FY 1981 decrease is attributable to general Congressional reductions. The FY 1982 change reflects adjustments consistent with Army priorities.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.03.A

Title: Combat Surveillance, Target Acquisition and Identification

DOD Mission Area: #521 - Electronics and Physical Science (ED)

Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This project funds the exploratory development performed by the Combat Surveillance and Target Acquisition Laboratory. Major areas are weapons location technology with emphasis on a passive, automated, linear base, acoustic, artillery target location system to replace the current manual system; investigations of sensor data transmission with the objective of reducing vulnerability to detection and jamming, reducing radio frequency spectrum requirements, eliminating relays, and reducing size, weight, and cost; development of radar techniques for the detection, classification, and identification of stationary nonfiring targets under all visibility conditions; development of radar techniques for the classification and identification of moving targets under all visibility conditions; development of lightweight, low-cost, common radar modules which will lower life cycle costs of future radar systems due to commonality in logistics, maintenance, and training requirements; development of a low-cost, multipurpose, tactical radiation measurement device which will perform the functions presently requiring several separate devices; investigation of noncooperative battlefield identification friend or foe; and development of multistatic radar technology to enhance sensor coverage and survivability on the battlefield.

G. (U) RELATED ACTIVITIES: Related development is performed by the Navy and Air Force. Work is coordinated during reviews conducted by the Office of the Under Secretary of Defense for Research and Engineering, through interlaboratory visits and communications, attendance at specialized scientific meetings and conferences, inter-Service liaison, technical reports, and the Annual Tri-Service Radar Symposium. Additionally, the Army and the Defense Advanced Research Projects Agency (DARPA) are participating in a joint program to find new or improved solutions in the radar netting area under Program Element 6.27.26.A., Army Support of DARPA.

H. (U) WORK PERFORMED BY: In-house work is performed by the US Army Electronics Research and Development Command at Fort Monmouth, NJ, and at Adelphi, MD. Contractors include Harris Corporation, Melbourne, FL; Texas Instruments, Dallas, TX; Georgia Institute of Technology, Atlanta, GA; RCA, Princeton, NJ; Hughes Aircraft Company, Culver City, CA; Motorola, Scottsdale, AZ; AIL Division Cutler Hammer, Long Island, NY; Malibu Research Associates, Santa Monica, CA; Harshaw Chemical, Cleveland, OH; Oak Ridge National Laboratory, Oak Ridge, TN; and Applied Physics Laboratory, Johns Hopkins University, Baltimore, MD.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Prior technological efforts have resulted in or contributed to type classification and procurement of the AN/PPS-5, AN/PPS-15, AN/TPQ-36, and AN/TPQ-37 radars; initiation of advanced development of

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

DOD Mission Area: #521 - Electronics and Physical Science (ED) Budget Activity: #1 - Technology Base

the Surveillance and Target Acquisition Radar for Tank Location and Engagement, and full-scale development of the Modular Integrated Communications and Navigation System. The feasibility of a lightweight, efficient, low-cost, gallium arsenide Ku band radar transmitter/receiver has been demonstrated. Tests of the Antiarmor Surveillance and Target Acquisition Radar (ASTAR) were successfully conducted. Stationary target detection and classification techniques were successfuly demonstrated. An ultra-low side lobe Ku band radar antenna using a low-cost, tilted-beam antenna concept was successfully fabricated and demonstrated. Technology obtained in an ongoing demonstration of radar netting techniques has been applied as the basis for a proposed netted radar system.

2. (U) FY 1981 Program: Continue technological support to ongoing developmental programs. A radar testbed will be completed and tested which uses solid state transmitter-receiver, charge-coupled device radar signal processor, and tilted-beam antenna. Development of a radar suitable for remotely piloted vehicles will be initiated. Vehicular-mounted low-probability-of-intercept (LPI) locators will be tested against emitter locators and jammers. Stationary target classification efforts will emphasize improving the present 5-target algorithms, and applying them to both moving and stationary targets. Design studies for wideband adaptive ground antenna systems to provide multiple control antenna enhancement for the Modular Integrated Communications Navigation System will be initiated. Work will continue on temperature-stable solid-state ratemeter detector, and stable glass fiber and leuko dye gamma dosimeters. The feasibility tests for a netted radar system for ground surveillance will be completed, and feasibility tests of multistatic radar hardware will continue.

3. (U) FY 1982 Planned Program: Flight testing of the low-probability-of-intercept radar for remotely piloted vehicles will be initiated. Feasibility testing of multistatic radar hardware will be completed. Stationary target classification analysis will continue, with emphasis on applying this knowledge to noncooperative identification friend or foe. The design parameters for a foliage-penetrating radar will be evaluated, and the first components built and tested. The design phase of the wideband adaptive ground antenna system will be completed, and exploratory prototype development initiated. Efforts to develop solid state nuclear imaging systems (gamma camera and light detection and ranging system) will continue, and a prototype of the dosimeter section of a miniature, multipurpose radiac device will be developed.

4. (U) FY 1983 Planned Program: Continuation of the FY 1982 program. Continue efforts on stationary target detection and classification, noncooperative battlefield identification friend or foe, common radar modules, and tactical multistatic radar. The design and fabrication of a foliage-penetrating radar will be completed, and validation field testing begun. Application of target classification technology to other radar programs, such as the Standoff Target Acquisition System, will

Program Element: #6.27.03.A

Title: Combat Surveillance, Target Acquisition and Identification

DOD Mission Area: #521 - Electronics and Physical Science (ED)

Budget Activity: #1 - Technology Base

be initiated. Prototype development of a gamma camera and light detection and ranging system will commence. Continue effort on miniature, multipurpose radiac device. Continue effort to provide a capability to identify and locate enemy nuclear munitions on the battlefield.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTION SUMMARY

Program Element: #6.27.04.A
DOD Mission Area: #522 - Environmental and Life Sciences

Title: Military Environmental Criteria Development
Budget Activity: #1 - Technology Base

A. (U) RESOURCE (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	3127	3108	2815	2900	Continuing	Not Applicable
AF 25	Military Environmental Criteria Development	3127	3108	2815	2900	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program was established in FY 1977 to provide exploratory development of new technology in support of the Project Manager for Chemical Demilitarization and Installation Restoration. The current priority emphasis of the program is directed toward supporting prevention of contamination migration from the Rocky Mountain Arsenal, Denver, CO., and providing technology support to installations determined to have contamination problems. The needs are satisfied by: development of analytical techniques for identification and quantification of contaminants; research to characterize contaminants, determine their toxicities and provide data for the establishment of technology development which will support containment/decontamination efforts at other Department of Defense installations as problems are identified and plans are approved.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Requested FY 1982 funds are required to develop analytical methodology to identify and quantify contaminants found in soil, water, process disposal facilities, and biological tissues to be used in contamination surveys scheduled at twelve Army installations; to perform hazard analyses, toxicity screens and toxicological studies required to establish environmental levels for contaminants moving beyond Army installation boundaries or impacting facilities scheduled for disposal; to develop soil and water treatment processes to eliminate or reduce the concentration of contaminants to environmentally acceptable levels; and to develop techniques to decontaminate facilities and equipment which are excess to Army needs.

Program Element: #6.27.04.A
DOD Mission Area: #522 - Environmental and Life Sciences

Title: Military Environmental Criteria Development
Budget Activity: #1 - Technology Base

D. (U) COMPARISION WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional to Completion	Total Estimated Costs
RDTE					
Funds (Current Requirements)	3127	3108	2815	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	3556	3906	3798	Continuing	Not Applicable

The FY 1980 $448 thousand decrease resulted from reprogramming to higher priority programs.
The FY 1981 $1,091 thousand reduction resulted from directed and general congressional reductions.
The FY 1982 $898 thousand decrease results from reprogramming to higher priority programs.

E. (U) OTHER APPROPRIATION FUND: Not Applicable

F. (U) DETAIL BACKGROUND AND DESCRIPTION: Increasing public concern and national interest in the environment, coupled with the progressive encroachment of civilian communities to the borders of previously isolated Army installation have resulted in growing concern about the potential threat posed by the movement of groundwater contaminants to the borders of the installations and beyond. As a result of military, Congressional and public interest in such contamination at Rocky Mountain Arsenal, direction was provided by the Assistant Secretary of the Army for Installation, Loyistic and Financial Management (ASA(I,L&FM) to establish a comprehensive program for correcting the total Army problem. Responsibility for this program was assigned to the Project Manager for Chemical Demilitarization and Installation Restoration (PM CDIR) and a charter was approved by the Secretary of the Army on 22 August 1975. Effective 1 October 1978 PM CDIR was redesignated the US Army Toxic and Hazardous Materials Agency (USATHAMA). An overall plan of approach to the problem was developed which involves three principal phases, namely; Installation Assessment, Technical Systems Development and Decontamination Operations. The RDTE funded part of this plan applies primarily to the Technical Systems Development Phase. The other phases of the plan are accomplished with Operation and Maintenance, Army (OMA) and Military Construction, Army (MCA) appropriations. The technology effort consists of three areas: Analytical Systems Technology, Contaminant Level Criteria Development (establishment of environmentally acceptable levels of tolerance for each contaminant), and Decontamination Technology. A detailed plan for addressing contamination problems at Rocky Mountain Arsenal was established and work is in progress. In additional, effort is directed toward establishing acceptable environmental levels for concentrations of pollutants by performing chemical and toxicological studies for Army peculiar pollutants when such levels are not available. Further, evaluation of existing technology and development of new technology is being performed as necessary to control migration pollutants, provide analytical methods and decontamination techniques to support these efforts.

Element: #6.27.04.A Title: Military Environmental Criteria Development
DOD Mission Area: #522 - Environmental and Life Sciences Budget Activity: #1 - Technology Base

G. (U) RELATED ACTIVITIES: Conduct of the Installation Restoration (IR) Program and efforts to preclude duplication of effort involves extensive interface with a significant number of other Government agencies. These include, Departments of State, Health Program and Human Services, Agriculture, Transportation, Interior, US Nuclear Regulatory Commission, Environmental Protection Agency, National Academy of Sciences, Department of Defense (DOD) Explosives Safety Board, and state and local governments. On 23 July 1976, the Department of the Army was designated 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 installation restoration program as it relates to all contamination, including chemical, biological and radiological. This mission is the assigned responsibility of USATHAMA. There is no duplication of effort within the Army or DOD concerning this program.

H. (U) WORK PERFORMED BY: In FY 1982 approximately 22% of the funding will be assigned to the US Army Medical Bioengineering Research and Development Laboratory, Ft Detrick, Frederick, MD, for toxicology of chemical contaminants leading to the establishment of environmental levels. Approximately 30% of the dollars will be assigned to Chemical Systems Laboratory. Product Assurance Directorate, and the US Army Armament Research and Development Command, APG, MD, for contractual efforts to assist in developing advanced techniques for sampling, handling and storing contaminated samples. The balance of the RDTE program resources (48%) will be used for development of decontamination process technology. It is estimated that approximately 70% of the total program in FY 1982 will be in contracts; 3% will be assigned to Government agencies outside the Army and 27% will be used for in-house efforts. Principal current contractors include: Calgon, Pittsburg, PA; Arthur D. Little, Boston, MA; Stanford Research Institute, Palo Alto, CA, Midwest Research Institute, Kansas City, MO; and Atlantic Research Corp, Alexandria, VA.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplsihments: This Program Element was established in FY 1977 to prevent hazards to the public health and safety from contamination migrating off DOD Installations to surrounding communities and from release of previously contaminated property to the public. The program is divided into three areas of emphasis (a) Analytical Systems (development of methods to determine levels of trace contaminants in soil and water); (b) Contaminant Level Criteria Development (determine environmentally safe levels of chemical contaminants in the environment and subsequent presentation to the regulatory agencies); (c) Decontamination Technology (develop systems to contain, reduce or eliminate contamination). From FY 1977 through FY 1980 accomplishments in each of these technical areas are described as follows:

(a) (U) Analytical Systems: Qualitative analytical techniques were developed to quickly screen contaminated waters to establish a baseline of compounds present on an installation. Those techniques include Gas Chromatgraph/Mass Spectrometry and High Pressure Liquid Chromatography. Valid quantitative analytical methods were developed at the low detection levels required by Environmental Standards to the part per trillion range. Thirty-seven of these methods were developed during the period. A Quality Control program was established and implemented to ensure consistency and reliability of data from various in-house and contractor laboratories. "Standard Analytical Reference Materials" traceable to the National Bureau of Standards were developed for contaminants of concern.

Program Element: #6.27.04.A Title: Military Environmental Criteria Development
DOD Mission Area: #522 Environmental and Life Sciences Budget Activity: #1 - Technology Base

(b) (U) Contaminant Level Criteria Development: Environmental levels do not exist for many contaminants found during installation surveys. The Army Surgeon General has been tasked to screen these contaminants in a problem definition study and select specific contaminant compounds for toxicological studies from which environmental levels can be recommended to the Regulatory Agencies. Problem definition studies have been performed on 50 contaminants and follow-on toxicity work was conducted on seven compounds found at Rocky Mountain Arsenal and other installations. Environmental levels have been recommended for all seven compounds.

(c) (U) Decontamination Technology: This technical area involves the development of water and soil treatment processes for large areas, secondary waste elimination, subsurface water management techniques and control of contaminant transport phenomenon. During the period, a pilot containment/treatment system was installed and operated at Rocky Mountain Arsenal. This system consists of a series of dewatering wells, a 1500 ft. bentonite clay barrier anchored into an impermeable strata some 23 ft. below the surface, a granular carbon adsorption system and a series of recharge wells. Contaminated groundwater is removed from the aquifer, treated and then reinjected into the aquifer downstream of the barrier. This system has successfully processed over 20 million gallons of contaminated groundwater since installation. Design criteria was also developed for a system to isolate the sources of contamination at Rocky Mountain Arsenal. Water treatment studies were performed involving both organic and inorganic removal techniques. Granular carbon adsorption and ultraviolet ozonolysis processes were tested using waters at the sources of contamination at Rocky Mountain Arsenal. Studies were performed on methods to remove fluoride from groundwater in support of the pilot containment/treatment system at Rocky Mountain Arsenal. Development efforts were initiated to identify treatment methods for wastewater lagoon sediment contaminated by explosive materials. Several containment and groundwater control alternatives were evaluated and recommendations made for future development efforts.

2. (U) FY 1981 Planned Program: Increased effort is being directed toward the development of analytical methods for the identification and quantification of approximately 12 chemical compounds found in the soil, water, process waste disposal facilities and biological tissues of organisms at 5 Army installations scheduled for contamination surveys. Methods for extraction and preservation of samples, as well as the development of standard analytical reference materials for use in laboratory quality control and measurement are being developed. In the Contaminant Level Criteria Development area, problem definition studies, toxicity screening and follow-on toxicity studies are being performed on chemical compounds found in the soil, water, process waste disposal facilities and biological tissues at the Army installations undergoing contamination surveys. Additionally, 12 candidate compound are undergoing hazard analysis; three toxicity screens and one full-scale toxicity study, using vegetation, mammals, wildlife, domestic and aquatic animals, are in progress. The primary development efforts for decontamination/containment technology involve three major aspects; the development of a treatment method for explosive contaminated lagoon sediment; a total containment method for isolating hazardous landfills; and a well point ground water control approach to remove contaminated ground water from the subsurface for treatment. In addition, techniques that apply in-situ and excavated processing, such as soil activation, chemical fixation and chemical neutralization/vegetative uptake, are being screened for applicability. Methods for decontaminating buildings and equipment are under evaluation. Water treatment systems are being developed to remove suspended solids, organics, inorganic salts and metals.

Program Element: #6.27.04.A Title: Military Environmental Criteria Development
DOD Mission Area: #522 - Environmental and Life Sciences Budget Activity: #1 - Technology Base

3. (U) FY 1982 Planned Program: Analytical methods will be developed for identification and quantification of approximately eight additional chemical compounds found in soil, water, process waste disposal facilities, and biological tissue of organisms from five Army installations scheduled for contamination surveys. In addition, development of analytical methodology for detection and quantitative analysis of degradation and process by-products from developmental decontamination process will be initiated. In the area of Contaminant Level Criteria Development, problem definition studies, toxicity screening and follow-up toxicity studies will be continued on chemical compounds found in soil, water, process waste disposal facilities and biological tissues. Some ten new compounds will undergo hazard analysis, five toxicity screens and one full-scale toxicity study using vegetation, mammals, wildlife, domestic, and aquatic animals. Limited laboratory studies of in-situ containment/treatment techniques will be initiated. Water treatment studies will build upon the technical data base from ongoing comprehensive surveys. Building and equipment decontamination techniques will be investigated in the laboratory. Treatment systems will be field tested at two installations. Development work for treating explosive contaminated lagoon sediment will be completed. Containment technology to completely isolate landfills will be piloted and monitored for control effectiveness. The well point groundwater control concept will be field tested. Number of personnel supported with requested FY 82 funds: Professional-18, Support-7.

4. (U) FY 1983 Planned Program: Analytical methods will be developed for the identification and quantification of approximately eight chemical compounds found in soil, water, process waste disposal facilities and biological tissue from five Army installations scheduled for contamination surveys. Approximately six compounds will undergo hazard analysis, one toxicity screen, and one full scale toxicity study. Preliminary design criteria for final containment or treatment measures resulting from five environmental surveys will be finalized. Field and pilot water treatment studies will be conducted as input to the technology base development for contaminated installations. New decontamination techniques for chemical agent or explosive contaminated buildings will be piloted. In-situ teaching methods to treat contaminated soil will be investigated.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.05.A
DOD Mission Area: #521 - Electronics & Physical Sciences (ED)

Title: Electronics and Electron Devices
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	12866	14309	15298	18236	Continuing	Not Applicable
AH9401	Microwave Tubes and subsystems	787	1554	2404	3504	Continuing	Not Applicable
AH9402	Pulse Power Technology and subsystems	836	702	0	990	Continuing	Not Applicable
AH9403	Displays and Peripherals	689	796	1646	1782	Continuing	Not Applicable
AH9404	Integrated Circuits Tech	1874	2860	2542	2798	Continuing	Not Applicable
AH9405	Cost Effective VSLI	1881	1519	728	1113	Continuing	Not Applicable
AH9406	Reliability	240	482	732	964	Continuing	Not Applicable
AH9407	Millimeter Wave Devices and Circuits	1348	1907	2574	2065	Continuing	Not Applicable
AH9408	Microwave Integrated Circuits	1393	1048	1666	1619	Continuing	Not Applicable
AH9409	Acoustic Signal Processing Devices	1270	1141	1414	1505	Continuing	Not Applicable

Program Element: #6.27.05.A
DOD Mission Area: #521 - Electronics & Physical Sciences (ED)

Title: Electronics and Electron Devices
Budget Activity: #1 - Technology Base

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
AH9410	Frequency Control	1053	816	1201	1380	Continuing	Not Applicable
AH9411	Power Sources and Systems	1495	1484	391	1476	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This exploratory development program in electron devices and related materials technologies is resolving critical component barrier problems which are preventing performance, cost, size, weight, and reliability improvements in Army electronic equipment to meet specific enemy threats. This project will provide required increases in electron device performance; on this base, critical new and improved electronic systems concepts are being developed to provide the technological superiority of our forces. Specifically, the program encompasses the development of selected basic electronic building blocks which pace the development of approximately 50 Army systems concepts; included are integrated circuits, solid state devices, microwave tubes, power sources, millimeter components, frequency control, and display devices. These device developments are directly coupled to systems objectives in electronic warfare, night vision, communications, avionics, data processing, combat surveillance and target acquisition, guidance and fire control, navigation and position location, and missile technology.

C. (U) BASIS FOR FY 1982 REQUEST: The FY82 program in electron devices is aimed at developing: (1) low-cost, compact, ruggedized solid state transmitter/receiver components for 94, 140, and 220 GHz millimeter wave radars for target acquisition, detection, tracking and terminal homing systems for penetrating adverse weather and battlefield obscurants; (2) higher power, coherent 220 GHz transmitter sources (pulsers, tubes, duplexers) for increased angular and range accuracy for all-weather, smoke penetration, target acquisition and track radar; (3) signal-processing technology to provide an ECCM capability in data links for Standoff Target Acquisition System (SOTAS) and Joint Tactical Information Distribution System (JTIDS) and the capture, correlation, and targeting of new Electronic Warfare (EW) threats; (4) high-efficiency, small-size GaAs FETs and InP Gunn devices for broadband frequency agile amplifiers for secure data links and expendable jammers and broadband limiters for sensitive, burnout-proof, intelligence-gathering receivers; (5) surface acoustic wave devices for intercept receivers, jam-resistant data links and C3 systems and acousto-optic devices for intercepting, sorting, identifying, and locating enemy emitters (SPRINGTIME); (6) high-rate, high-energy-density, low-cost nickel-zink batteries with 2-1/2 times the energy density of present secondary batteries used in the XM1 and M60 tanks and the Advanced Attack Helicopter; (7) high jammer-to-signal, efficient infrared (IR) sources for protection of Army aircraft; (8) increased system capabilities through

Program Element: #6.27.05.A
DOD Mission Area: #521 - Electronics & Physical Sciences (ED)

Title: Electronics and Electron Devices
Budget Activity: #1 - Technology Base

technology insertion of advanced signal processing and memory using computer-aided design for hybrid and monolithic circuits; (9) affordable high-precision quartz oscillators for frequency synthesizer references and clocks in secure, nonjammable communications, navigation and surveillance systems; (10) interactive sunlight-legible, low-power, rugged, handheld/manportable vehicular and airborne displays required for timely, effective decisionmaking in automated communications, Combat Support and Program-Wide Support systems and transparent graphic displays operable directly over standard Army maps automatically displaying realtime communications, electronic, and imagery intelligence information.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	12866	14309	15298	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	14619	14867	16728	Continuing	Not Applicable

Funding differences between Congressional Descriptive Summaries submitted last year (1980) and this year (1981) are as follows:

1. (U) FY 1980 reduction was due to minor reprograming actions to satisfy urgent, high-priority Army requirements.

2. (U) FY 1981 funding decrease reflects the application of general Congressional reductions.

3. (U) FY 1982 decrease results from increased efficiencies and general inflation reductions.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.27.05.A
DOD Mission Area: #521 - Electronics & Physical Sciences (ED)

Title: Electronics and Electron Devices
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This program represents the Army's prime source of funds for solving critical electronic component deficiencies in combat equipment/systems. The program developments are designed to insure superiority of our combat forces. The technological gap between the US and the Communist Bloc has been closing very rapidly over the past several years. It is imperative that the funding for this Program Element be increased in order to exploit new breakthroughs and maintain our lead in key device technologies. 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. Needed for these development objectives are devices for the Army that are economical to produce, 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 higher reliability. Device feasibility thereby established is basic to orderly development planning, and the expanded technology base provides systems designers with the necessary new 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.

G. (U) RELATED ACTIVITIES: Coordination is achieved with other government agencies through the Department of Defense (DOD) Advisory Group on Electron Devices (AGED) and the interagency Advanced Power Group to preclude any duplication of effort. Related PE 6.37.42.A, Advanced Electron Devices.

H. (U) WORK PERFORMED BY: The Electronics Technology and Devices Laboratory (ET+DL), Fort Monmouth, New Jersey. This Army laboratory is scheduled to use approximately 50% of the program funds contractually. Principal contractors are: P. R. Mallory, Burlington, MA; Watkins-Johnson, Palo Alto, CA; Radio Corporation of America, (RCA), Burlington, MA; Somerville, Camden, Princeton, NJ; TRW, Redondo Beach, CA; Hughes Aircraft Co., Fullerton and Torrance, CA; Northrop, Roll Meade, IL; EG&G, Salem, MA; Raytheon, Waltham, MA; Rockwell International, Anaheim, CA; Westinghouse, Pittsburgh, PA; Motorola, Scottsdale, AZ; Power Electronics Association, Lincoln, MA; Honeywell, St. Petersburg, FL; Electro Mag Se, Atlanta, GA; ILC Technology, Sunnyvale, CA; and Texas Instruments, Dallas, TX.

Program Element: #6.27.05.A
OOD Mission Area: #521 - Electronics & Physical Sciences (ED)

Title: Electronics and Electron Devices
Budget Activity: #1 - Technology Base

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS

1. (U) FY 1980 and Prior Accomplishment: In FY 1980 the program was very successful in developing critically needed electronic devices which will improve the Army's capability to see, track targets, and communicate on the battlefield.

a. (U) Microwave/Millimeter Wave Device - Demonstrated feasibility of a 94 GHz radar receiver and 70 GHz binocular radio using low-cost integrated dielectric waveguide components. Developed 18-watt pulsed power, 94 GHz, diode combiner at 140 GHz for use in terminal guidance for missiles and munitions. Developed low noise Gunn diodes for local oscillators at 60 and 94 GHz--a critical element for all millimeter wave receivers. Developed one-kilovolt-4-nanosecond pulser for millimeter wave radar for tanks, Remotely Piloted Vehicles, and beamrider applications. Initiated the development of a compact, lightweight, magnetic modulator for the laser rangefinder for the XM1 tank. Completed the evaluation of the 3.2-millimeter transmitter traveling wave tube for use in tank fire control radars. Completed the development of a Ku-Band broadband power Field Effect Transister amplifier capable of 2 watts over a 14-16 GHz band and initiated the development of a Ku-Band broadband power amplifier. Initiated the development of a low noise GaAs for use in tactical receivers. Initiated the development of a pulsed diode capable of 20 watts peak power, Ku-Band, for integration in a high-power solid state amplifier for the Multienvironment Active Radio Frequency Seeker (MARFS). Completed the hot pressed Boron Nitride selective emitter development providing for a 20% improvement in output for the AN/ALQ-144 countermeasures Set. Initiated the competitive development of an efficient 8-14-micron infrared source (solid selective emitters and molecular gases).

b. (U) Microelectronic Device - A second-generation programable digital-to-video converter was developed for cockpit display in the Night Navigator/Pilotage system. A demonstrated capability for fabrication of a high-speed IC frequency synthesizer on a single IC chip has opened new potentials for providing all Army tactical voice communication radios with affordable Electronic Counter-Countermeasures (ECCM) capability. A new efficient algorithm for applying the Fast Fourier Transform to intercepted enemy signals permits at least doubling the speed of Electronic Intelligence (ELINT) data processing for realtime acquisition and classification of enemy emitters.

c. (U) Passive Device - Completed the development of a Surface Acoustic Wave (SAW) programable matched filter for the processing of generalized waveforms in the Ultra-High Frequency range. Completed the development of an L-Band front-end SAW filter for application to receiver front ends. Completed the development of a SAW stabilized 1680 MHz tunable oscillator with improved frequency-temperature stability for radiosonde. Initiated the development of a 403 MHz SAW stabilized oscillator as a replacement for the 1680 MHz oscillator required for operation of radiosonde in the Federal Republic of Germany (FRG). Determined the feasibility of integrating SAW phase shifters and resonators on Gallium Arsenic. Developed and demon-

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strated a time-integrating correlator, triple product convolver and ultra-fast, realtime fourier transformers required for the interception, identication and location of enemy spread spectrum emitters. The feasibility of achieving 1X10-10 per g vibration resistance in high-stability resonators has been demonstrated and will allow for the development of spread spectrum systems to operate in a mobile jamming environment. The technical approach for a 5-10 ppm temperature-compensated, voltage-controlled crystal oscillator was established allowing for the development of a low-cost oscillator module for and a 2-5 ppm microprocessor-compensated crystal oscillator for super-high frequency radios. The development of a 2-digit sunlight-legible electroluminescent display for the Battery Computer System has been completed. The Tactical Video Display, having a 15-watt power dissipation and weighing 6 pounds, has been developed and will be incorporated in the TRAILBLAZER, TACJAM and QUICKFIX Electronic warfare systems.

d. (U) Power Sources - Completed the development of first-generation high-rate lithium battery structures and initiated designs of second-generation lithium batteries having a 50% increase in energy density over present (first generation) lithium batteries which will provide for enhanced equipment performance of laser designators, rangefinders, night vision devices and portable displays. Completed the development of a 2.5-kW AC-to-DC power processor using the new high-frequency active filtering technique which reduces the size and weight by 40%. Designed a high-temperature burner system to increase the efficiency of the thermo-electric generator by a factor of two. Developed a nickle-zinc cell design for a battery for the XM1 and M60 tanks having a 35-watt-hour/pound energy density (3 times improvement) and 400 cycle life (2 times improvement) over the lead acid battery presently used.

2. (U) FY 1981 Program:

a. (U) Microwave/Millimeter Wave Devices - Initiate development of millimeter wave monolithic dielectric waveguide integrated circuit receivers at 94, 140, and 220 GHz for mini-Remotely Piloted Vehicless, Helicopter All-Weather Target Acquisition Designa- tion System (HAWTADS), Beamrider, and Advanced Cannon-Launched Guided Projectile (CLGP) applications. Continue development of Impact Avalanche Transit Time (IMPATT) diode sources and diode combiners to develop higher power (10-20 watts at 220 GHz) to extend range of acquisition radar well beyond 3 km. Continue to develop extremely low noise mixer diodes (3-4 dB NF) for the 60 to 230 GHz region for Beamrider and a quasi-optical high-resolution radar. Start work on low-cost, low-power drain and rugged 140 GHz ferrite phase shifters for beam steering phase array radar. Complete the 2-kV, 4-nanosecond pulser and integrate with the 95 GHz magnetron for experimental target identification mm radar systems. Complete the magnetic modulator development and evaluate for laser radar and beamrider applications. Start development of a high current density (8-10 A/cm2) cathode with 2,000 hours life for millimeter wave tubes for tank fire control and remotely piloted vehicle radars. Initiate development of an integrated channelized receiver for QUICKLOOK-II and Team Pack

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Electronic Warfare Systems upgrades. Continue development of a low noise Field Effect Transister for tactical receivers. Initiate development of a 5-kW bulk semiconductor limiter for receiver protection for single antenna, pulse power radar and countermeasures systems up to 40 GHz (HAWTADS and ASTAR). Initiate development of pulsed sources at 16-18 and 35-40 GHz for missile seekers, fire control and surveillance radars. Continue development of the Ku-band solid state amplifier. Initiate development of a laser-cut, S-Band, crossed-field amplifier (CFA) secondary emitter for the AN/TPQ-37 radar.

b. (U) Microelectronic Devices - Establish feasibility of high-speed GaAs large-scale integrated circuits for planned use in high-speed signal-processing in fire-and-forget missiles and electronic counter-countermeasures applications. Design and fabricate an electrically alterable programable logic array for high-speed signal processors. Complete the modular adaptive signal sorter (MASS) design and fabricate a brassboard illuminator detector. Initiate effort on a classified standoff target acquisition system functional module utilizing previously developed technology employed in the MASS development. Initiate development of a completely militarized 16-kilobit Random Access Memory (RAM) and high-density military memories for insertion into the Joint Tactical Information Distribution System (JTIDS) and packet radio system. Initiate effort on a signal processor controller microcircuit with the means for controlling concurrent operation of several processing functions with improved system efficiency and throughput and eventual use in the portable all-source analysis center remote terminal system. Complete in-depth study of computer-aided design (CAD) approaches and implementations to define the necessary CAD development and modifications for cost-effective technology insertion of Large-Scale Integrated subsystems at 1-5 GHz for JTIDS-type synthesizers.

c. (U) Passive Devices - Hybrid optic techniques will be used to package a time-integrating correlator for field testing. Ultra-fast Bragg cell will be used to develop an optical countermeasures excisor. Start development of a moderate time bandwidth, produce monolithic surface acoustic wave (SAW) convolvers and memory correlators using epitaxial Gallium Arsenic and operating at Ultra-High Frequencies. Start development of a communications intercept receiver, utilizing a SAW compressive phase interferometer for operation in the 20-90 MHz band. Complete the development of a 403 MHz SAW stabilized oscillator for radiosonde operation in Germany. Develop high-stability crystals for low phase noise SOTAS oscillators. Initiate development of microprocessors compensated crystal oscillator for fast frequency hopping systems. Complete development of display panel to replace the unreliable, heavy power-hungry AN/UYQ-10 display used in TRAILBLAZER, TACJAM, and QUICKFIX electronic warfare systems. Prototype-quality, sunlight-legible, low-power message and graphics displays will be developed for the Unit Level Switch (SB-3865), the Digital Message Device (DMD) and the Digital Message Miniterminal (DMM). Initiate development of a fully transparent 11" x 15" display to cover the 20 km x 14 km front on a 1:50,000 paper map.

d. (U) Power Sources - Modify zinc anode structure and formulation to improve cycle life of the first-generation

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nickel-zinc battery for the XM1 and M60 tanks. Develop high-frequency switching technology for design of miniaturized, reliable high voltage power supplies for travelling wave tubes to reduce size, weight, and cost of data links and airborne jammer systems. Initiate development of a thermoelectric converter using high-temperature, high-efficiency materials (selenides) to increase thermoelectric conversion efficiency by 80%. Establish lithium second-generation cell designs for moderate rate discharge batteries. Initiate effort on third-generation lithium cells to double the energy density over the first-generation lithium cells (200 w-hr/lb vs. 100 w-hrs/lb).

3. (U) FY 1982 Program:

a. (U) Microwave/Millimeter Wave Devices - Continue development of low cost, small-size, and rugged monolithic dielectric waveguide integrated receivers at 94, 140, and 220 GHz for remotely piloted vehicles and guided munitions. Initiate development of extremely low cost, rugged, and burnout-resistant integrated circuit receivers at 94, 140, 220. Continue development of low noise Gunn sources for receivers at 140 GHz for terminal homing and missile guidance. Continue development of coherent pulsed source and combiners at 220 GHz to obtain high power (10-20 watts) for short pulses (50 nsec) to extend the range of acquisition radars beyond 3 kilometers. Continue to develop extremely low noise mixer diodes for the 60 to 230 GHz region for quasi-optical high-resolution radars. Continue work on low-cost, low-power-drain and rugged 140 GHz ferrite phase shifters for beam-steering phased array radars. Start development of 220 GHz power tubes and pulser package for increased angular and range accuracy for advanced radars. Insert prototype high current density 8-10 amps/cm2 in millimeter wave tubes. Initiate the development of Gunn diodes (15 watts at 16-18 GHz and 7 watts at 35-40 GHz) for broadband frequency agile transmitter sources. Complete the development and evaluation of a 1.25-pound, 6-watt field effect transister (FET) amplifier at 25% efficiency for use in data links and expendable jammers. Initiate development of broadband limiters for burnout-proof, sensitive, extremely broadband intelligence-gathering receivers. Initiate development of octave band FETs power amplifiers for next-generation antijam data links (Ku-Band). Begin development of a high jamming/signal ratio, 3-5u gaseous emitter source, to reduce required power input from 3 kW to 1 kW in a classified system. Continue the development and evaluation of an 8-14u infrared source. Demonstrate S-Band secondary emitter for the AN/TPQ-37 radar. C-Band tube for PATRIOT missile system secondary emitter.

b. (U) Microelectronic Devices - Develop integrated circuit technology which capitalizes on the use of high-speed GaAs materials for use as charge transfer devices for achieving high-speed output circuitry. Complete fabrication and testing of prototype high-speed Silicon on Sapphire (SOS) frequency synthesizers for use in existing communications and data link equipment. Fabricate Gallium Arsenic prescalers for front-end application to data links, with circuit dissipation of 10 mW at 2.5 GHz. Initiate development of Gallium Arsenic programable correlator for pattern recognition and noncooperative iden-

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tification friend/foe systems. Complete development of a military qualified 16-kilobit static random access memory as a low-cost replacement for use in data communictions systems.

c. (U) Passive Devices - Fabricate large-gain, wide bandwidth, acousto-optic processor for low-probability-of-intercept radars to cover enemy threat. Continue development of a communications intercept receiver utilizing a surface acoustic wave compressive, phase interferometer for operation in the 20-90 MHz. Continue development of low-cost techniques of fabricating high-stability resonators for advanced communication systems. Initiate development of low phase noise oscilator for standoff target acquisition system (SOTAS) and low-power oscillator for SINCGARS radio. Continue development of vibration-resistant, high-precision quartz crystal resonator to improve target location accuracy of SOTAS and to permit XM1 tank and UH-60 helicopter to operate in a jamming environment. Continue development of high-precision, low thermal hysteresis quartz crystal resonators to provide SINCGARS radio with smaller, lower power, lower cost "instant on" frequency standards or clocks. Continue development of microprocessor-compensated crystal oscillator for oscillator/synthesizer modules for SINCGARS radio. Initiate development of microprocessor compensation of doubly rotated quartz crystal unit for low-cost SINCGARS radio and Position Location Reporting System. Complete the development of sunlight-legible displays which provide 10 times savings in weight and power over other technologies. Begin integration of the high-contrast display into assemblies providing for standardardized tactical modular display packages. Fabricate multicolor displays for instructional/automatic test equipment, and cockpit displays. Complete development of a fully transparent 11" x 15" display to cover the 20 km x 15 km front on a 1:50,000 paper map.

d. (U) Power Sources - Continue advanced development of the zinc anode to attain a minimum 600-cycle useful life of the nickel-zinc battery for the XM1 and M60 tanks. Continue design of reliable miniaturized high-voltage power supplies for Travelling Wave Tubes to reduce size, weight, and cost of data link and airborne jammer systems (MICNS and AN/ALQ-136). Continue development of selenide thermoelectric modules capable of operation at 900 degrees Centigrade and increasing thermoelectric conversion efficiently by 80%. Establish capability of third-generation lithium cell for moderate power at limited temperatures.

4. (U) FY 1983 Program:

a. (U) Microwave/Millimeter Wave Devices - Complete development of low-cost, small-size, and rugged monolithic GaAs integrated receivers at 94, 140 and 220 GHz for remotely piloted vehicles and guided munitions. Initiate program to develop low noise oscillators with frequency range extended from 140 to 220 GHz for terminal homing and missile guidance. Continue to develop pulse compression combiners and initiate work on continuous wave combiners for radar and missile guidance using

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diodes at 220 GHz. Complete development of pulser components, pulser design, and experimental model package and integrate with 220 GHz transmitter package for STARTLE radar. Complete life evaluation of high current density cathode (8-10A/cm2) with 2000-hour tube operation and extend life to 5000 hours. Complete development of Gunn diode amplifiers (15 watts at 16-18 GHz and 7 watts at 35-40 GHz) for broadband frequency-agile and coherent radars. Complete development of pulsed Gallium Arsenic amplifiers (25 watts at 16-18 GHz and 10 watts at 35-40 GHz) for pulse widths of 4 microseconds and longer as used in pulse compression systems in missile seekers, fire control, and surveillance radars. Initiate a program to determine the optimum structure for pulsed 25-watt devices at Ku-band for surveillance/seeker applications. Complete integration of high jamming/signal ratio infrared source in testbed modulator. Complete evaluation of emitter/modulator for infrared source. Begin development of pulse and control circuitry for an advanced infrared jammer. Evaluate C-Band tube for PATRIOT missile secondary emitter.

b. (U) Microelectronic Devices - Initiate work on a modular analog-analog correlator which will operate as a microprocessor-controllable autocorrelator or cross-correlator as well as being reconfigurable as a multichannel binary-analog correlator with programable tap weights for content addressable memory, pattern recognition and noncooperative target identification. Develop specialized devices not amenable to very high-speed integrated circuit (VHSIC) program which address the very high speed signal processing in fire-and-forget missiles, electron countermeasures in dense electronic warfare environments, and electronic counter-countermeasures communications. Electrobeam-defined submicron GaAs technology will be extended to large-scale integration complexity and demonstrated with a receiver synthesizer function. Continue triservice effort on high-density bubble devices, leading to high-density bubble packages that can be used as building blocks for self-contained bubble stores for technology insertion in TRAILBLAZER electronic warfare system and AN/TTC-38/39 switches. Demonstrate functional capability of chip design and fabrication for use in a classified Standoff Target Acquisition System functional module. Signal processor-controller circuit chips designed for concurrent control of several signal-processing functions will be evaluated and demonstrated.

c. (U) Passive Devices - Implement acousto-optic triple-product convolver and optical exciser. Develop ultra-fast, realtime, high-speed Fourier Transform Devices for the Passive Acoustic Artillery Locator System (PAALS). Complete development of a communications intercept receiver, utilizing a surface acoustic wave compressive phase interferometer for operation in the 20-90 MHz band. Complete development of advanced monolithic acoustic devices using the surface-skimming mode of propagation for improved performance filters and oscillators at microwave frequencies. Initiate development of ultra-wide bandwidth Surface Acoustic Wave (SAW) devices and monolithic electronically tuned SAW processors and oscillators for receiver front ends. Continue the development of high-vibration-resistant, low phase noise oscillator. Complete the development of microprocessor-compensated crystal oscillators and microprocessor-based oscillator/synthesizer module

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development. Complete the development of high-precision, low-thermal-hysteresis quartz crystal resonators to provide SINCGARS radio with smaller, low power, lower cost "instant on" frequency standards or clocks. Demonstrate less than 1-watt power dissipation in handheld displays, less than 5 watts in larger displays, through integration of the high-contrast display and providing standardized tactical modules for data message devices and QUICKLOOK-II electronic warfare system. Demonstrate red, green phosphors for multicolor displays Conduct human factors and environmental testing of the 11" x 15" map overlay display. Initiate development of a 4' x 4' transparent display for All Source Analysis System (ASAS) and Tactical Display System (TDS).

d. (U) Power Sources - Finalize zinc anode design to attain a minimum useful battery life of 800 cycles for the nickel-zinc battery for the XM1 and M60 tanks. Complete design of reliable miniaturized, high-voltage power supplies for TWT's to reduce size, weight, and cost of data links (MICNS) and airborne jammer systems using high-temperature selenide converter. Identify cell components and products of reaction that can lead to operational safety problems with third-generation lithium batteries.

5. (U) Program to completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.06.A Title: Chemical Biological Defense and General Investigation
DOD Mission Area: #522 - Environmental & Life Sciences (ED) Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	11740	11411	22970	14390	Continuing	Not Applicable
A553	Chemical/Biological (CB) Defense and General Investigations	11740	11411	22970	14390	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Army, as the Department of Defense (DOD) Executive Agent, has responsibility for conducting a Research, Development, Test and Evaluation (RDTE) program coordinated with all the Services to provide the essential technology base upon which the Services can develop deterrent/retaliatory chemical weapons and chemical and biological defense (CW/CBD) systems on an individual or joint basis to meet their military operational needs. This program provides the interservice chemical/biological (CB) defense technology base. Exploratory Development is conducted to provide the technological base to counter the threat posed by potential enemy agents/munition systems; to enhance all aspects of physical defense including warning, detection, identification, decontamination, individual and collective protection; to investigate chemical compounds of military interest; to evaluate protection countermeasures, avoid technological surprise, and uncover leads for new retaliatory simulant agents; and to study agents and methodologies for the training of soldiers. The output is knowledge leading toward improvements in CB defense. This knowledge is also usable in advancing the retaliatory chemical agents/munitions technology.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: The program will include significantly expanded efforts with academia and industry to broaden the technology base required to support chemical-biological defense materiel requirements. Specifically, the program will include the continuation of the assessment of the effectiveness of protective, detection, identification, and decontamination systems against all threat agents in the integrated battlefield environments. Specific efforts will be

Program Element: #6.27.06.A Title: Chemical Biological Defense and General Investigation
OOD Mission Area: #522 - Environmental & Life Sciences (ED) Budget Activity: #1 - Technology Base

directed toward: continuation of exploratory development on innovative means of chemical, thermal, and radiative decontamination as well as mechanical removal; protective masks, garments, and gloves that provide agent resistance, field durability, and extreme environment operational capability. Additionally, exploratory development will be conducted on new innovative detection and alarm devices to improve response time and sensitivity and reduce logistics burden.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	11740	11411	22970	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	12431	12330	12687	Continuing	Not Applicable

The decrease in FY 1980 funding ($691 thousand) is the result of a refinement in program cost estimate and reprograming to other high priority Army requirements. FY 1981 decrease reflects the application of general Congressional reductions. The $10283 thousand increase in FY 1982 supports the recommendations of the Army Science Board and the Defense Science Board which are associated with biological and chemical technology base investigations to avoid surprise and enhance survivability on the contaminated battlefield.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.27.06.A Title: Chemical Biological Defense and General Investigation
DOD Mission Area: #522 - Environmental & Life Sciences (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This program supports the entire Department of Defense chemical and biological defense technology base and 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 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 includes 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.

G. (U) 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 except unique requirements in order to meet their advanced and engineering development needs, adoption of joint Service requirements where practicable, and preclusion of duplicative efforts. Coordination and cooperation is maintained with allied countries via Data Exchange Agreements, and with the North Atlantic Treaty Organization (NATO). Related technical investigations are conducted under Program Element 6.26.22.A, Chemical Munitions and Chemical Combat Support. The technology developed under Program Element 6.27.06.A, Chemical Biological Defense and General Investigations, progresses into Program Element 6.37.21.A, Chemical Defense Materiel Concepts, and subsequently into Program Element 6.47.25.A, Chemical Defense Materiel.

H. (U) WORK PERFORMED BY: In-house by United States (US) Army Chemical Systems Laboratory, Edgewood, MD. Contractors include Shock Hydronamics, Sherman Oaks, CA; Honeywell Corporation, St. Petersburg, FL; Ash Stevens Incorporated, Detroit, MI; Batelle, Columbus, OH; Brunswick Corporation, Marion, VA; Southern Research Institute, Birmingham, AL; Mine Safety Appliance, Pittsburgh, PA; Midwest Research Institute, Kansas City, MO; and Bendix Corporation, Towson, MD.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishment: During 1978, the following were accomplished: completed exploratory development (XD) on the detector kit for chemical agents in water and the ionization detector which enhances the sensing capability of the M8 Chemical Alarm System. Additionally, the feasibility of laser remote sensing techniques was completed; and conceptual studies for simplified collective protection for field shelters and residual gas-life indicator for large area

Program Element: #6.27.06.A Title: Chemical Biological Defense and General Investigation
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filters were completed. In FY 1979, the following were accomplished: completed exploratory development on the decon tamination apparatus for vehicles (DAV), and the Automatic Liquid Agent Detector (ALAD); completed evaluation of the German 7-ton decontamination unit; and completed construction of prototype for rapid decontamination system (jet exhaust decontamination system). It was confirmed that the protective overgarment can be worn for 28 days in a nontoxic environment and continue to meet protection criteria when exposed to toxic chemicals. Exploratory development on the simplified collective protection equipment was initiated. During FY 1980, the following was accomplished: (a) completed investigation and drafted report on facemask filter plugging by battlefield particulates; (b) completed exploratory development of simplified collective protection equipment and transferred to advanced development based upon approval Letter of Agreement (LOA); (c) completed exploratory development on Automatic Liquid Agent Detector and M8 Chemical Alarm Simulator; (d) established feasibility of ionization detector for small handheld contamination monitor and jet exhaust techniques for large scale vehicle decontamination; (e) continued exploratory development on the advanced Chemical Agent Detector and Alarm with emphasis on blister and nerve agent detection as well as surface surveillance for contamination or completeness of decontamination; (f) also, continued exploratory development of second generation remote detection system using differential absorption and scattering laser techniques for detecting a broad spectrum of agents in all physical states. In addition, the search was initiated for new, improved protective materials for use in masks and overgarments that will satisfy requirements for operation at environmental extremes, resistance to field solvents, and durability.

2. (U) FY 1981 Program: The program will include: (a) completion of exploratory development (XD) of the Advanced Chemical Agent Detector Alarm (ACADA); (b) implementation of research on facemask filter plugging by battlefield particulates; (c) completion of investigation of the flow characterization and measurement of thickened liquids to describe their behavior in defensive and deterrent/retaliatory systems; and (d) continuation of investigation of innovative means of chemical, thermal, and radioactive decontamination techniques, as well as mechanical removal of contamination. Laser photolysis, microwave, and high-intensity infrared are examples of innovative decontamination concepts. Identification and assessment of candidate persistent and nonpersistent training and trialing simulant agents will continue. The exploratory development of an improved personal decontamination kit will be initiated. Studies will be initiated on charcoal regeneration concepts to increase useful field life of filters, overgarments, and other charcoal-bearing chemical protection materials. Exploratory development will be initiated on a biological agent test kit. Studies will be initiated to evaluate potential threat of plugging large collective protection filters by battlefield particulates. Number of personnel supported: professional 133; support 45.

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3. (U) FY 1982 Planned Program: The program will include significantly expanded efforts with academia and industry to broaden the technology base required to support chemical-biological defense materiel requirements. Specifically, the program will include improvements in the chemical warfare total threat model; completion of the Materials and Design Requirements Handbooks for chemical and biological contamination avoidance; completion of exploratory development for a protective mask for high performance aircraft, vehicle mounted nuclear, biological, and chemical reconnaissance system, and biological agent verification kit. Exploratory development will continue on innovative means of chemical, thermal and radiative decontamination as well as mechanical removal; protective materials for masks, gloves, and garments that provide agent resistance, field durability, and extreme environment operational capability; identification and verification of candidate persistent and nonpersistent training and trialing simulants; charcoal regeneration and residual life monitors to increase useful life of filters, overgarments, and other charcoal-bearing protection materials. Additionally, exploratory development will be initiated on a combined nuclear, biological, and chemical detec tion/alarm system to reduce the logistics burden; advanced collective protection systems for vehicles and shelters; detector/alarm integration into combat vehicles for automatic sensing/activation for collective protection equipment, potential techniques such as mass spectrometry, pizoelectric crystals, and liquid crystals for detection and identification; and laser, microwave, ion mobility spectrometry and photoacoustic techniques for a new-generation biological alarm. The magnitude of this program reflects the Army's urgent need to upgrade the NBC technology base to enhance future battlefield survivability. This program employs a total of 191 personnel: 128 professional and 63 support.

4. (U) FY 1983 Planned Program: The effectiveness of protective and detection systems against all potential threat agents in tri-service environments will continue to be assessed. Exploratory development will continue on new innovative concepts such as laser photolysis, microwave, and high-intensity infrared for decontamination; differential absorption and scattering laser techniques for remote detection and monitoring; and mass spectrometry, pizoelectric crystals, and liquid crystals for detection and identification. Identification and assessment will continue on candidate persistent and nonpersistent training and trialing simulants. Exploratory development will be completed on a decontamination station kit and improved personnel decontamination kit.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.07.A Title: Mapping and Geodesy
DOD Mission Area: #522 - Environmental and Life Sciences Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1979 Actual	FY 1980 Estimate	FY 1981 Estimate	FY 1982 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	4431	5020	6058	6924	Continuing	Not Applicable
A855	Topographic/Geodetic Technology	4431	5020	6058	6924	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Army and DOD tactical operations and strategic planning require rapid access to precise position, azimuth, and elevation data and to descriptive terrain information. The Mapping and Geodesy Program investigates and develops responsive and cost-effective means for meeting these requirements. Methods and equipment for collecting, processing, displaying, and disseminating geodetic, topographic, and military data and products are developed within this program.

C. (U) BASIS FOR FY 1981 RDTE REQUEST: The requested funding for FY 1982 is required to continue work on specific needs of the Field Army and of the Defense Mapping Agency. Field Army needs include: gyroscopic azimuth devices for artillery survey application, low-cost optical/inertial techniques for rapid position determination, improved map designs and production procedures, and terrain analysis focused on intervisibility and mobility. Defense Mapping Agency needs include the development of digital and interactive techniques for imagery data extraction and elevation determination and the use of hybrid electro-optical and digital techniques for imagery data extraction. DMA also requires a high order positioning and gravity determination system to support advanced strategic missile systems.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

Program Element: #6.27.07.A Title: Mapping and Geodesy
DOD Mission Area: #522 - Environmental and Life Sciences Budget Activity: #1 - Technology Base

	FY 1980	FY 1981	FY 1982	Additional To Completion	TOTAL Estimated Cost
RDTE					
Funds (current requirements)	4431	5020	6058	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	4466	5652	5702	Continuing	Not Applicable

Differences between the FY 1981 submission and the current request are as follows:

In FY 1980 a decrease of $35 thousand was due to undistributed Congressional reductions.

In FY 1981 a decrease of $632 thousand is attributable to the application of general congressional reductions and reductions for increased efficiencies.

In FY 1982 the increase of $356 thousand supports increased efforts in hydrology to meet Rapid Deployment Force requirements.

E. (U) OTHER APPROPRIATION FUNDS: ($ in thousands) Not Applicable

Program Element: #6.27.07.A Title: Mapping and Geodesy
DOD Mission Area: #522 - Environmental and Life Sciences Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The Mapping and Geodesy Technology Base Program develops new or improved means for rapid acquisition, processing, and dissemination of positional information, mapping data, and military geographic information. End items directly support future map production and topographic support activities affecting strategic and tactical deployment of forces and weapons systems. The program covers areas of Geodesy and Point Positioning, Mapping and Geographic Analysis, and provides the 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. The program addresses science and technology objectives for Command Systems, Intelligence/Surveillance/Target Acquisition and Fire Support capability categories in the Army Science and Technology Objectives Guide (STOG).

G. (U) RELATED ACTIVITIES: This Program Element applies results of basic research performed under Program Element 6.11.02.A, Defense Research Sciences, Project B52C, 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 Defense Mapping Agency (DMA) and the Under Secretary of Defense for Research and Engineering (USDRE). 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 avoided by annual DOD Apportionment and Budget Reviews, DMA Technology Base Reviews, periodic DOD Topical Reviews and technical coordination among the Service research laboratories.

H. (U) WORK PERFORMED BY: Approximately 60% of the work is performed in-house at the US Army Engineer Topographic Laboratories, Ft. Belvoir, VA. The balance is performed by commercial contractors or other government agencies. Total contracted effort for FY 1982 will be $2,600,000. The five major contractors are: Ampex Corps., Redwood City, CA, Litton System, Inc., Woodland Hills, CA, Honeywell, Inc. St. Petersburg, FL, General Electric Space Division, Philadelphia, PA; and Perkin Elmer Corp., Danbury, CT. There are sixteen additional contractors with contracts in this program totaling $1,400,000.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: A carbon dioxide waveguide laser was selected for use in developing a surveying instrument for low-visibility conditions. Baseline field data was established for evaluation of rapid gravity survey equipment being developed for the Defense Mapping Agency to support geodetic requirements of strategic missiles. An interactive system for field preparation of terrain graphics from digital data was assembled and tested. Applications programs were

Program Element: #6.27.07.A Title: Mapping and Geodesy
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developed in support of the continuing research being done with the Digital Imagery Analysis Laboratory. A demonstration model for the Field Exploitation of Elevation Data (FEED) was assembled. This system provides perspective views of terrain, flight path overlays, and radar masking in support of tactical commanders. Feasibility for a Quick Reaction Multicolor Printer was demonstrated and advanced development was initiated.

2. (U) FY 1981 Program: Design of a surveying instrument for low conditions is being completed. Inertial positioning system modifications needed to meet Defense Mapping Agency (DMA) strategic missile geodetic requirements are being determined. The interactive system for preparation of terrain analysis from digital data is being upgraded and tested. A prototype variable geometry laser printer for correcting geometric distortion of imagery is being fabricated. The Digital Imagery Analysis Laboratory (DIAL) is being augmented with a hardcopy capability and parallel transfer disks procured for the DIAL/Laboratory Demonstration System (DEMONS) in order to demonstrate feasibility of reducing digital image processing time to support DMA and Army needs. Work is in progress to develop a capability to detect and locate vertical obstructions to support Cruise missiles. Radar parameter guides are being developed. Hardware and software components for computer-assisted photo interpretation are being developed. The objective of this effort is to demonstrate the feasibility of an Interactive Digital Feature Extraction System for future DMA advanced and engineering development.

3. (U) FY 1982 Planned Program: A surveying instrument for low-visibility conditions will be tested and transitioned to advanced development. A rapid geodetic survey system will be evaluated for ability to meet Defense Mapping Agency requirements in support of strategic missiles. Performance of the prototype variable geometry laser printer will be evaluated. Cartographic production processes that can support the Quick Reaction Multicolor Printer now in development will be investigated. Problems of interpreting symbolization on hardcopy and electronic displays will be investigated. Several of a continuing series of terrain analysis guides will be completed. Personnel supported by this program include 60 professional and 5 support.

4. (U) FY 1983 Planned Program: In-house and contractual efforts will continue in the development and testing of interactive techniques of digital imagery feature extraction. Development of multi-image automated interpretation techniques and experimental software for terrain analysis will continue. Standards for electronic display symbol design will be published. Fabrication of a radar image analysis system will be initiated. Several of a continuing series of terrain analysis guides will be completed. A guide for predicting minefield locations based upon terrain factors will be completed.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.09.A Title: Night Vision Investigations
DOD Mission Area: #521 - Electronics & Physical Science (ED) Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	10174	10674	13490	15019	Continuing	Not Applicable
DH95	Night Vision Investigations	10174	10674	13490	15019	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Army has a need for a cost-effective means to fight during periods of darkness and limited visibility with a relative combat capability that is equal to that of day. This program element supports the development of technology to ensure the United States (US) maintains its lead in the ability to acquire and engage targets under all battlefield conditions. This combat capability is required to counter the threat of a foe who plans and trains to continue combat operations during periods of darkness and limited visibility. Using advanced technologies and new concepts in the field of electro-optics, this program develops new techniques, components, and devices that will result in significant cost reductions and performance improvements for night vision devices.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Funds requested provide for research and exploratory development to improve performance effectiveness, simplify, and reduce life cycle costs of future night vision systems. Major efforts will be in the areas of Visionics, Thermal Imaging, and Lasers. Visionics - Efforts will be concentrated on the validation and application of visionics man-machine performance models to determine optimum designs of electro-optic hardware. Models will continue to be upgraded to incorporate the adverse effects of camouflage, atmospheric conditions, and countermeasures based on data collected during field experiments. Thermal Imaging - Continue development of forward-looking infrared (FLIR) devices with a tenfold increase in sensitivity for penetration of obscurants; e.g., fog, smoke, dust. Continue to develop technology base for third-generation infrared systems and multispectral imagers which will have greatly improved performance over present systems. Increase development of lightweight electro-optical sensor and target seekers for use in terminal homing of smart munitions. Lasers - continue development of laser sources for target acquisition and integrated engagement systems. Continue the integration of these lasers with heterodyned forward-looking infrared to form an all-weather sensing system, as well as new precision laser designators. All of these efforts are pointed toward improving the Army's ability to acquire and engage targets under all weather conditions.

Program Element: #6.27.09.A Title: Night Vision Investigations
DOD Mission Area: #521 - Electronics & Physical Science (ED) Budget Activity: #1 - Technology Base

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	10174	10674	13490	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	9183	11402	14529	Continuing	Not Applicable

Increase in FY 1980 ($991) was for work on a forward-looking infrared (FLIR) image processor, countermeasure/counter-countermeasure lasers, Polymeric Microelectronics, and to cover cost growth in the Surveillance Target *Acquisition Radar for Tank Location and Engagement* (STARTLE) program. The FY 1981 decrease reflects the application of general Congressional reductions. Decrease in FY 1982 ($1039) was due to program realignment and higher priority projects.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.09.A Title: Night Vision Investigations
DOD Mission Area: #521 - Electronics & Physical Science (ED) Budget Activity: #1 - Technology Base

F. (U) 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. The Visionics program is primarily concerned with the development of tactical effectiveness models, the refinement of a target signature data base, and the exploitation in technology demonstrator configuration of new sensor ideas and concepts. The performance and field utility of sensors for both direct acquisition and weapons system applications are studied using analytical models. Results from these models are the basis for engineering judgments of technological concepts prior to hardware development. Models are used to portray realistically the performance of the various sensors on the active battlefield against various threat weapon systems. These simulation models include both the "man in the loop" and automatic features for unmanned applications. Far Infrared thermal imaging technology is directed toward fabrication and initial testing of second-generation Forward Looking Infrared (FLIR) and the Surveillance Target Acquisition Radar for Tank Location and Engagement (STARTLE). A new generation of high-performance FLIR systems is being developed which uses high-density, Charge Coupled Device (CCD) focal plane arrays. The CCD effort seeks to double the standoff range of present FLIR in airborne applications and greatly enhance the performance of combat vehicle FLIR under conditions of poor visibility. Increased search effectiveness is provided by automatic target-cueing and image enhancement techniques. Large two-dimensional staring focal plane arrays which integrate the CCD signal processing with 8-12 micron detectors offer significantly improved system sensitivity while reducing mechanical and optical complexity. The concept of a common module carbon dioxide laser and definition of a family of compact modular elements compatible with FLIR is being developed. Applications of this laser family include rangefinders, battlefield Identification Friend or Foe, beamrider missile guidance, target designators, and wind sensors. Common modules and interface elements for integration with FLIR are constructed and tested. Because of the noncommercial aspects of night vision and electro-optical technologies, it is essential to maintain internal research and development activity.

G. (U) RELATED ACTIVITIES: Close coordination is maintained with the Navy, Air Force, and Marine Corps to avoid duplication. Through the Joint Logistics Commanders (Army, Navy, and Air Force) coordinating groups have been established to ensure that maximum use is made of limited assets; e.g., the Navy is developing 8-14 micron second-generation infrared detectors, while the Army is developing those sensitive to 3-5 micron energy. The Army has responsibility for the Configuration Management of the first-generation Thermal Imaging Common Modules used by all Services. In addition, an active international program of technical cooperation is maintained with many countries, particularly those of the North Atlantic Treaty Organization (NATO) and the Quadripartite countries (America, Britain, Canada, and Australia).

H. (U) WORK PERFORMED BY: Night Vision Laboratory, Fort Belvoir, VA. Representative contractors are: Philco Ford

Program Element: #6.27.09.A Title: Night Vision Investigations
DOD Mission Area: #521 - Electronics & Physical Science (ED) Budget Activity: #1 - Technology Base

Corporation, Aeronutronics Division, Newport Beach, CA; Martin Marietta, Orlando, FL; Hughes Aircraft, Culver City, CA; and Texas Instruments, Dallas, TX.

1. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Second-generation image intensifier tubes have been developed and are now in production. Gallium arsenide photo cathode technology for third-generation intensifiers with greatly increased sensitivity and reliability has been developed and is now in night vision goggles in Engineering Development. In the Visionics area, models to predict range of intensifier and visual search performance completed, and techniques established to include the effects of smoke and target signature variation on the evaluation of electro-optical viewing systems. Programs were initiated to develop a flat-panel, helmet-mounted display for use by helicopter pilots, and a miniature camera tube for possible use in Remotely Piloted Vehicles (RPV's). A second-generation Thermal Imaging program to demonstrate high-density detector focal planes, up to 5000 detectors, was initiated. Uncooled, midperformance infrared (IR) imagers were evaluated for applications such as driving through smoke and fog. Fabricate nonscanning, thermoelectrically (TE) cooled, staring focal plane (third-generation thermal) sensor, for possible application in automatic tracking imaging for smart munitions in the mid-1980's. Development of 10.6 micron laser and hetrodyned forward-looking infrared systems (FLIR's) which will be integrated into an all-weather target sensing system was initiated.

2. (U) FY 1981 Program: Continue development of second-generation FLIR's for heliborne and armor/antiarmor applications with ranges compatible with increased missile ranges, 10.6 micron lasers, heterodyned FLIR for foul weather penetration, and third-generation thermal imagers. Begin development of a high-reliability, low-cost, lightweight, nonscanning thermal system for use with self-guided munitions. This program element supports the work of 89 civilian professional and support personnel.

3. (U) FY 1982 Planned Program: Continue development of second-generation forward-looking infrared (FLIR) with improved performance for aircraft and combat vehicle application. Continue work on third-generation thermal imagers for low-cost, lightweight system requirements. Continue development of laser sources in the .5-3 and 3-20 micron bands for target acquisition and integrated engagement systems. This program element supports the work of 121 civilian professional and support personnel.

4. (U) FY 1983 Program: Continue development of high-sensivity, small element detector array coupled with low noice figure charge coupled device for multielement staring sensor. Initiate reliability/producability development of integrated focal

Program Element: #6.27.09.A Title: Night Vision Investigations
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plane arrays. Millimeter wave and CO2 multisensor all-weather trade-off analysis will be completed and the all-weather specification defined for Advanced Development. Continue validation and application of visionics man-machine performance models to determine optimum designs of electro-optic hardware.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.15.A Title: Tactical Electronic Warfare Technology
DOD Mission Area: #521 - Electronic and Physical Sciences (ED) Budget Activity: #1 - Technology Base

A. RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	5924	8272			Continuing	Not Applicable
A042	Tactical Electronic Warfare Techniques	4308	5773			Continuing	Not Applicable
A904	Tactical Electronic Warfare and Intelligence Techniques	1616	2499			Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program supplies the exploratory development technology in support of all Army Electronic Warfare (EW) programs. Technologies from voice frequencies through radar and optics are utilized to provide new concepts of countermeasures (CM) and counter-countermeasures (CCM). Technological advances are urgently needed to support development/fielding of electronic/signals warfare equipments. Present size, weight, location accuracy, limited output power, and sohpisticated signal processing techniques are some of the many system characteristics which must be solved by modern technology to ensure the use of the frequency spectrum by friendly forces while denying its use to the enemy. The rapidly increasing use of precision-guided weapons necessitates a corresponding effort in the detection and countering of such threats. Investigation and development is continuing to insure that the latest developmental US missiles, communications, electronics, and night vision systems will function satisfactorily in a hostile CM environment.

C. Basis for FY 1982 RDTE Request: Major technology thrusts will be pursued in the following areas: Efforts to obtain jammers; Simulations and analysts to defeat current proximity fuze threat; field tests of devices; development of power management modules; pursue efforts on Unintentional Radiation Exploitation (URE) detection; achievement of to counter weapons systems associated with both communication and noncommunication systems; continue development of optical sensor upgrade and continue exploitation of critical signals; improve Radar warning detection performance; initiate digital radio frequency (RF)

memory applications against pulse doppler systems; continue infrared (IR) threat identification and simulation; review system requirements for high intensity (HI) resolution sensors; continue electro-optical (EO) target signature characterization and modeling to advance optical warning and detection techniques; study
study spread spectrum jamming concepts; breadboard and field test distributed jamming techniques; and development of software for digital signal radion fingerprinting.

D. COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	5924	8272		Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	7151	8876		Continuing	Not Applicable

FY 1980 decrease due to reprograming to meet higher priority Army requirements. Decrease in FY81 and FY82 due to budgetary constraints not anticipated in FY81 budget submission.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.15.A Title: Tactical Electronic Warfare Technology
DOD Mission Area: #521 - Electronic and Physical Sciences (ED) Budget Activity: #1 - Technology Base

F. DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is the exploratory development of tactical electronic warfare (EW), to include electronic countermeasures (ECM) and electronic counter-countermeasures (ECCM) techniques, components and equipment to be targeted against enemy communications and noncommunications systems associated with hostile weapon systems and units. As methods of communications/electronics become more sophisticated, equipment must also become more sophisticated if we are to adequately counter new threats. Technology development is also required to minimize the total cost of development, acquisition and operation of electronic warfare equipment.

G. (U) RELATED ACTIVITIES: This work is in direct support of program elements 6.37.45.A (Tactical ESM Systems), 6.37.55.A (Tactical ECM Systems), 6.47.45.A (Tactical ESM Systems), and 6.47.50.A (Tactical ECM Systems). Work on the development of electronic counter-countermeasures (ECCM) technology supports numerous Army electronics systems in the area of communications and noncommunications. Tri-Service technical efforts in electronic warfare receive extensive review as a result of participating in Joint-Service Technical Programs, Electronic Counter-Countermeasure Workshops and Joint Technical Coordinating Groups which reduce duplication among the Services. Coordination is also furthered through Tri-Service preparation of a Technology Coordinating Paper on Electronics and the annual reviews by the Under Secretary of Defense for Research and Engineering (USDRE).

H. (U) WORK PERFORMED BY: The US Army Electronics Research and Development Command (ERADCOM), Adelphi, MD, consisting of the Electronic Warfare Laboratory (EWL), Fort Monmouth, NJ; US Army Signals Warfare Laboratory (SWL), Warrenton, VA; Office of Missile Electronic Warfare (OMEW), White Sands Missile Range (WSMR), NM; Harry Diamond Laboratories (HDL), Adelphi, MD; and Electronics Technology and Devices Laboratory (ETDL), Fort Monmouth, NJ. Supporting efforts are provided by the Letterman Research Institute, San Francisco, CA; Naval Weapons Center, China Lake, CA; Georgia Institute of Technology, Atlanta, GA; Pacific Missile Test Center, Point Mugu, CA; Air Force Avionics Laboratory, Wright Patterson Air Force Base, OH, and Rome Air Development Center, Griffiss AFB, NY. Contractors include: Hughes Aircraft Company, Culver City, CA; Stanford Research Institute, Huntsville, AL; GTE Sylvania, Mountain View, CA; RCA Corporation, Princeton, NJ; Honeywell Incorporated, Lexington, MA; Rockwell International, Anaheim, CA; Quest Research Corporation, McLean, VA; ITEK Corporation, Lexington, MA; Sanders Associates, Nashua, NH; and Hazeltine Corp., Greenlawn, NY.

Program Element: #6.27.15.A Title: Tactical Electronic Warfare Technology
DOD Mission Area: #521 - Electronic and Physical Sciences (ED) Budget Activity: #1 - Technology Base

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1980 and Prior Accomplishments: Special CHAFF has been fabricated and a CHAFF Breadboard design has been started on the The have been tested and the threat analysis completed. Laser Warning Receiver (LWR) requirements have been established and Millimeter Wave Radar Warning Receiver subsystem integrated with the AN/APR-39 for tests. Wideband preamps for Millimeter Wave RWR's have been fabricated. The Laser Beamrider Countermeasures Analysis has been completed.

Successful field testing has proved the validity of using expendable repeaters in Radar Targeting. Radar jamming sorter/tracker algorithms were developed, and analysis of active/passive decoys was initiated. Improved UV detector was fabricated and Wide Field of View (WFOV) IR sensor study was completed. Long Wave Length Laser Warning Receiver(LWL)(LWR) hardware development started, and of present targets continued. Laser Air-to-Surface Missile (ASM) decoy CM techniques demonstrated. In a joint program with Naval Weapons Systems Laboratory and the Army Electronic Techniques and Devices Laboratory, a high-power, broad-bandwidth jammer amplifier was designed utilizing electron-bombarded semiconductor (EBS) active devices rather than conventional tubes or transistors. Initial investigations in the Electro-optics ESM area demonstrated the feasibility of A continuous wave (CW) heterodyne receiver/transmitter has been developed and tested to define limitations of Preliminary antenna design concepts were investigated for both broadband transmit and Ultra High Frequency (UHF) homing antennas, and a contractual effort to fabricate a was started.

2. FY 1981 Program: An existing Navy jamming system (AN/ALQ-99) and a high gain antenna will be integrated into a The proximity fuze threat and the signal environment in which it must operate will be determined. Flight test against CM for Pseudo random pulse repetition internal and pulse comparison systems using Digital Radio Frequency Memory will be developed. Installation and testing of a will be accomplished, and development of a subsystem will be initiated. Efforts will be made to characterize optical jamming effects, and Forward Looking IR (FLIR) CM techniques for Advanced Laser Coding Schemes (including fast repeater and barrage jamming)

will be analyzed. Final selection of the technology and optimization of expendable jammer device parameters for will be made. Air Defense EW System (ADEWS) threat analysis and effectiveness/survivability measurements will be completed. Missile detection IR/UV mechanism analysis and signature and atmospheric measurements will begin. Transition basic Begin testbed development and the key development of subsystems. Build and develop radio frequency (RF) circuits and processing for Complete redissemination experiments and examine storageability. Construct model of the selected noncomm conformal antenna and start testing to verify performance estimates and predictions. Continue Continue analysis on the potential vulnerability of digital communications to Electronic Countermeasures (ECM). Refine techniques to detect, collect, and process Develop breadboard models of the best antenna and matching units for and conduct feasibility testing with emphasis on applications.

3. FY 1982 Planned Program: Initiate efforts for high power source and airborne antenna array developments to obtain adequate Conduct simulation/analysis to (a) determine (b) evaluate likely ECCM techniques, and (c) predict most probable time period. Complete contract for devices and field test. Initiate effort to develop power management modules for MEJ. Initiate test and evaluation of and continue monolithic microwave DF assembly development. Transition basic Improve Radar Warning Detection performance and add processing capability to subsystem. Complete initiate DRFM application against systems; develop Millimeter (MM) CM techniques Evaluate advanced jamming and decoy IRCM techniques to include complex waveforms, blooming directional and spectrally selective decoys, as well as detection, tracking, and jamming low-power laser systems. Continue infrared/ultraviolet (IR/UV) analysis and measurements. Continue electro-optical (EO) target signature characterization and modeling parameters of optical warning for discrimination and Forward Looking Infrared (FLIR) detection. Continue Analyze active jammer for laser beamrider missile. Demonstrate Product Improvement Program (PIP). Complete brassboard and demonstrate Perform susceptibility study of and address weaponization. Continue jamming Digital, ECM Vulnerability Study, and

Program Element: #6.27.15.A Title: Tactical Electronic Warfare Technology
DOD Mission Area: #521 - Electronic and Physical Sciences (ED) Budget Activity: #1 - Technology Base

Test

Approximately twenty-five professional and two support personnel at US Army Electronic Research and Development command are involved with program management, contract monitoring, and a limited amount of in-house laboratory experimentation and modeling.

4. FY 1983 Planned Program: Initiate effort for improved power management modules to Complete high power source and antenna developments. Conduct final testing of Transition power management models to advanced development.

to advanced development. Initiate integration of monolithic Microwave DF assemblies with prototype Very High Speed Integrated Circuits (VHSIC) signal processing hardware. Analyze processing algorithms for new signal processing/display. Continue development of countermeasures (CM); finalize development of pulse repetition frequency/radio frequency (PRF/RF) agile signal processor; and begin tests of techniques. Continue Update missile models and develop hardware specification for advanced decoy system.

Continue target signature characterization and parametric modeling of Optical Warning Receiver (OWR). Begin fabrication of Assess high energy laser (HEL) threat. Transition Product Improvement (PIP). Develop design for Joint Tactical Information Distribution Systems (JTIDS) main beam nulling antenna. Continue analysis of enemy signals to determine vulnerability to Digital ECM. Continue algorithm development of Advanced Signal Processor with off line confidence testing. Study ECM against Spread Spectrum modulation.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #A042 Title: Tactical Electronic Warfare Techniques
Program Element: #6.27.15.A Title: Tactical Electronic Warfare Technology
DOD Mission Area: #521 - Electronics and Physical Science Budget Activity: #1 - Technology Base

A. DETAILED BACKGROUND AND DESCRIPTION: Improve Army Tactical electronic warfare (EW) capability to: (1) Protect both air and ground forces against radar, electro-optical (EO) and infrared (IR) homing missile threats, and radar and optically guided weapons; (2) intercept, identify, locate, target and counter command, control, and communications (C^3), Data Links, intelligence, surveillance, and target acquisition (ISTA), Radar, EO and IR, as well as missile and other weapons by means of new, adaptive and expandable EW techniques; (3) Reduce vulnerablily of friendly communications electronics (CE), and missile systems to hostile EW actions. For noncommunications EW the approach is to develop a new generation of threat compatible equipment, both modular and expandable. This equipment will permit deployment in high-risk areas and provide realtime mission capabilities while circumventing some of the inherent constraints of ground operation and low-performance, constrained airborne platforms. For the protection of combat systems the general approach is to provide warning, jamming, or decoying of the weapon and/or operator. To accomplish effective jamming against the new radars and missiles which contain numerous ECCM features, will be developed. will be developed which will deploy rapidly and much better match the characteristics of the protected target to defeat, schemes. For the vulnerability/ECCM area the approach includes development of ECCM technology for communications, development of ECCM technologies for combat surveillance systems, and development of EW threat technologies for use in EW missile vulnerability programs.

B. (U) RELATED ACTIVITIES: This work is in direct support of the Program Manager for Aircraft Survivability Equipment and of programs/projects 6.37.45.A/D905 (Tactical Electronic Support Measures (ESM)), 6.37.45.A/D925 (Tactical Electronic Warfare and Intelligence Command and Control Systems), 6.37.55.A/D251 (Protective Electronic Warfare EW Equipment), 6.37.55A/DK14 Expendable Jammers), 6.37.18.A/D626 (Nonmissile Vulnerability/Susceptibility), 6.37.18.A/D267 (Missile Susceptibility), 6.37.55.A/DK12 (Division Tactical Electronic Countermeasures (ECM)Systems), 6.37.55.A/DK13 (Non-Communications ECM), 6.47.45.A/D906 (Tactical ESM Systems, 6.47.45.A/D926 (Tactical Electronic Warfare and Intelligence Command and Control Systems), 6.47.50.A/DL12 (Division Tactical ECM Systems), 6.47.50.A/DL14 (Expendable Jammers), and 6.47.50.A/DL13 (Non-Communication ECM). Triservice technical efforts in electronic warfare receive extensive review as a result of participating in Joint-Service Technical Programs, Electronic Counter-Countermeasure Workshops and Joint Technical Coordinating Groups which reduce duplication among the Services.

Project: #A042 Title: Tactical Electronic Warfare Technology
Program Element: #6.27.15.A Title: Tactical Electronic Warfare Techniques
DOD Mission Area: #521 - Electronics and Physical Science Budget Activity: #1 - Technology Base

C. (U) WORK PERFORMED BY: The Electronic Warfare Laboratory (EWL), US Army Electronics Research and Development Command (ERADCOM), Fort Monmouth, NJ, is the in-house developing organization responsible for this project. Contractors providing support to this program during FY80 include: Signatron, Lexington, MA; SRI, Arlington, VA; Calspan, Buffalo, NY; RCA Corp., Burlington, MA; Sanders, Nashua, NH; Varo, Garland, TX; Tasker, Chatsworth, CA; Hughes, Culver City, CA; ITT Avionics, Nutley, NJ; Perkin-Elmer, Wilton, CN; and Martin Marietta, Orlando, FL.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY80 and Prior Accomplishements: Special chaff has been fabricated and tested, and environmentally degradable chaff has been demonstrated in the laboratory. Core data base for generic chaff was completed and is being categorized. Software for data acquisition and reduction on the ultraviolet (UV) high-resolution spectrometer has been initiated. Breadboard design has been started on the Countermeasure Program.

Laser Warning Receiver (LWR) requirements have been established and Millimeter Wave Radar Warning Receiver (RWR) subsystem was integrated with the AN/APR-39 for tests. Wideband preamps for Millimeter Wave RWR's have been fabricated. The Laser Beamrider Countermeasures Analysis has been completed. Air Defense EW System (ADEWS) prototype, and a user requirement for this system developed. ADEWS Low Band and high countermeasures (CM) efforts continue. The groundwork for power management modules for the microwave expendable jammer (MEJ) was laid by Modular Adaptive Signal Sorter (MASS) program. Initial techniques for optimization of the AN/ALQ-144 infrared jammer against current and projected future threats (i.e., STINGER POST, MAVERICK technology) was initiated. Infrared/ultraviolet (IR/UV) signatures and measurements and UV missile simulations were completed. Improved UV detector was fabricated and Wide Field of View (WFOV) IR sensor study was completed. Long-Wave-length (LWL) Laser Warning Review (LWR) hardware development started and of present targets continued. Optical CM effects measurement continued, and CM against sensor Thermal Imagers for Air-to-Surface Missiles (ASM) and selected Automatic Aircraft Artillery (AAA) weapons began. The laser ASM decoy CM technique was demonstrated via field testing.

2. FY 1981 Program: An existing Navy jamming system (AN/ALQ-99) and a high gain antenna will be integrated into a helicopter, and feasibility tests conducted to evaluate concepts for jamming radars from a standoff position. Proximity fuze threat and the signal environment in which the proximity fuze must be operated will be determined. Flight test against CM for pseudo-random pulse repetition interval (PRI) and pulse comparison systems using Digital Radio Memory (DRFM) will be developed and integrated

with the AN/ALQ-136. Installation and testing of a [redacted] will be accomplished, and development of a [redacted] will be initiated. Optimization of the AN/ALQ-144 IR Jammer will continue. Simulation and identification of future [redacted] will begin, and the susceptibilities of decoys and jammers will be evaluated. Efforts will be made to characterize optical jamming effects, and Forward Looking IR (FLIR) susceptibility model development will be completed. Final selection of the technology and optimization of Expendable Jammer device parameters for [redacted] will be made. Initiate high-accuracy LWR development and FLIR signature data base. Complete ADEWS threat analysis and effectiveness/survivability measurements. Initiate Missile Detection IR/UV mechanism analysis and signature and atmospheric measurements. Transition basic MASS signal processor to AD. Begin [redacted] testbed development and the key develop of [redacted] Build brassboard microwave steerable null antenna processor (MSNAP) GRC-103 interface and develop radio frequency (RF) circuits and processing for [redacted] experiments and examine storageability. Finalize design of [redacted]

3. FY 1982 Planned Program: Initiate efforts for high-power source and airborne antenna array developments to obtain adequate [redacted] Conduct simulation/analysis to (a) determine [redacted] (b) evaluate likely ECCM techniques, and (c) predict most probable future [redacted] Conduct design trade-offs to [redacted] Complete contract for [redacted] and conduct field test. Initiate effort to develop power management modules for microwave expendable jammer (MEJ). Initiate power management and technical electronic support measure modular adaptive signal sorter (ESMMASS) signal processing upgrades; initiate test and evaluation of [redacted] and continue monolithic [redacted] assembly development. Transition basic [redacted] Develop optical sensor upgrade and continue exploitation of critical signals. Improve radar warning detection performance and add [redacted] subsystem. Complete [redacted] refine pseudo-random algorithms after tests with AN/ALQ-136; initiate DRFM application against [redacted] systems; develop millimeter countermeasure (MM CM) techniques [redacted] Continue identification and simulation of future infrared (IR) Threat Missile Systems. Evaluate advanced jamming and decoy IRCM techniques against these systems. Continue infrared/ultraviolet (IR/UV) analysis and measurements. Perform system requirements review for high-intensity (HI) resolution sensors. Establish remote sensing for tactical missile evaluation and select candidate sensor and processing

technologies. Continue electro-optical (EO) target signature characterization and modeling parameters. Continue, Continue FLIR assessment and susceptibility analysis. Demonstrate, and prepare for transition to AN/GRC-103 product improvement. Complete brassboard and demonstrate, Build intermediate frequency (IF) brassboard of parallel channel Fast Frequency Hopping (FFH). Perform study addressing weaponization of OUTLAW INDIAN technology. Approximately eighteen professional and two support personnel at the Electronic Warfare Laboratory are involved with program management, contract monitoring, and a limited amount of in-house laboratory experimentation and modeling.

4. FY 1983 Planned Program: Initiate effort for improved power management modules to

Conduct final testing of for hand-emplaced expendable jammer (EXJAM). development/operational test (DT/OT) II and Field Demonstration Test and Evaluation (FDTE) for hand-emplaced expendable jammer (EXJAM). Initiate contract to harden for artillery-delivered EXJAM. Transition power management modules to advanced development (AD). Initiate efforts to develop miniature automatic Transition modular adaptive signal sorter (MASS) power management upgrades, assembly to advanced development (AD). Initiate integration of monolithic, assemblies with prototype very high speed integrated circuit (VHSIC) signal-processing hardware. Evaluate trade-off of MM Wave RWR techniques for optimum warning capability. Continue development of countermeasure (CM); finalize development of pulse repetition frequency/radio frequency (PRF/RF) agile signal processor, test digital radio frequency memory (DRFM) capability against signals, and begin tests of techniques. Continue Continue IR/UV signature and atmospheric measurements. Develop plume radiation code dynamic missile simulation.

Continue target signature characterization and parametric modeling of Optical Warning Receiver. Complete effects analysis and initiate test program. Begin fabrication of laser beamrider CM. Transition Develop design for Joint Tactical Information Distribution Systems (JTIDS) main beam nulling antenna. Define modulation code combinations and formulations for radar electronic counter-countermeasure (ECCM) technique.

5. (U) Program To Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

Project: #A042 Title: Tactical Electronic Warfare Technology
Program Element: #6.27.15.A Title: Tactical Electronic Warfare Techniques
DOD Mission Area: #521 - Electronics and Physical Science Budget Activity: #1 - Technology Base

7. Resources: ($ in thousands)

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	4308	5825	- -	- -	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	5137	6164	- -	Not Shown	Continuing	Not applicable

Decrease in FY 1980 funds resulted from reprograming of funds to higher priority Army requirements. Decrease in FY81 is attributed to the application of general Congressional reduction. FY82 decrease due to budgetary constraints not an $222K FY81 increase due to amended budget and inflation. FY82 decrease due to budgeting constraints not anticipated in FY81 submission.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.16.A Title: Human Factors Engineering in Systems Development

DoD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	6209	6409	9215	9296	Continuing	Not Applicable
AH70	Human Factors Engineering in System Development	6209	6409	9215	9296	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:

1. (U) User Problem: Improve US Army artillery system effectiveness in combat; increase US Army's ability to fight in built-up areas; improve individual soldier's personal equipment and its compatibility with all other items (weapons, gas mask, load-carrying equipment, and armored vest); reduce noise damage to hearing among military personnel; improve performance of individual and crew-served weapon systems during periods of reduced visibility and smoke on the battlefield; improve development of visual displays for future Army air defense systems; reduce aircrew workload imposed by the introduction of new electronic displays, controls and data processing equipment into Army helicopters; improve ammunition resupply procedures.

2. (U) Objective: Human factors technology development must be conducted to furnish soldier-machine interface data to US Army Materiel Development and Readiness Command (DARCOM), Project and Product Managers in order to integrate that data into the design of the weapon system as early as possible to assure full weapon system effectiveness in the field.

3. (U) Products: This project guides the design, development, test and evaluation of Army materiel to make best use of soldier capabilities and avoid human limitations. Specific weapon systems benefiting from this program include: XM-1 Tank turret development, Black Hawk Helicopter equipment display , Artillery Battery Computer System, COPPERHEAD/155mm Howitzer equipment employment, XM198 Self-Propelled Howitzer equipment employment, infantry fighting vehicle, infantry vehicle with TOW antitank weapon, Hellfire weapon, enhanced self-propelled artillery weapons system, command, control, and communications in artillery fire support, new hand guns & rifles, new load-bearing equipment, nuclear, biological and chemical (NBC) equipment & logistic systems such as ammunition handling & packaging.

Program Element: #6.27.16.A Title: Human Factors Engineering in Systems Development

DoD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

4. (U) How Used: Guide lines and procedures furnished DARCOM Project and Product Managers have guided the development of (1) a battery level computer for the Artillery Fire Direction Center, (2) the TOW antitank weapon, (3) new infantry body armor and helmets, (4) fire control equipment for tanks, (5) automatic data processing systems for conventional artillery, (6) mounting of anti-tank weapon systems on armored personnel vehicles, and (7) protection for ammunition handlers in combat loading the tank while under hostile fire. This program also directly assists the development, design, test and evaluation of many other Army weapon systems.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Research will identify soldier/equipment shortcomings during Military Operations in Built-up Areas (MOBA). Field evaluation and testing of the effectiveness of equipment changes for MOBA will be accelerated. Other work will improve procedures to increase the accuracy and timeliness of artillery fire; reduce armored vehicle internal noise and thereby reduce hearing damage to the crew; seek means to improve soldier and crew performance in low visibility and smoke environments. This program will also attack problems of how to reduce time required to maintain equipment; how to improve air defense weapon system effectiveness by accelerating the human decision making process; how to improve soldier/equipment performance in hitting moving targets and how to improve the Army system of ammunition resupply.

D. (U) BASIS FOR CHANGE BETWEEN FY 1982 and FY 1981 CONGRESSIONAL DESCRIPTIVE SUMMARIES: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional to Completion	Total Estimated Cost
RDTE					
Funds (Current Requirements)	6209	6409	9215	Continuing	Not Applicable
Funds (As shown in FY 1981 submission)	6741	7740	8151	Continuing	Not Applicable

The decrease in FY 1980 and FY 1981 is due to general Congressional reductions.
The increase in FY 1982 reflects greater emphasis on soldier/equipment compatibility in materiel development.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.27.16.A Title: Human Factors Engineering in Systems Development

DoD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This program is conducted by the U.S. Army Human Engineering Laboratory (HEL), Aberdeen Proving Ground, MD, which is a unique, central laboratory of the U.S. Army Materiel and Readiness Command (DARCOM), that provides research and development support to all of the DARCOM Commodity Commands and Project Managers in the technology area, Human Factors Engineering. Under this program, the Laboratory conducts fundamental and applied research, weapon system concept feasibility evaluation; system performance measurements; and provides human factors engineering application support on Army materiel items throughout development. The Laboratory operates a DoD-wide scientific data bank which includes data collected anywhere in the world in this technology field. This program, through research and field experiments, supports the development of small arms, infantry weapons, aviation, artillery, missile systems, communication and electronics equipment, combat vehicles, wheeled vehicles, clothing and personal equipment. The ultimate objective of this work is to assist in the development and production of the most effective and least expensive weapons and equipment for United States soldiers for combat anywhere in the world. Human factors engineering detachments or offices are located at major Army development activities, U.S. Army Training and Doctrine Command (TRADOC), and the Project Manager for Training Devices (PM TRADE), and the Cold Region Test Center.

G. (U) RELATED ACTIVITIES: This Laboratory (HEL) is a leader in tri-service coordination, e.g., under a tri-service human factors technology coordination group HEL chairs or participates in a helicopter human factors engineering sub-committee and a human factors test and evaluation sub-committee; assembles all appropriate data and publishes all tri-service human factors engineering design standards and Human Factors Engineering Design Handbooks, chairs two NATO Research and Development committees and performs an independent human factors engineering review for all major Army materiel systems. Biomedical input into Army materiel design is coordinated through this program. These activities assure that there is no unnecessary duplication within Army and Department of Defense.

H. (U) WORK PERFORMED BY: In-house work is performed by the U.S. Army Human Engineering Laboratory, Aberdeen Proving Ground, MD, supported by U.S. Army Tank-Automotive Research and Development Command, U.S. Army Missile Command, U.S. Army Communication Research and Development Command, U.S. Army Armament Research and Development Command, and the U.S. Army Natick Research and Development Command. The top five contractors exceeding $25,000 per contract are: AAI Corporation, Baltimore, MD; Andrulis Research Corporation, Bethesda, MD; Food Machinery Corporation, San Jose, CA; Litton Systems, Inc., Woodland Hills, CA; and Magnavox Govt and Industry Electronics Corporation, Fort Wayne, IN. In addition to the five major contractors, a total of $95,000 was distributed to four other commercial concerns.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. FY 1980 AND PRIOR ACCOMPLISHMENTS: Designed, fabricated and successfully tested the concept for an artillery ammunition resupply vehicle. This concept provides much faster and safer rearming of tanks under battlefield conditions, thus improving

Program Element: #6.27.16.A Title: Human Factors Engineering in Systems Development

DoD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

combat capability. With Army Natick Laboratories, developed a highly successful new field uniform for female soldiers. Initiated R&D on new ammunition packaging concepts which will greatly improve efficiency at ammunition supply points. Successfully demonstrated weapons effects and communication capabilities and limitations in military operations in built-up areas.

2. (U) FY 1981 Program: Conduct field tests to improve artillery command, control and communications. Evaluate concepts for artillery fire control systems, using smart communication devices. Conduct cockpit simplification experiments to integrate aircrew information requirements into new type displays. Evaluate human performance associated with forward area fueling and arming of attack helicopters under realistic conditions. Examine man-machine interface problems arising when the individual soldier uses the protective mask, chemical protective clothing and various types of equipment requiring use of vision such as fire control equipment. Conduct human factors engineering for medium antitank weapon program. Determine the capability and limitations of "netted" communications systems in built-up areas.

3. (U) FY 1982 Planned Program: Complete field artillery evaluation begun in FY 1981. Develop optimum procedures for aircrew interaction with multifunction controls and displays. Complete ammunition resupply field test. Examine selective spectrum lighting for military applications. Investigate problems associated with military operations in a tropic environment when smoke is employed. Measure aiming/tracking errors and develop aiming strategies to improve effectiveness of infrared equipped antitank weapons. Continue research on the soldier/fire control equipment interfaces in order to improve first round hit capabilities of tanks. This program involves 87 professional and 45 support personnel.

4. (U) FY 1983 Planned Program: Conduct evaluations to improve maintenance in active and reserve artillery units. Improve the human factors engineering model of soldier (uniform/fighting load/weapon) performance. Monitor R&D in smoke generating munitions and devices to assure proper man/machine interface. Damage risk criteria for noise effects on hearing will be more precisely defined for small arms, small cannons and artillery categories. Provide data to support development of new doctrine and equipment concepts for combat support in 24 hour environment. Aircrew performance data with state-of-the-art controls and displays will be compiled for the design community. Conduct field experiments to assist with assessment of candidate weapons for the Improved Medium Anti-Armor Assault Weapon System (IMAAWS). Continue evaluations of equipment suitability for military operations in built-up areas.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.17.A
Title: Human Performance Effectiveness and Simulation
DOD Mission Area: #552 - Environmental and Life Science (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	3383	3252	3619	3802	Continuing	Not Applicable
A790	Human Performance Effectiveness and Simulation	3383	3252	3619	3802	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This element is concerned with the development of improved technology required for the design of Army jobs, the development of job procedures and aids, and more reliable measurement of individual and unit readiness through the diagnosis of skill deficiencies. The goal is the development of effective techniques for training and maintaining individual and unit skills. These developments are required to achieve effective operational capabilities in the face of decreasing quality and quantity of available personnel, increasing complexity and costs of maintaining and operating operational and training systems, and decreased availability of formalized training facilities. New developments in micro-electronics, television video-disc storage and display techniques, and computerized processing of information offer the opportunity to simulate a variety of individual and team performance situations. If weapon systems are to achieve their designed capabilities, personnel available for operating and maintaining them must be trained to and kept at a high level of skill proficiency.

C. (U) BASIS FOR FY 1982 RDTE REQUESTS:

1. (U) Increased tech base will permit the analysis of the information needs of personnel in various command and control systems, which will facilitate the operational integration of the various systems. Increased tech base will also permit the development of procedures for the timely integration of personnel and training subsystems with the hardware subsystem during the design stage. It will also permit the development of procedures for trading-off information processing/storage requirements between the human operator and computer support subsystems. Tech base research will further permit the impact of training guidelines for the design of simulation/training device systems for the training of air defense, field artillery and tank crews; infantry units; and aviators. It will also develop techniques for using operational tactical data sub-systems for training on the operation/employment of major computer-based tactical systems ("embedded" training). It will further lead to the development of improved procedures for assessing the training effectiveness of new training methods/techniques. Tech base R&D will lead to a better understanding of how emerging electronic technology may most be utilized for the design and development of more cost-effective training methods, simulation and training devices.

Program Element: #6.27.17.A Title: Human Performance Effectiveness and Simulation
DOD Mission Area: #552 - Environmental and Life Science (ED) Budget Activity: #1 - Technology Base

2. (U) This program represents a continuing effort to make advances in behavioral psychology that will lead to improved human performance through use of improved job procedures and new methods for training. Electronic technology will be exploited for this purpose. Results of this research will be used for later advanced development research.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional to Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	3383	3252	3619	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	3383	3467	3482	Continuing	Not Applicable

Decrease in FY81 is attributable to the application of general congressional reductions. FY82 changes result from Army reprogramming actions.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.17.A
DOD Mission Area: #552 - Environmental and Life Science (ED)

Title: Human Performance Effectiveness and Simulation
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The objectives of this research are threefold: 1) to improve the human factors aspects of battlefield automated systems, 2) to improve the cost-effectiveness of simulation and training devices, and 3) to permit the introduction of human performance parameters into land combat models/simulations. Research related to the first objective will lead to improved battlefield automated systems through: improved man-computer communication techniques, improved display symbology, development of decision-making aids, development of intelligence analysis aids, and development of standardized operating procedures for personnel and training subsystems of tactical command and control systems. Technological base research directed at the second objective will lead to: development of improved training procedures for simulating command group performance in command and control systems, development of training devices/simulators for the IFV/CFV infantry systems, improved procedures for assessing individual, crew/team and unit performance, improved guidance on training cognitive skills required in weapon system and electronic maintenance, and guidance on the degree of simulation fidelity required in the design of cost-effective simulators and training devices. Research to meet the third objective will permit the integration of human performance parameters into computer models/simulations used in developing new tactical doctrine. The research required will include both analytic and empirical investigations.

G. (U) RELATED ACTIVITIES: This research is coordinated with Navy Program Element 6.26.57.N, Training and Human Engineering Technology, and with the Air Force Program Element 6.22.05.F, Training and Simulation Technology, through DOD Topical Reviews, Training and Personnel Technology Conferences, Annual Budget and Apportionment Reviews, and participation in Tri-Service groups such as the Committee on Training, DOD/NASA Simulation Technology Coordination Panel, Helicopter Research Coordination Panel, Joint Technical Coordinating Group-Simulators and Training Devices, and the Technical Advisory Group for Maintenance Training. In addition, this research is coordinated with other service elements, such as the Air Force Human Resources Laboratory (AFHRL), the Naval Personnel Research and Development Center (NPRDC), the Army Project Manager for Training Devices (PM TRADE), the Army Human Engineering Laboratory (HEL), and the Naval Training Equipment Center (NTEC) to cover related research in visual displays, training simulation, human factors in operational testing, aviation crew performance, and instructional technology. Data exchange among Army Research Institute, related Army agencies, and other services is used to eliminate unnecessary duplication of research.

H. (U) WORK PERFORMED BY: Contractors include: Human Resources Research Organization, Alexandria, VA; WICAT Inc., Salt Lake City, UT; and Science Applications, Inc., McLean, VA and five other contractors. In-house work is performed by the US Army Research Institute for the Behavioral and Social Sciences at Alexandria, VA; and its field units distributed at major installations, including Ft Benning, GA; Ft Hood, TX; Ft Knox, KY; Ft Leavenworth, KS; Ft Sill, OK; and the Presidio of Monterey, CA.

Program Element: #6.27.17.A
DOD Mission Area: #552 - Environmental and Life Science (ED)

Title: Human Performance Effectiveness and Simulation
Budget Activity: #1 - Technology Base

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1981 and Prior Accomplishments: A model of tactical command and control systems information flow was developed to provide design criteria and operational procedures for use in the development of battlefield automated systems. Interactive man-computer graphic display procedures were developed to aid in tactical analysis and planning. Fidelity requirements for visual and motion simulation in flight simulators were experimentally determined; transfer functions derived represent the first behaviorally-based, quantitative criteria for the design of simulators for helicopter pilot training. Procedures for defining training device requirements and required design characteristics were developed. The use of operational system computer capabilities to test the skills of systems personnel (i.e., Skill Qualification Test) was successfully evaluated. The relative training effectiveness of several tank gunnery devices was determined and recommendations were made for the design of specific simulation devices to provide necessary skill training to armor system training developers.

2. (U) FY 1981 Program: Recommend a set of standard tactical display symbols needed to improve interoperability across various automated command and control systems. Determine human performance parameters relevant to the design of improved combat simulation computer models. Develop and evaluate preliminary criteria for determining the impact of automation on battalion command group performance. Evaluate alternative methods of instruction for range estimation and target identification for Aero-scout helicopter pilots' training. Develop human factors design guidelines for the proper utilization of information data bases within automated command and control systems. Expand the concept of using the computer capability of operational systems for Skill Qualification Testing, to include adaptive testing (i.e., adapting the test to the demonstrated capabilities of the person being tested). Begin development of criteria for the design of an aviation training research facility. Assess procedures for the application of videodisc technology for tactical training and for skill qualification testing. Develop an automated aid for determining battalion command group training requirements. Develop procedures to transform task performance requirements data into system design characteristics and training equipment design requirements. A total of 26 professional and 5 support personnel are involved in this effort.

3. (U) FY 1982 Planned Program: Continue research relating human information requirements to the design of battlefield automated communications, command and control, and intelligence (C^3I) systems. Finalize recommendations for standard symbology for tactical information displays. Evaluate the impact of the inclusion of human performance parameters in land combat models on model validity. Develop user-oriented guidelines for determining fidelity levels for simulators and training devices. Finalize the design of an aviator training research simulator for the UH-1 crew station and for motion simulation. Validate and extend procedures for information control and intelligence analysis in All Source Analysis System (ASAS). Continue examination of the influence of computer-based automation on command and control system performance. Develop program of instruction for rotary wing aviator training that maximizes flight simulator use and minimizes use of operational aircraft.

Program Element: #6.27.17.A Title: Human Performance Effectiveness and Simulation
DOD Mission Area: #552 - Environmental and Life Science (ED) Budget Activity: #1 - Technology Base

4. (U) FY 1983 Planned Program: Evaluate methods for performance information feedback to participants in engagement simulation training exercises at the National Training Center. Evaluate the utility of computer-based voice recognition and synthesis techniques in selected combat simulations. Develop guidelines for integrating training device and simulator design requirements with procedures for instructional systems development (ISD). Determine procedural and system factors which degrade or facilitate human judgment and decision-making in a complex battlefield situation. Evaluate alternative analytic models for predicting training device effectiveness. Evaluate a program of instruction that maximizes the utilization of flight simulator for rotary wing pilot training. Continue assessing impact of automation on personnel subsystems and overall system performance in computer-based command and control systems.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.19.A Title: Mobility & Weapons Effects Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1979 Actual	FY 1980 Estimate	FY 1981 Estimate	FY 1982 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	4877	5251	6275	7685	Continuing	Not Applicable
AT40	Mobility & Weapons Effects Technology	4877	5251	6275	7685	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The potential for fighting a numerically superior, modern, mechanized opponent in a European environment requires that the effectiveness of the combat engineer be significantly increased. Exploratory development in military engineering can increase the effective employment and survivability of the Army's sophisticated weapons systems through: (1) providing ground mobility/countermobility technology that exploits the best killing characteristics of our new weapons and insures that battlefield terrain is used effectively as a force multiplier; (2) providing techniques for rapid repair of battle-damaged facilities and construction in support of combat and logistical elements in the theater of operations; (3) increasing our knowledge of weapons effects and the response of protective structures to nuclear and conventional munitions; (4) and providing technology for decreasing an enemy's ability to acquire targets, thus increasing the survivability of fixed installations supporting combat operations.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: The US Army Engineer Combat Development Center, in the Engineer Family of Systems Study, identified critical combat engineering deficiencies in mobility, countermobility, and survivability. This program element addresses the identified deficiencies. The funds requested are to be used to bring to fruition programs on rapidly emplaced protective positions, damage to Warsaw Pact petroleum facilities predictions, an Israel-oriented terrain data base, a hyrdolic forecast system, and innovative alternatives to construction materials. In addition, funds will be applied to programs started in previous years on membrane-confined soil stabilization, earth-moving with the use of explosives, obstacle construction, and in characterizing the background signature of the environment to enhance counter-target acquisition techniques. New programs and initiatives that will be pursued with the requested funds include load tests in cohesive soils, railroad rehabilitation evaluation, and innovative mine detection and neutralization techniques. The accomplishments expected from these programs will enhance the effectiveness of the combat engineer in support of the combat forces on the modern battlefield and to increase the survivability of our forces.

Program Element: #6.27.19.A Title: Mobility & Weapons Effects Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	4877	5251	6275	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	4912	6079	6148	Continuing	Not Applicable

The decrease of $35 thousand in FY 1980 results from a mandate from Congress to decrease the amounts paid for travel and overtime. The decrease of $828 thousand in FY 1981 is attributable to the application of general Congressional reductions. The increase of $127 thousand in FY 1982 results from the need to fund high-priority research to increased research emphasis in hydrology and mine/countermine problems.

E. (U) OTHER APPROPRIATION FUNDS: ($ in thousands): Not Applicable

Program Element: #6.27.19.A
DOD Mission Area: #523 - Engineering Technology (ED)

Title: Mobility & Weapons Effects Technology
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Research is conducted in the areas of weapons effects, combat engineering, base development in the theater of operations, military hydrology, and construction technology for military facilities. Specific objectives are: to provide the Army a capability to predict the effects and response of military targets to nuclear and non-nuclear munitions; to develop design and operational criteria for field fortifications; to develop design criteria and construction techniques for underground hardened facilities; to develop, improve and apply engineering technology for military road and airfield systems, lines of communication and base facilities, and logistics over-the-shore operations; to develop ground mobility techniques that assure terrain is used to maximum advantage; to develop techniques for rapid prediction of hydrologic conditions affecting military operations; to develop methods for standoff detection of mines under all conditions of terrain and environment; and to develop techniques and criteria for determining the physical properties and response of earth materials important to combat engineering and military construction activities supporting combat operations.

G. (U) RELATED ACTIVITIES: Program Element 6.11.02.A, Defense Research Sciences, Project AT22, Research in Soil and Rock Mechanics. Formal coordination of related mission-oriented research by the Navy, Air Force, Defense Nuclear Agency, Department of Interior, Department of Transportation, and the Department of Energy is conducted through annual technical reviews, the Joint Services Civil Engineering Research and Development Coordinating Group and joint interagency activities. Informal coordination is conducted through frequent individual contracts. Coordination precludes duplication of effort.

H. (U) WORK PERFORMED BY: Approximately 83 percent of the work is performed in-house. The US Army Engineer Waterways Experiment Station, Vicksburg, MS, serves as the managing laboratory and is the primary performing activity. A portion of the work in the weapons effects area is performed by the US Army Construction Engineering Research Laboratory, Champaign, IL. Contractors are selected in accordance with Defense Acquisition Regulation Procedures.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: The vulnerability of earthen dams to conventional explosions was determined. Procedures were formulated for predicting the overturning of bridge spans from surface tactical nuclear bursts. The weapons effects information and analysis system was expanded and updated and a draft user's manual was prepared. The feasibility of using slurry explosives to create antiarmor ditch obstacles was determined. A computer analysis method for assessing hardness of structures was finalized and used to evaluate several protective systems. Fiberglass reinforced earth-covered arches were determined to be feasible for use as ammunition storage bunkers. The Army Mobility Model was upgraded by validating the obstacle module and modifying the linear feature crossing module. A computerized method for deriving digital mobility - terrain data bases from conventional sources was developed and made operational. Methods to make simpler mobility predictions from the Army Mobility Model were developed for use in the Combined Arms Combat Development Activity (CACDA) Corps Battle Game. The mobility-terrain data base for West Germany was updated for use in the Army Mobility Model and for use by CACDA. Map overlays displaying

Program Element: #6.27.19.A
DOD Mission Area: #523 - Engineering Technology (ED)

Title: Mobility & Weapons Effects Technology
Budget Activity: #1 - Technology Base

groundwater supply potential for selected Mid-East areas were developed and produced for use by the Rapid Deployment Forces and other users. Shortfalls in hydrology-related manuals and bulletins were identified and documented. Tests with artillery and fuel-air explosive rounds were conducted on typical urban concrete block walls to develop hardening and demolition criteria. Cellular concrete reinforced with steel fibers was determined to be the most effective fragment-absorbing material for use in construction of a mock urban training village. Methods were developed for computing and comparing features from digital imagery for determination of camouflage effectiveness. A field reference manual was prepared explaining how to repair bomb craters in runways with existing techniques, materials, and equipment. Preliminary guidelines were developed for use of membrane confined soil piers and abutments. Hot-mix asphalt recycling design criteria were validated for use in pavement rehabilitation.

2. (U) FY 1981 Program: Criteria for predicting breaching of dams by nuclear and conventional explosives will be finalized. A user's manual for the computerized weapons effect information and analysis system will be published and distributed to users. A fallout radiation prediction model to improve troop safety and assess collateral damage on the battlefield will be developed. The effects of weak soil seams and backpacking on ground shock to Ballistic Missile Defense (BMD) silos from nuclear blast will be determined. Design guidance on feasible concepts for electromagnetic pulse/electromagnetic interference shielded enclosures which house tactical support equipment will be provided. The effectiveness of rock-rubble screens as overhead protection from conventional weapons will be established. Antiarmor ditching demonstration tests will be conducted for the 18th Engineer Brigade in Europe using demolitions. A simplified mobility model will be developed for use in cross-country mobility mapping by the Engineer Topographic Laboratories and the Defense Mapping Agency. Design concepts for protecting the Army's mobile field computer system from the effects of conventional weapons will be formulated. A preliminary design of a prefabricated concrete pier module for use in military container ports and preliminary procedures for evaluating war damage to port facilities will be developed. A NATO field experiment for thermal camouflage of selected installations at a test site in Germany will be conducted. Primary and alternative repair systems for repairing bomb damaged runways will be tested with an engineer battalion and a reserve unit. Procedures for recycling used pavement materials for rehabilitation of deteriorated pavements will be finalized. Criteria and construction methods for a mock urban troop training village will be finalized. Improved surfacing materials to withstand traffic from tracked vehicles will be developed for use by the Army on training installations. Current technologies and operational procedures to update the Army's hydrologic capability will be defined and provided to field units.

3. (U) FY 1982 Planned Program: Design concepts will be formulated for protecting artillery emplacements from damage by conventional weapons. Field tests will finalize recommendations for quick response armor and artillery fighting positions and candidate protective systems for rapidly emplaced fighting positions. Design criteria will be developed to provide fixed installations with counter surveillance techniques for an enemies thermal sensing. The concept for development of an air-delivered rapid runway repair kit will be finalized. Field tests of projectile explosions above, within, and below shield slabs will be conducted to determine the influence of blast waves on buried structures. The levels of degradation of Warsaw Pact POL distribution systems from given US weapon systems will be determined. A mobility terrain data base for Israel will be

Program Element: #6.27.19.A
DOD Mission Area: #523 - Engineering Technology (ED)

Title: Mobility & Weapons Effects Technology
Budget Activity: #1 - Technology Base

developed. The linear feature crossing module of the Army Mobility Model will be validated. Procedures for selective demolition of urban buildings will be developed. Methods for using satellite and radar meteorological data in battlefield hydrologic forecasts will be finalized. The effectiveness of line charges for neutralizing mines will be evaluated. Field tests to demonstrate the application of membrane confined soils as an expedient structural construction material will be conducted. Tests using asphalts for rapid and stabilization to enhance mobility during over-the-shore operations will be conducted. Earth moving tests with explosives to bridge dry gaps for mobility crossings will be conducted. The results of demolition tests on model streets with conventional munitions will be evaluated to develop criteria for barrier creation in urban areas. Field load tests on a drilled shaft constructed in cohesive soils will be conducted. The present practices for military railroad inspection, maintenance, and rehabilitation will be evaluated. The performance of bonded concrete overlay pavements constructed by other agencies will be evaluated. Potential innovative concepts for using fabrics as economical alternatives to natural materials in earthwork facilities will be defined. The program will be executed by the 800 professional and 650 support personnel at the Waterways Experiment Station in Vicksburg, MS.

4. (U) FY 1983 Planned Program: A method for predicting vulnerability of industrial buildings to tactical nuclear weapons will be developed. Techniques for creating improved barriers using commercially available explosives, chemicals, and mechanical devices will be developed. Design guides for rubble screens, slabs, and multi-layered systems to shield against conventional weapons attack will be finalized. A model for predicting slip and shearing at buried structure/soil backfill interfaces resulting from explosive shock will be developed. Field validation tests of final candidate explosive designs for rapid atomic demolition munition emplacement will be conducted. Methods for predicting evacuation times of immobilized vehicles and for evaluating obstacle barrier and counterbarrier effectiveness in mobility operations will be developed. A methodology to analyze terrain-equipment-operator effects on engineer equipment performance will be finalized. A draft military hydrology field manual on streamflow forecasting will be prepared. An index system will be developed for field use to rapidly determine the protection provided by a particular field fortification. Concepts for protective systems which can be reconfigured for use in a variety of fighting positions will be finalized. Procedures for repairing war damage to port facilities will be validated. New camouflage concepts and models for optical and microwave phenomena will be evaluated. Recommendations and a design of the best foundation and capping materials for repair of damaged runways will be formulated. Procedures for using membrane confined soils as an expedient structural construction material will be finalized. A methodology for design and construction of drilled piers in cohesive soils will be finalized. Problem areas will be defined and possible solutions will be evaluated in placement of bonded concrete overlays on existing pavements. Guidance criteria will be developed on the use of material strengthening by confinement for application to construction of foundation layers for roads, airfields, storage and parking areas. The program will be executed at the Waterways Experiment Station in Vicksburg, MS.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.20.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Environmental Quality Technology
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	9020	6886	8681	9300	Continuing	Not Applicable
D048	Environmental Quality Research & Development	3145	2279	2894	3000	Continuing	Not Applicable
A835	Identification & Health Effects of Military Pollutants	3519	2911	3657	3800	Continuing	Not Applicable
A896	Environmental Quality for Construction & Operation of Military Facilities	2356	1696	2130	2500	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Federal, state, and local regulations require that the Army minimize the impact of its peacetime operations on the environment. This program element provides the exploratory development support to the Army's program for compliance with these regulations. The major program thrust is to provide the technology base necessary to enable the Army to meet the 1984 timeframe and beyond pollution abatement requirements. The program element consists of three projects: Project A835, performed by The Surgeon General, is concerned with the development of toxicological data on Army-unique pollutants for use in establishing safe environmental effect levels to support development of pollution control and monitoring technology. Project D048 efforts are performed by the US Army Materiel Development & Readiness Command (DARCOM) and is aimed at developing pollution abatement, treatment, and recovery methods for Army ammunition plants, arsenals, and depots. Project A896, performed by the Chief of Engineers, develops pollution abatement, impact assessment, and resource management methods for Army installations. The program is responsive to the science and technology objectives for environmental quality contained in the Army Science & Technology Objectives Guide (STOG).

Program Element: #6.27.20.A
Title: Environmental Quality Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED)
Budget Activity: #1 - Technology Base

C. (U) BASIS FOR FY 1982 RDTE REQUEST: The funds requested for FY 1982 will permit continuation of research to develop environmental effects criteria for pollutants unique to Army operations, develop environmental monitoring and management systems, and pollution control and treatment technology to enable the Army to meet regulatory requirements. Funds will enable completion of mammalian and aquatic toxicity studies; physical, chemical, and biological treatment methods; and procedures for aiding assessment of environmental impacts.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	9020	6886	8681	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	9465	10165	10497	Continuing	Not Applicable

D048 - A decrease of $465 in FY 1980 in the current submission is due to reprograming of funds to higher priority programs; the decrease of $1462 in the current request for FY1981 reflects apportionment of the Congressional cut against the Program Element and reduction for increased efficiency; a decrease of $1035 in the current submission for FY 1982 is due to reprograming to higher priority efforts.

A835 - The decrease of $78[illegible] in the current submission for FY 1981 results from apportionment of the FY 1981 Congressional cut against the Program Element, the decrease of $126 in the current submission for FY 1982 reflects a reduction of funds to meet higher priority needs.

A896 - The decrease in FY 1981 of $1011 in the current submission results from apportionment of an FY 1981 Congressional cut in the Program Element; the decrease of $655 in the FY 1982 program for the current submission reflects reprograming to meet higher priority needs.

E. (U) OTHER APPROPRIATION FUNDS: ($ in thousands): Not Applicable.

Program Element: #6.27.20.A Title: Environmental Quality Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The program was initiated in 1973 to consolidate and better coordinate fragmented environmental quality exploratory development activities within the Army. The program is aimed at providing cost effective technology in support of the Army's need to achieve compliance with pollution abatement and environmental enhancement requirements for its industrial plant and military installation operations. The technical thrust areas of the program are: Environmental and Health Effects Research aimed at developing a data base of mammalian, aquatic, and vegetative chronic and acute toxicity information on the unique chemical wastes resulting from Army munitions plants and other pollution sources; Environmental Monitoring, Management, Assessment and Planning Technology to provide effective methods, procedures and systems for measuring and identifying pollutants, assessing environmental impacts of planned actions and information data bases for effectively performing management and planning functions with appropriate consideration of environmental protection and enhancement; Source Reduction, Control and Technology to provide a technology base of methods, processes, and systems to enable the Army to deal effectively with the pollution problems at its industrial facilities and military installations.

G. (U) RELATED ACTIVITIES: Projects AH68 (Processes in Pollution Abatement Technology) and BS04 (Identification and Health Effects of Military Pollutants) in Program Element 6.11.02.A, Defense Research Sciences, comprise the basic research portion of the Army Environmental Quality Technology Base Program. Project AH68 is concerned with gaining an understanding of the fundamental chemical/physical processes that occur during treatment/disposal of munitions waste; Project BS04 is concerned with investigating the feasibility of developing less costly and time-consuming methods for conducting toxicology studies. Other related Program Elements incude 6.27.04.A, Military Environmental Criteria Development, which provides support to Army Installation Restoration Program and 6.27.77.A, Systems Health Hazard Prevention Technology, Project A878, Health Hazards of Military Materiel. Project A878 addresses the occupational health research program of The Surgeon General. Program Element 6.27.20 provides technology transfer to the pollution abatement activities being accomplished in the Military Construction, Army (MCA) and the Operation and Maintenance, Army (O&MA) appropriations. There is no duplication of effort within the Army program or with the programs of the Air Force and Navy. The Air Force and the Navy have environmental quality research efforts directed toward satisfying their specific mission needs. In areas of common interest, joint efforts are monitored by the Department of Defense through annual budget/apportionment reviews and periodic Topical Reviews on program areas of tri-Service interest. Semiannual meetings of the Joint Services Civil Engineering Research & Development Coordination Group (JSCERDCG) enable coordination of technical programs among the Services. Service coordination is further enhanced through the DOD Area Coordination Paper Nr. 42 on Environmental Quality Research and Development. Inter-Service coordination occurs routinely at the technical level on joint programs and technical efforts of mutual interest. Other federal agencies pursue environmental quality research programs related to their roles in the federal government. These are: The Environmental Protection Agency (EPA), Department of Health and Human Services (HHS), Department of the Interior (DOI), National

Program Element: #6.27.20.A Title: Environmental Quality Technology
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Aeronautics and Space Administration (NASA), Department of Agriculture (DA), the Department of Energy (DOE), Department of Transportation (DOT), and the Department of Housing and Urban Development (HUD). Coordination with these agencies is undertaken at the technical level to avoid duplication. Joint programs are undertaken in areas of common interest.

H. (U) WORK PERFORMED BY: Approximately 48% of the research effort is performed in-house by the US Army Toxic and Hazardous Materials Agency, Aberdeen Proving Ground, MD; US Army Armament Natick Research and Development Command, Dover, NJ; Research and Development Command, Natick, MA; Mobility Equipment Research and Development Command, Ft. Belvoir, MD; Test and Evaluation Command, Dugway Proving Ground, UT; US Army Medical Bioengineering Research Laboratory, Ft. Detrick, MD; Construction Engineering Research Laboratory, Champaign, IL; Waterways Experiment Station, Vicksburg, MS; and Cold Regions Research and Engineering Laboratory, Hanover, NH. Contractors include: Hercules Inc., Radford, VA; Mason and Hauger, Middletown, Iowa; Thiokol Inc., Shreveport, LA; JRB Associates, McLean, VA; Virginia Polytechnic Institute, Blacksburg, VA; New York Polytechnic Institute, Brooklyn, NY; and Ciccone Associates, Woodbridge, VA; EG&G Bionomics, Wareham, MA; Inveresk Research International LTD, Edinburgh, Scotland; SRI International, Monlo Park, CA; IIT Research Institute, Chicago, IL, and The National Academy of Science, Washington, DC.

1. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Program objectives and priorities were formalized in FY 1977 in the Army Science and Technology Objectives Guide (STOG). Science and Technology objectives for the environmental quality technology program address the need for improvement in the technical areas of environmental and health effects research; environmental monitoring, management, assessment and planning technology; and environmental pollution source reduction, control and treatment technology. Accomplishments in these technical areas included: establishment of temporary environmental and health effects guidelines for critical wastes resulting from munitions manufacture, development of a computer system for aiding preparation and review of environmental impact assessments and statements; development of field survey techniques for pollution detection and analysis; development of munition plant pollution monitoring devices, and a process for removing explosive wastes from munition plant wastewater. Other accomplishments have included: development of leachate control from landfills; evaluation of aqueous foam for noise attenuation; development of design criteria for application of rotating biological contractor to Army sewage treatment plants.

2. (U) FY 1981 Program: Efforts are continuing to complete development and selection of suitable technology for abatement of pollutants from Army munition plants and depots. A treatment system for electroplating wastes is being completed,

and several new technologies such as ultrasound/ozonation are being evaluated for potential application at Army industrial facilities. Studies to requalify recovered explosives from obsolete ordinance items for reuse are being performed. Problem defination studies of air and water pollution from munitions demilitarization operations are in process. Physical/chemical characterization studies of stack gases from TNT production are being completed. The use of supercritical water is being evaluated as a means for treating hazardous wastes. Other activities to be accomplished are: demonstration of a computer system for identification of environmental impacts of planned actions; preparation of guidelines for sanitary landfill design operation.

3. (U) FY 1982 Planned Program: Efforts are planned toward optimization of techniques for recovery of explosives and propellants from obsolete munitions in the DOD inventory; development and testing of monitors for toxic and hazardous materials in munition plant effluents will be initiated; development and evaluation of new technology for abatement/treatment of munitions waste will be continued; subchronic mammalian oral toxicological studies of tetranitro octahydro tetracine (HMX) will be continued; environmental fate studies of trinitrotoluene (TNT) and nitroguanidine in air will be initiated; research will be initiated to develop a data base of environmental effects for air and water pollution from CW/BW agent production facilities to complement ongoing research to develop a data base on pollutants generated by chemical demilitarization operations; characterization studies will be started on ash residues from explosive munitions incineration operations; development of management systems for assessment and planning of environmental programs will be continued; development and evaluation of pollution control and monitoring systems for military installations will be continued. The in-house personnel required to support the program includes 73 professionals and 30 support.

4. (U) FY 1983 Planned Program: Efforts planned for the FY 1983 program include completion of aquatic and mammalian toxicological studies for six munition compounds; studies will be initiated on environmental fate of smokes and obscurants and hazardous wastes; characterization studies will be initiated on air and water effluents from production of chemical and biological warfare agents. Developments and evaluations of new technology for control of munitions plant effluents will be completed; research will be continued to develop and evaluate techniques for recovery and reuse of explosives and propellants from obsolete DOD munitions; investigation of technology for disposal/treatment of obsolete explosives/propellants not recoverable will be initiated; test and evaluation of monitoring instrumentation for munition plant effluents will be performed.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.22.A
Title: Manpower Personnel and Training
DOD Mission Area: #522 - Environmental and Life Sciences (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	5418	5020	6137	7796	Continuing	Not Applicable
A791	Manpower Personnel and Training	5418	5020	6137	7796	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The volunteer Army today is faced with a dual manning problem: reduced supply of numbers and capabilities required for complex technical jobs, and concurrently increasing demands for high technology skills for operation and maintenance. Research is required to produce more effective methods of recruiting, selecting, and assigning personnel to maintain a combat effective force. More effective methods of personnel system management are required, especially for developmental systems. Also, more effective, simpler methods are required for integrating the mental and physical capabilities of personnel into the design of new weapons and materiel systems. Design and development of appropriate instructional technology and new training programs are required for continuing individual soldier skill development. Methods which will promote soldier commitment to the Army and to enhance unit cohesion while sustaining high performance are needed.

C. (U) BASIS FOR FY 1982 RDTE REQUEST:

1. (U) Increased tech base will develop more effective recruiting, accession, and assignment systems needed to maximize use of the available pool of manpower talent and resources while also improving methods of using fewer manpower resources in new systems. The design of training programs which meets the pace and level of individual abilities, with emphasis on continued skill enhancement and team/unit skill development in operating units must be enhanced. Development of methods to improve integration of the soldier into his unit, to increase unit cohesion and to improve mission readiness is needed.

2. (U) No projected research for FY 1981 was cancelled or deferred in this program element.

3. (U) This effort represents a continuing requirement to apply new techniques to use soldiers more effectively through research on manpower, personnel and training problems. New advances in behavioral psychology are combined with technological advances such as micro computers, video discs, and optimization models to improve the Army's practices in training and utilization of soldiers.

Program Element: #6.27 A Title: Manpower Personnel and Training
DOD Mission Area: #552 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	5418	5020	6137	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	5418	5462	5486	Continuing	Not Applicable

Decrease in FY81 is attributable to the application of general congressional reductions. The funding increase planned for 1982 reflects recognition of the specific personnel research efforts required to improve the recruiting and retention of military personnel.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Current manpower personnel and training efforts focus on research to solve problems associated with manning and maintaining the force, training for combat readiness, and organizational cohesion and effectiveness. The research provides methods to predict available quality resources from the youth manpower pool; instruction on how to motivate, train, support and evaluate recruiters. Also included are new assessment processes for Army leaders and key combat arms enlisted personnel and improvement of the Army's Officer and Enlisted Personnel Management Systems. New efforts include developing methods for determining and trading-off personnel performance requirements with alternative designs of new weapons systems and for automating systems used to assess, select, and allocate soldiers for training and unit assignment. Training research currently provides methods for performance-based "hands-on" skill development and evaluation. New efforts are directed towards development of training programs and training management systems which employ computer-interactive technology. Such programs enable individuals to proceed at their own pace and reach their maximum skill level by the use of integrated training "packages" in both residential and non-residential courses. The goal is a continuing development of individual on-the-job skills in conjunction with attaining a high level of collective skills in teams and units. Current research to support organizational cohesion and effectiveness provides a basis for assessing the state of readiness in military units in terms of leadership, communication between levels, measures of motivation, command climate, discipline and command effectiveness. New efforts are directed to relating leadership, communications, and measures of soldier commitment to actual unit training and performance in simulated combat situations.

G. (U) RELATED ACTIVITIES: This effort is coordinated with Air Force Personnel Utilization Technology, P.E. 6.26.03.F; Navy Personnel Support Technology, P.E. 6.27.63.N; Education and Training, P.E. 6.36.43.A; Training and Simulation Technology, P.E. 6.22.05.F. Interservice coordination is assured through Department of Defense sponsored topical reviews, annual budget and apportionment reviews, Tri-Service participation in preparation of Technology Coordinating Papers and Technical Advisory Groups (TAG) in such areas as selection and assignment techniques, leadership development, and technical training. This includes both coordination of efforts and avoidance of unnecessary duplication of effort. Coordinated research programs are conducted with the Air Force, Navy and Department of Labor.

H. (U) WORK PERFORMED BY: Contractors include: McFann Gray Associates, Carmel, CA; Litton Systems, Inc., Sunnyville, CA; Center for Management Organizations, University of South Carolina, Columbia, SC; McBer Associates, Boston, MA; Human Resources Research Organization, Alexandria, VA; Perceptronics, Woodland Hills, CA and four other contractors. In-house work is performed by the US Army Research Institute for the Behavioral and Social Sciences at Alexandria, VA and its field units distributed at major installations, including Ft Bliss, TX; Ft Knox, KY; Ft Ord, CA and Ft Benjamin Harrison, IN.

Program Element: #6.27.22.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Manpower Personnel and Training
Budget Activity: #1 - Technology Base

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS

1. (U) FY 1980 and Prior Accomplishments: Past research has produced an information data base of enlisted performance and first-tour retention factors in the first five years of the volunteer force. Methods to improve training evaluation programs and the Soldier's Manuals in the Battalion Training Management System have been developed and applied. A taxonomy for training scenarios for advanced air defense weapons systems has been evaluated and adopted at the Air Defense School. New on-the-job, self-paced training techniques for selected combat and support skills have been developed and tested and are being used in advanced development. Methods and materials for selecting and assigning Initial Entry Rotary Wing (IERW) pilots were developed and are being used in new IERW selection procedures. Training of skill performance with interactive videodisc systems was demonstrated. The effects of personnel turnover on team and unit performance were determined and methods developed to counter such effects in armor crews. Programs for orientation of junior enlisted personnel to the Army during training and initial assignment were developed and adopted. New training methods to enhance skill retention and transfer, with particular emphasis on combat and equipment maintenance jobs, were developed.

2. (U) FY 1981 Program: Development of procedures to institutionalize improved methods of projecting manning and skill maintenance requirements during the weapons system acquisition process; development of new modes of assessing recruit potential in order to increase the utilization of available personnel; produce improved recruiting methods and procedures by determining the factors related to recruiting productivity; improvement of Army selection and assignment methods through the determination of physical and mental requirements for operating weapons systems and relate these to required system performance standards; development of improved methods for personnel affordability in new systems through estimation of training costs and training device requirements early in the design of new systems; improvement of present methods for designing training for job performance through relating job skill training to task complexity; evaluation of training effectiveness by providing improved tools and procedures for measuring job proficiency; development of better methods for integrating soldiers into their first unit of assignment through assessing the organizational factors associated with assimilating replacements; development of automated personnel assignment procedures to improve unit level personnel assignment and utilization; development of methods to utilize computer technology for generating training scenarios and feedback skill qualification test results; design of methods for simulating complex military organizations; application of systems theory to organizational design, restructuring, and management.

3. (U) FY 1982 Planned Program: Attain improved recruiting effectiveness through methods for identifying the personnel and environmental factors related to recruiter productivity; develop better methods for matching soldier measures of performance to actual job requirements; produce improved models for assessing ability/task trade-off in system design; produce improved job performance training through developing better strategies for effective maintenance training; develop job proficiency measurement tools for evaluating training effectiveness; produce improved techniques for leaders and commanders to better integrate soldiers into their units; determine the organizational factors in assimilating new replacements; develop leaders through analysis of skills and knowledges related to command action and Army unit management. A total of 78 professional and 33 support personnel are involved in this research effort.

4. (U) FY 1983 Planned Program: Expand the applications of an integrated model for the acquisition of new Army systems in which trade-off options between human and hardware capabilities are identified and resolved during system design and development; continue to apply talent resource census information to Army recruiting and investigate the situational factors influencing volunteering for service; determine variables which are most effective in determining recruiter productivity; try out simulation-based methods for training senior leaders in the employment of highly complex military staff organizations under battlefield conditions; develop methodology for assessing and improving those aspects of military cohesiveness found to be significantly related to indicators of unit performance and mission readiness.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.23.A
Title: Clothing, Equipment, and Shelter Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	6364	6317	5586	6864	Continuing	Not Applicable
AH98	Clothing and Equipment Technology	5392	5512	5042	6149	Continuing	Not Applicable
A427	Tactical Rigid Wall Shelters	972	805	544	715	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: A strong in-house and contractual Exploratory Development Program is conducted to improve combat clothing, individual equipment, field service support equipment, and shelters in order to significantly increase the soldier's effectiveness in combat and survivability on the modern-day battlefield. Improved combat clothing is needed to provide the soldier comfort and protection in both normal and extreme climatic conditions, and to provide camouflage, ballistic, chemical, flame, and thermal protection. Modern camouflage must decrease the probability of detection by an enemy using many modes of sophisticated surveillance ranging from daylight visible to night surveillance and thermal imaging devices. Improved protection from the increasing lethality of fragmentation weaponry is required for both ground and aircrew soldiers. For combat vehicle crewmen to escape from burning vehicles such as tanks and armor personnel carriers, a minimum of ten seconds protection is needed. This capability does not now exist. In addition, with the ever-increasing threat of chemical/biological warfare, protection against chemical/biological attack is required, in conjunction with all of the above. Exploratory Development in tactical rigid-wall shelters will improve the capability of the shelters to resist the threat of nuclear, chemical, and biological warfare as well as improve the resistance of the shelters against conventional warfare. It is also part of a Department of Defense (DOD) effort to meet the American National Standard Institute (ANSI) and International Organization for Standardization (ISO) specifications and simultaneously reduce the proliferation of various sizes and types of tactical shelters and special-purpose vans currently in the inventory, provide improved performance, and reduce maintenance time and costs. The current emphasis on housing command and control functions, hospitals, missile systems, and Fire Direction Centers in tactical shelters requires extensive effort in hardening of shelters from the effects of Nuclear, Biological, and Chemical (NBC) as well as conventional threats. This program will yield the technology to ultimately field multipurpose, hardened, standard shelters for all of the DOD.

Program Element: #6.27.23.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Clothing, Equipment, and Shelter Technology
Budget Activity: #1 - Technology Base

Development effort in tentage is required to attain the capability to: design field shelters which are more habitable and which more fully meet field-operational requirements, reduce the logistical support and financial investment required for current field shelters; and explore materials and design concepts for improving chemical protection. The major thrust of the organizational field equipment efforts is to provide greater mobility (lighter weight) and improve efficiency by using less fuel and power, and reducing water consumption and waste products, visual signature, and noise levels. Field laundry and bath systems essential to the health and welfare of the combat soldier must also be compatible with chemical decontamination needs of the future.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Conduct research pertaining to the development and improvement of fibers, fabrics, materials, and new design applications for combat clothing, personal equipment, and field service support equipment to increase the survivability of the soldier on the battlefield. Conduct research to insure that these new materials and combinations of materials exhibit superior performance in the face of operational threats (ballistic, chemical agent, flame, and thermal/infrared detection), as well as environmental conditions (extreme cold, extreme heat, rain, physiological stress). Develop procedures for protection of Army material and systems under all types of field conditions, both in use and while in storage. Determine resistance of new materials, materiel, supplies and systems to microbial degradation and contamination. Expand program to develop means for providing individual and collective protection against chemical agents for the soldier and his equipment, and to improve laundry/bath systems to enable a more efficient and faster method to decontaminate personnel, clothing, and equipment.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	6364	6317	5586	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	4394	6837	5272	Continuing	Not Applicable

AH98 - An overall increase of $2100 thousand in FY 1980 and $809 thousand in FY 1982 funding requirements resulted from the acceleration of the critical program to develop fibers/fabrics for chemical/biological protective clothing ensembles. The funding level decrease of $383 thousand in FY 1981 is a result of general reductions by Congress.

Program Element: #6.27.23.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Clothing, Equipment, and Shelter Technology
Budget Activity: #1 - Technology Base

A427 - A decrease of $130 thousand in FY 1980 funds resulted from FY 1979 program acceleration which yielded the technology to permit ahead-of-schedule completion of work effort in support of tactical field shelters. The decrease of $137 thousand in FY 1981 funding level is a result of general reductions by Congress. The decrease in the FY 1982 funding requirement results from high priority being placed on the nuclear hardening of tactical shelters and the development program being accelerated into Advanced Development with minimum exploratory testing and evaluation.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.23.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Clothing, Equipment, and Shelter Technology
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This program is designed to: improve human performance and soldier survivability; reduce the weight of soldier's clothing and equipment; upgrade levels of protection against chemical agents, flame, and fragmentation threats; provide countermeasure systems against detection by electro-optical devices; and explore the use of new materials and designs to protect the eyes against nuclear flash, laser, and ballistic threats. Also included are efforts to improve field service equipment, field life support facilities, tactical rigid-wall shelters, and the development of design criteria for field shelters.

G. (U) RELATED ACTIVITIES: In order to preclude a duplication of effort, related research is coordinated with each of the other military services who develop their own service-related clothing and individual equipment items. Coordination and liaison with industry is accomplished by the US Army Natick Research and Development Laboratories. The Exploratory Development efforts in clothing and equipment move to Advanced Development under Program Element (PE) 6.37.47.A, Soldier Support/Survivability, and to Engineering Development under PE 6.47.13.A, Combat Feeding, Clothing and Equipment. Advanced Development in tactical rigid-wall shelters is performed in PE 6.37.26.A, Combat Support Equipment, Project D428, Tactical Rigid-Wall Shelters. Engineering Development is conducted in PE 6.47.17.A, General Combat Support, Project D429, Tactical Rigid-Wall Shelters.

H. (U) WORK PERFORMED BY: The major in-house effort is performed by the US Army Natick Research and Development Laboratories, Natick, MA. Other Government activities involved are US Army Institute of Environmental Medicine, Natick, MA; US Army Materials and Mechanics Research Laboratory, Watertown, MA; US Army Chemical Systems Laboratory, Aberdeen Proving Ground, MD; Dugway Proving Ground, UT; US Army Armaments Command, Dover, NJ; and National Bureau of Standards, Washington, DC. Current contractors are Brunswick Corp, Marion, VA; Kaman Avidyne Division, Burlington, MA; Albany International, Dedham, MA; Celanese Corporation, Summit, NJ; and E. I. du Pont de Nemours, Wilmington, DE. In addition there are 24 other contracts for $1,143,150.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Development of the technology underlying the new Battledress Uniform System was completed. Evaluations of women soldiers wearing complete field uniforms and load-carrying equipment were conducted to assure women are properly equipped and protected for their expanded role in the Army. Work was initiated on novel concepts for cold weather clothing which will result in the integration of several items of cold weather clothing into a new system with up to 30% reduction in weight and bulk. Processes and methods to obtain carbon-laminated or impregnated materials with optimum CB protection were evaluated. Work was initiated on materials having the capability of combining CB protection with flame resis-

Program Element: #6.27.23.A
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Title: Clothing, Equipment, and Shelter Technology
Budget Activity: #1 - Technology Base

tance, and several flame-retardant finishes were tested on the standard overgarment material. Filters with a range of spectral and transmission characteristics designed to provide optimum eye protection when used with specific photochromic dye systems were obtained. An experimental test method was developed to impact individual textile yarns ballistically and to measure the material reaction in quantitative units of stress, strain, and time. Computerized colorant programs (pigment and dye) were validated and are now used routinely. Development of a statistical method to evaluate results of a fabric color-matching experiment was complete. Work was completed on the analytical effort for tactical rigid wall shelters (3 for 1 expandable). Work continued on the determination of the response to these shelters to dynamic loading and forces. Models were developed to determine the adequacy of changes in the design of tactical rigid-wall shelters. Work continued on evaluating commercial, nondestructive test devices to detect loss of integrity in bonding of panels for tactical shelters and the influence of thermal loading on the skin to core delamination. Work was initiated on: solving the Nuclear, Chemical, Biological (NBC) ballistic threat for tactical shelters based on a review of the nuclear environment in which these shelters must be operated, and preparation of computer codes for the structural analysis of these shelters in the NBC environment. Effort was started on fabricating an Electromagnetic Interference (EMI) Protection Kit for the nonexpandable shelter.

2. (U) FY 1981 Program: In Exploratory Development on fibers/fabrics for Chemical/Biological (CB) protective ensembles, exploit the potential of wet-laid nonwoven materials containing activated carbon. Continue program to dry-lay lightweight, nonwoven materials with an activated carbon ingredient for CB applications. Evaluate advanced chemical protective materials to determine their ability to extend protection level, shelf life, and to reduce the heat stress associated with current chemical protective clothing. Continue investigation of improved charcoal binders, formations, and materials to extend the wear life of chemical protective clothing. Continue development of activated carbon using continuous process to reduce cost. Continue compounding of butyl phophazene rubber fabricated into molded or dipped sheets and coated fabrics for flame-retardant, chemical-protective handwear. Conduct evaluation of wrapped carbon yarns, crushed foam, and spun-bonded/melt-blown webs for chemical protective properties. Evaluate effects of atmospheric conditions on carbon-impregnated materials to increase CB clothing shelf life. Evaluate advanced insulating materials for weight and bulk reductions in cold weather clothing. Complete design and fabrication of a radar-absorbent material which will significantly reduce ability of detection using electronic sensing devices. Investigate woven and nonwoven fabrics for camouflage in snow-covered terrains, and develop concepts to improve camouflage of shelters in conventional tactical employments. Complete collation of all available anthropometric data to provide a basis for development of an integrated sizing system for field clothing for the female soldier. Biomechanical analysis on males/females using modified load-carrying equipment will be conducted to provide design criteria for advanced load-carrying system. Initiate effort to enhance flame, ultraviolet and abrasion resistance on spun-bonded/melt-blown materials. Establish in-house capability to assess noise attentuation properties of textile materials and composites. Relationship between material properties and mechanism of accoustical energy attenuation will be determined. Initiate

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development of novel combat clothing system concepts with multiple protective capability against flame, ballistic, chemical, and nuclear threats. Continue work on heaters, tent fabrics, inflatable beams, and habitability problems. Continue dynamic analysis of frame-and-panel designs for tactical, rigid-wall shelters. Work will continue on developing a more general dynamic analysis using a less detailed model including blast overpressure loading. Continue evaluation of Nondestructive Testing (NDT) devices and make a determination as to the suitability for Army use. Continue study of effects of thermal loading on the delamination of honeycomb panels. Continue development of design methodology for tactical shelters exposed to the Nuclear, Biological, Chemical (NBC) ballistic threat. Fabricate nuclear overpressure panels to interface with Army family of standard shelters. Perform simulated nuclear test on nonexpandable shelter. Continue screening of new biocidal compounds; evaluate new materials and systems being proposed for military use for susceptibility to microbial deterioration.

3. (U) FY 1982 Planned Program: Work will be conducted to develop: flame-resistant and chemical protective liner for combat vehicle and aircraft crews; elastomeric materials for use in Chemical/Biological (CB) protective systems; and combined reactive/sorptive materials also for use in CB protective materials. Investigate new methods of incorporating active charcoal in flexible cellular materials. Complete effort on wet-and-dry-laid nonwoven materials with activated carbon for CB applications. Develop decontaminating techniques for CB clothing to increase service life. Initiate effort to develop protection against new enemy ballistic threats. Continue work on new concepts to incorporate CB, ballistic, and flame protection into one combat uniform, and reduce weight and bulk of current combat clothing while maintaining protective quality. Complete evaluation of combat uniforms with low-infrared emittance and evaluate reduction of soldier's thermal signature. Continue effort to quantify interaction of night vision sights with eye to give better understanding of effects of camouflage patterns at night. Complete critical assessment and evaluation of all standard clothing tariffs (sizes) for Army men and women. Utilize integrated sizing study data to draft initial single-size clothing system patterns. Continue screening new biocidal compounds; continue evaluation of materials proposed for military use for susceptibility to microbiological degradation. Continue work on habitability, CB protection, and design for tents. Continue work on improving field latrine/bath/laundry/waste disposal systems. Initiate an optimum design study for tactical rigid-wall shelters. Continue study of delamination of honeycomb panels with investigation of both Nondestructive Testing (NDT) methods and mechanisms which cause delamination. Continue designs for tactical shelters to meet the Nuclear, Biological, Chemical (NBC) threat and to define potential design modifications and trade-off costs to meet the specified threat. Determine capability of composite, computer-coded panel designs to meet nuclear threats. Personnel involved: professional - 51, support - 22.

4. (U) FY 1983 Planned Program: Continue research on fibers/fabric for Chemical/Biological (CB) protective ensembles with specific emphasis on applying Rationalization, Standardization, and Interoperability (RSI) clothing programs. Continue investigating candidate CB agent-impermeable materials to reduce heat stress; developing elastomeric coating systems and films;

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investigating new methods to incorporate active charcoal in flexible cellular materials to improve the form of binder and activated carbon; developing activated carbon-filled hollow fibers; preparing activated-carbon fabric and yarn from petroleum pitch; and developing laminated fabric structures. Investigate perspiration poisoning response of materials, and analyze the structure and physical property relationship for elastomers. Continue developing decontaminating techniques for CB clothing. Continue development of new concepts to employ advanced insulation materials into cold weather clothing. Analyze areas of conflict in interoperability of camouflage materials among North Atlantic Treaty Organization (NATO) countries and initiate means for overcoming them. Evaluate materials newly released to commercial market for flame-retardance properties and possible military application. Devise protective concepts for self-supporting and frame-supported structures and consider homogeneous and heterogeneous fabric panels and laminates. For tactical rigid-wall shelters, expand the optimum design with new structural concepts in addition to the frame-and-panel concept. Continue panel design and Nondestructive Testing (NDT) studies including requirements for blast and ballistic protection. Continue to investigate and support the establishment of Nuclear, Biological, Chemical (NBC)/ballistic requirements and to define design modifications and trade-offs required in tactical shelter structures to meet specific threat levels. Investigate means for rapidly moving tactical shelters short distances (approximately 1000 feet) for complexing (joining) shelters. Continue screening of new biocidal compounds; evaluate new materials and systems being proposed for military use for susceptibility to microbial deterioration.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #AH98 Title: Clothing and Equipment Technology
Program Element: #6.27.23.A Title: Clothing, Equipment, and Shelter Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: This program is designed to increase the soldier's effectiveness in combat and survivability on the battlefield by: improving human performance, environmental protection, and personal comfort; reducing the weight of soldier's clothing and equipment; upgrading levels of protection against chemical agents, flame, and fragmentation threats; investigating countermeasure systems that provide camouflage of the soldier against detection by electro-optical devices; and exploring the use of new materials and designs to protect the eyes against nuclear flash, laser, and ballistic threats. Also included are efforts to improve field service equipment, field life support facilities, development of design criteria for field shelters, development of procedures for protection of Army materiel and systems under all types of environmental conditions while the equipment is both in use and in storage; and determination of resistance of new materials, materiel, supplies, and systems to microbial degradation and contamination.

B. (U) RELATED ACTIVITIES: In order to avoid a duplication of effort, related research is conducted by coordination with each of the other Services which develop their own Service-related clothing and individual equipment items. Coordination and liaison with industry is accomplished by the US Army Natick Research and Development Laboratories. The Exploratory Development efforts in clothing and equipment move to Advanced Development (AD) under Program Element (PE) 6.37.47.A, Soldier Support/Survivability, and to Engineering Development under PE 6.47.13.A, Combat Feeding, Clothing and Equipment.

C. (U) WORK PERFORMED BY: The major in-house effort is performed by the US Army Natick Research and Development Laboratories, Natick, MA. Other Government activities involved are US Army Institute of Environmental Medicine, Natick, MA; US Army Materials and Mechanics Research Laboratory, Watertown, MA; US Army Chemical Systems Laboratory, Aberdeen Proving Ground, MD; and Dugway Proving Ground, Provo, UT. Current contractors are Union Carbide, New York, NY; Albany International Research, Inc., Dedham, MA; Celanese Corp., Summit, NJ; E.I. du Pont de Nemours & Co., Wilmington, DE; and Georgia Tech Research Institute, Atlanta, GA. There are 21 other contracts worth $908,000.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Development of the technology underlying the new Battledress Uniform System was completed. Evaluations of women soldiers wearing complete field uniforms and load-carrying equipment were conducted to assure that women are properly equipped and protected for their expanded role in the Army. Work was initiated on novel concepts for cold weather clothing which will result in the integration of several items of cold weather clothing into a new

Project: #AH98 Title: Clothing and Equipment Technology
Program Element: #6.27.23.A Title: Clothing, Equipment, and Shelter Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

system with up to 30% reduction in weight and bulk. Processes and methods to obtain carbon-laminated or impregnated materials with optimum Chemical Biological (CB) protection were evaluated. Work was initiated on materials having the capability of combining CB protection with flame resistance, and several flame retardant finishes were tested on the standard overgarment material. Filters with a range of spectral and transmission characteristics designed to provide optimum eye protection when used with specific photochromic dye systems were obtained. An experimental test method was developed to impact individual textile yarns ballistically and to measure the material reaction in quantitative units of stress, strain, and time. Computerized colorant programs (pigment and dye) were validated and are now used routinely. Development of a statistical method to evaluate results of a fabric color-matching experiment was completed.

2. (U) FY 1981 Program: In Exploratory Development on fibers/fabrics for Chemical/Biological (CB) protective ensembles, exploit the potential of wet-laid, nonwoven materials containing activated carbon. Continue program to dry-lay lightweight, nonwoven materials with an activated carbon ingrediant for CB applications. Evaluate advanced chemical protective materials to determine their ability to extend protection level, shelf life, and to reduce the heat stress associated with current chemical protective clothing. Continue investigation of improved charcoal binders, formations, and materials to extend the wear life of chemical protective clothing. Continue development of activated carbon using continuous process to reduce cost. Continue compounding of butyl phophazene rubber fabricated into molded or dipped sheets and coated fabrics for flame-retardant, chemical-protective handwear. Conduct evaluation of wrapped carbon yarns, crushed foam, and spun-bonded/melt-blown webs for chemical protective properties. Evaluate effects of atmospheric conditions on carbon-impregnated materials to increase CB clothing shelf life. Evaluate advanced insulating materials for weight and bulk reductions in cold weather clothing. Complete design and fabrication of a radar-absorbant material which will significantly reduce ability of detection using electronic sensing devices. Investigate woven and nonwoven fabrics for camouflage in snow-covered terrains, and develop concepts to improve camouflage of shelters in conventional tactical employments. Complete collation of all available anthropometric data to provide a basis for development of an integrated sizing system for field clothing for the female soldier. Biomechanical analysis on males/females using modified load-carrying equipment will be conducted to provide design criteria for an advanced load carrying system. Initiate effort to enhance flame, ultraviolet, and abrasion resistance on spun-bonded/melt-blown materials. Establish in-house capability to assess noise attenuation properties of textile materials and composites. Relationship between material properties and mechanism of accoustical energy attenuation will be determined. Initiate development of novel combat clothing system concepts with multiple protective capability against flame, ballistic, chemical, and habitability problems. Continue screening of new biocidal compounds; evaluate new materials and systems being proposed for military use for susceptibility to microbial deterioration.

Project: #AH98 Title: Clothing and Equipment Technology
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DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

3. (U) FY 1982 Planned Program: Work will be conducted to develop: flame-resistant and chemical-protective liner for combat vehicle and aircraft crews; elastomeric materials for use in Chemical/Biological (CB) protective systems; and combined reactive/sorptive materials also for use in CB protective materials. Investigate new methods of incorporating active charcoal in flexible cellular materials. Complete effort on wet- and dry-laid nonwoven materials with activated carbon for CB applications. Develop decontaminating techniques for CB clothing to increase service life. Initiate effort to develop protection against new enemy ballistic threats. Continue work on new concepts to incorporate CB, ballistic, and flame protection into one combat uniform, and reduce weight and bulk of current combat clothing while maintaining protective quality. Complete evaluation of combat uniforms with low-infrared emittance and evaluate reduction of soldier's thermal signature. Continue effort to quantify interaction of night vision sights with the eye to give a better understanding of effects of camouflage patterns at night. Complete critical assessment and evaluation of all standard clothing tariffs (sizes) for Army men and women. Utilize integrated sizing study data to draft initial single-size clothing system patterns. Continue screening new biocidal compounds; continue evaluation of materials proposed for military use for susceptibility to microbiological degradation. Continue work on habitability, CB protection, and design for tents. Continue work on improving field latrine/bath/laundry/waste disposal systems. Personnel involved: professional, 43; support, 20.

4. (U) FY 1983 Planned Program: Continue research on fibers/fabrics for Chemical/Biological (CB) protective ensembles with emphasis on Rationalization, Standardization, and Interoperability (RSI) development of CB clothing. Continue work on: investigating candidate CB agent-impermeable material to reduce heat stress; developing elastomeric coating systems and films; investigating new methods to incorporate active carbon charcoal in flexible cellular materials to improve the form of binder and activated carbon; developing activated carbon-filled hollow fibers; preparing activated carbon fabric and yarn petroleum pitch; and developing laminated fabric structures. Investigate perspiration poisoning response of materials, and analyze structure and physical property relationship in elastomers. Continue developing decontaminating techniques for CB clothing. Continue development of new concepts to employ advance insulation materials into cold weather clothing. Continue design studies for camouflage of shelters. Analyze areas of conflict in interoperability of camouflage materials among North Atlantic Treaty Organization (NATO) countries and initiate means for overcoming them. Evaluate materials newly released to commercial market for flame-retardance properties and possible military application. Screen new material development for noise attenuation capability. Devise protective concepts for self-supporting and frame-supported structures, and consider homogeneous and heterogeneous fabric panels and laminates. Continue screening of new biocidal compounds and evaluating new materials and systems being proposed for military use for susceptibility to microbial deterioration.

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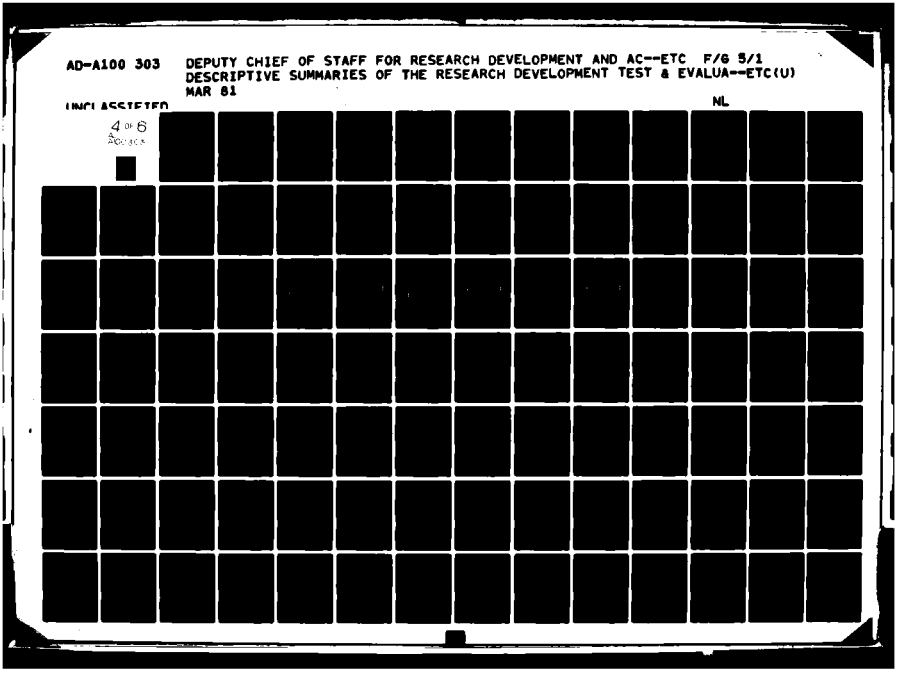

Project: #AH98 Title: Clothing and Equipment Technology
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5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not Applicable

7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	5392	5512	5042	6149	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	3292	5895	4233	Not Shown	Continuing	Not Applicable

An increase of $2100 thousand in FY 1980 and $809 thousand in FY 1982 funding requirements resulted from the acceleration of the critical program to develop fibers/fabrics for chemical/biological protective clothing ensembles. The funding level decrease of $383 thousand in FY 1981 is a result of the application of general reductions by Congress.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.24.A
Title: Joint Services Food System Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	5316	5952	5736	6833	Continuing	Not Applicable
AH99	Joint Services Food System Technology	5316	5952	5736	6833	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Army, as Executive Agent of the Department of Defense, conducts the DOD Food Research, Development, Testing and Engineering Program in support of all the military services and the Defense Logistics Agency. The program is designed to meet unique military requirements for food systems to support ground combat, air and shipboard operations, and in garrison. It identifies items and technology available from industry which can be adapted or modified to fill military needs. Research and development programs are conducted when industry cannot provide required support due to lack of specialized expertise or knowledge of military systems and operations. Examples of such unique problems are: extending stability and safety of special combat rations designated for prepositioned wartime reserves; reducing weight and volume to minimize the logistical burden and accommodate extreme space limitations associated with military weapon systems such as nuclear submarines and ground armored vehicles; packaging to survive extreme mechanical and environmental stresses through long supply routes to remote locations and airdrop delivery systems; ensuring essential nutrition under extreme climatic and possible chemical, biological, and nuclear conditions to military forces worldwide and mass feeding of military personnel under combat conditions. The primary objective of this Joint Service program is to modernize and modularize the design and operation of DOD food systems consistent with available and projected technological/capabilities of private industry and other government agencies augmented by in-house developments where particular military requirements cannot be satisfied otherwise.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: This program provides for the development, integration, and systematic application of food, equipment, packaging and other relevant technologies to the analysis and design of new and/or improved food and food service concepts and systems. Specific projects responding to requirements that have been identified by the military depart-

Program Element: #6.27.24.A
DOD Mission Area: #527 - Environmental and Life Sciences (ED)

Title: Joint Services Food System Technology
Budget Activity: #1 - Technology Base

ments include: concept development and testing of advanced combat food service systems for the Army and Marine Corps; in-port food service systems for Navy ships to significantly reduce workload and manpower requirements; design of a new ration system for Marine Corps amphibious and rapid deployment forces; an Air Force mobilization and forward base feeding system; an Army hospital food service system designed to reduce operating costs; food service doctrine and procedures for operations in chemical and biological environments; food service concepts for small isolated military groups and remote locations; food service systems designed to meet the special mobility requirements of the MX and ground-launched cruise missile (GLCM) weapon systems; and the design of improved food service systems for future Navy ship construction. Also under investigation are methods to improve food service system economy and efficiency.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	5316	5957	5736	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	5552	6088	7850	Continuing	Not Applicable

In FY80 $236 thousand was reprogramed to higher priority Army requirements. In FY81 the $136 thousand decrease is attributable to the application of general Congressional reductions. The difference of $2114 thousand for FY82 is due to a rescoping of the program after the acceptance of the Irradiated Food Program by the US Department of Agriculture and subsequent transfer of program assets and inflation.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.24.A
Title: Joint Services Food System Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED)
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: While the commercial food industry is relatively advanced and is providing a high-quality food supply to the civilian sector, it is based on sophisticated, labor-intensive, high-energy system of distribution of mostly refrigerated and frozen food products or shelf-stable products with short shelf lives. The commercial food industry is oriented towards transfer of food from the farm to the local supermarket, while military rations may be transported anywhere in the world, by any available means and be stored under potentially adverse conditions often for long periods of time. After all this military rations must still be affordable, safe, nutritionally adequate and highly acceptable to the troops at the point and time of consumption. An organized systematic approach is used to assess the capabilities and deficiencies of existing military food systems and to identify available technology and projected advancements in food, equipment, and related fields which can be applied to the Services' feeding problems. Items and systems selected must meet critical standards for readiness, ease of deployment, performance, and supportability. The objective is to upgrade the responsiveness of the military food service systems to existing and projected operational requirements. New concepts developed under this program utilize the most cost-effective solutions with the shortest feasible development cycle.

G. (U) RELATED ACTIVITIES: This work is being conducted as part of the DOD Food RDT&Eng Program which also includes programs in the following: Program Elements 6.11.02.A, Project AH52, Basic Research in Support Equipment for the Individual Soldier; 6.37.47.A, Project D610, Food Advanced Development; and 6.47.13.A, Project D548, Military Subsistence Systems. This is a coordinated Joint Military Service Program, and there are no other equivalent federal or in-house facilities available for the conduct of those required research and development activities. Some technical expertise developed under this program is employed in support of military food supply and service operations worldwide--thus, in addition to improving our military food systems, the research program complements and backs up multibillion-dollar annual DOD Joint Services food service operations/activities.

H. (U) WORK PERFORMED BY: The majority of effort (about 70%) is conducted in-house by the US Army Natick Research and Development Laboratories, Natick, MA. Other Army and government laboratories that have provided assistance include the Letterman Army Institute of Research, the Presidio of San Francisco, CA; the Construction Engineering Research Laboratory, Champaign-Urbana, IL; the Regional Laboratories of the Department of Agriculture; and the General Services Administration. Various academic institutions have also performed work in this program, such as the University of Massachusetts, Amherst, MA; University of Nebraska, Lincoln, NE; Bowling Green University, Bowling Green, OH; Massachusetts Institute of Technology and Harvard University, Cambridge, MA; Baylor College of Medicine, Houston, TX; Worcester Polytechic University, Worcester, MA; New York University, New York City, NY; Texas A&M University, College Station, TX; and University of California, Los Angeles, CA. Contractors include National Academy of Science, Washington, DC; Arthur D. Little, Cambridge, MA; ARA Food Service,

Program Element: #6.27.24.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Joint Services Food System Technology
Budget Activity: #1 - Technology Base

Philadelphia, PA; General Electric Co., Schenectady, NY; Ralston Purina Corp;, St. Louis, MO; Simcon, Inc., McLean, VA; and Factory Mutual Research Corporation, Norwood, MA.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: A new type food of service system designed for and tested on board the USS Saratoga has proven so successful that it has been adopted by the Navy directly out of development for all aircraft carriers and is now being introduced, in part, on virtually all other operating Navy ships. A new military food service system providing more customer choice was developed for Marine Corps installations. It significantly increases individual participation rates by those personnel authorized to subsist at government expense. Other studies have shown ways to improve yields and shorten food preparation times, with consequent savings in energy and operating costs. The problem of unpalatable liquid diets for certain patients has been partially solved by a new developmental process now being adopted by the Medical Corps. The first phase of a new high-technology system development to reduce labor costs for large military hospital food service operations is undergoing operational evaluation. Concept studies were completed of future field feeding systems for the Army, Marine Corps, and Air Force, to provide for substantially increased performance. These studies exploit advances in field shelters, tray pack technology and food service equipment design offering significant potential economies in manpower, logistics, and other resources. Reliable, rapid, and more sensitive methods have been developed for measuring the amount of soy protein extenders to ground meat, for detection of flour beetle contamination, for assay of microbial load and toxin contamination, for measuring deterioration of foods and effectiveness of antioxidants, and for measuring texture of flaked meats and compressed food bars. These tests are necessary for quality assurance, quality control, and quality assessment of military subsistence and rations. Advances in dehydration and compression techniques have allowed a reduction in weight and volume of food components used in military rations and have improved efficiency of production, enhanced product nutrition, enhanced troop acceptance, and lowered procurement costs. An emergency/assault ration has been developed for the Marine Corps, intended for short-term use (3-5 days) in the initial phase of an assault or in other situations where resupply may be prohibited. Acquisition of the emergency/assault ration will insure better food system readiness for the rapid deployment forces. These freeze-dried and compressed foods also reduce the frequency of the of resupply/replenishment cycle for Navy ships at sea, increasing mission range and endurance. Other studies have led to the military adoption of highly acceptable ground beef extended with soy protein concentrate, and flaked and formed steaks by the Military Services. Personnel involved included 97 professional and 52 support positions.

Program Element: #6.27.24.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Joint Services Food System Technology
Budget Activity: #1 - Technology Base

2. (U) FY 1981 Program: Concept development and applied technology efforts are being conducted in support of: future combat feeding systems for the Army, Marine Corps, and Air Force to substantially increase performance and mobility by exploiting technological advances for their potential economies in manpower and logistics; future food service systems for the Navy afloat to improve sailors' morale and performance, satisfy severe space and storage limitations onboard as well as to enhance efficiency and cost effectiveness; Army remote or isolated feeding situations inaccessible and ineffectively supplied by normal means; strategic CONUS MX missile system with its unique logistical and operational concept; OCONUS-based GLCM system with its unique requirements for low signature, high mobility, no trained food service personnel and operation in potential Chemical, Biological, and Nuclear (CBN) environment; high-priority requirements for providing food service capability in NBC-contaminated environments; Navy in-port food service system designs that will consolidate and exploit existing assets in achieving significant economies of scale-up operations; new generation of food service systems for fixed Army hospital aimed at minimizing labor while significantly improving operational efficiency by exploiting advanced state of the art in freeze-serve and patient tray systems; advanced designs of combat rations for amphibious and rapid deployment forces to reduce logistical burden, enhance nutrition and troop acceptance as well as lower the cost and assure commercial producibility; a new in-flight feeding system to support crews and troops on critical military airlift missions; automated managerial control systems for military food service operations, as well as new managerial training techniques to address the operational deficiencies identified by the Defense Audit Service; determination of microbiological safety and human acceptance for new and modified subsistence items and rations, and the development of improved stability and quality measurement techniques to improve the quality control and quality assessment of military subsistence and rations; food preparation heat transfer determinations to improve yields, shorten food preparation time, and save food preparation energy costs; investigations on the appropriate level of military subsistence packaging to prevent microbial recontamination and pest penetration to ensure safety, minimize losses and enhance our capability for long-term holding and storage of strategic prepositioned wartime reserves; improvements in field and garrison food service equipment and sanitation facilities to exploit the technological advances capable of providing potential economies in energy utilization, manpower requirements, and logistics.

3. (U) FY 1982 Planned Program: Continue concept development and technology effort in support of: future more efficient, highly mobile, less manpower-intensive combat food service systems for the Air Force, Army, and Marine Corps; food service capability in NBC-contaminated environments; specialized food service systems for the Air Force's MX and GLCM missile systems; unique tactical requirements for remote and isolated locations where resupply is severely limited; advanced Navy Afloat Food Service systems which consider logistical limitations, operational efficiency, and labor reduction; new in-flight feeding system to support crews and troops on critical longer duration military airlift missions; automated managerial control systems, new managerial training techniques, and new garrison food service systems to increase the efficiency of and

Program Element: #6.27.24.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Joint Services Food System Technology
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decrease the waste in military food service operations; improved stability and quality measurement techniques, and the determination of microbiological safety and human acceptance parameters for new and modified subsistence items and rations in order to enhance the quality assurance, quality control, and quality assessment of military subsistence and rations; improved methods for processing, packaging, and storing food items to improve quality, reduce food losses, and enhance commercial producibility and affordability; basic heat transfer studies on food service equipment to improve yields, shorten food preparation times, and provide consequent savings in energy costs and improved field food service sanitation technology to eliminate potential health hazards and enhance operational and logistical efficiency. Initiate concept development and technology effort in support of development of integrated defense subsistence logistic system for worldwide wartime food service aimed towards enhanced readiness and maximum cost effectiveness; development of improved feeding concepts for Navy ships while sailors are dispersed and confined to battle stations; integrated, modularized feeding systems for wartime mobilization conditions that would address the particular requirements of dispersion of US forces to collocated operating bases; a combustion technology program for improved safety and fuel efficiency and diversity of field burners.

4. (U) FY 1983 Planned Program: Continue prior initiatives in support of: development of highly mobile, significantly less manpower-intensive field food service systems for the Marine Corps and Army; the development of food service systems for the Navy Afloat to increase sailor morale while improving the efficiency of operations while underway and in battle; the development of specific food service systems to support the strategic MX and GLCM missile systems; the development of food service systems suitable for use in toxic NBC environments; the development of automated control systems, managerial training techniques, new garrison food service systems, and waste management techniques to decrease the waste in and increase the efficiency of military food service operations; the development of integrated modularized food service systems suitable for mobilization wartime conditions; and improving the protection provided by subsistence packaging for military items against the rigors imposed by military logistics, including long-term storage under extreme environmental conditions and potential hazardous NBC contamination. Initiate development efforts aimed specifically at improvement of food service in extreme Arctic conditions and an analysis of logistics alternatives for the maritime prepositioning of subsistence to support units of rapid deployment and strike forces.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.25.A
DOD Mission Area: #521 - Electronic and Physical Sciences

Title: Computer and Information Sciences
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	1269	1858	1822	2182	Continuing	Not Applicable
DY10	R&D in Multicommand Data Systems	1269	1858	1822	2182	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program's major thrust is to develop and utilize advances in computer software for near-term cost and quality improvements for both DOD weapons and multicommand ADP systems. Included are efforts to: (1) assist DOD/DA program managers in the planning and control of software development; (2) to improve the reliability, usability, adaptability, and cost-effectiveness of multicommand ADP systems and defense computer applications; and (3) to focus on the support of current standard programing languages, including the development of programing tools and the implementation of a new standard high order language, and to facilitate NATO interoperability. Some work on advanced hardware peripherals and computer technology is included in support of the Standard Army Multicommand Management Information Systems (STAMMIS), the Tactical Management Information Systems (TACMIS), and the acquisition of the Vertical Installation Automation Base Line (VIABLE).

C. (U) BASIS FOR FY 1982 RDTE REQUEST:

1. (U) This program will specifically address the requirements definition process, resources estimating, performance measurement, and software project management efforts. The techniques will aim to reduce costs of computer software development, improve efficiencies in the STAMMIS user environment, and reduce duplication of effort. Research in Software Sciences will identify factors in programing efforts as well as methodologies for estimating maintenance programing efforts. Research in software restructuring will reduce the complexity of the maintenance cycle and the costs incurred in current procedures. Research efforts in verification and validation are targeted at providing a disciplined approach to insure that each end item product in the software development functions as prescribed in the software requirements. Efforts under this program element will include support for modernization of multicommand ADP hardware systems and upgrading of large-scale software systems presently employed in military installations throughout the world.

Program Element: #6.27.25.A Title: Computer and Information Sciences
DOD Mission Area: #521 - Electronic and Physical Sciences Budget Activity: #1 - Technology Base

2. (U) A primary FY 1982 thrust is to accelerate the use of new proven software advances by Program Managers and defense contractors. The FY 1982 research and exploratory development costs appear to be reasonably close to the originally planned development costs identified in the Program Objective Memorandum and the Defense Computer Resources Technology Plan published in June 1980, which outlines key technology issues for DOD embedded computer applications and established target budgets for R&D initiatives addressing those issues.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional to Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	1269	1858	1822	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	1269	2009	2119	Continuing	Not Applicable

FY 1982 RDTE funding was decreased due to funding constraints. The FY 1981 decrease is attributable to the application of general congressional reductions.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.27.25.A Title: Computer and Information Sciences
DOD Mission Area: #521 - Electronic and Physical Sciences Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Recent studies by the Army and the Department of Defense (DOD) have established that the development and timely delivery of software of adequate quality is a major problem in weapon systems development. A major defense program initiative is underway to define and implement new software policies and procedures. To make possible the successful implementation of these new policies and procedures, this computer sciences and technology program will refine, evaluate, and apply advanced computer software tools and techniques and instill a software engineering discipline with rigor similar to that characterizing hardware development programs. The primary thrusts of this Army Computer and Information Sciences Program are: (1) Requirements Analysis; (2) Metrics and Life-Cycle Planning Technology; (3) Distributed Systems; and (4) Support of Standard Languages. In the area of requirements analysis, the objective is to develop an experimental Interactive Automated Requirements System (ARS) based on existing systems. Army development schedule reductions and cost reductions up to 30 percent are expected from integration of this system. In the area of metrics and life cycle planning the work addresses the inability to project and manage cost, schedule, and performance in software development by developing and demonstrating within operational elements an interactive Automated Project Management System (APMS). Life cycle development/evaluation of cost estimation procedures is continuing and will be integrated into the APMS. Benefits will result in a simplified and expanded methodology and automated tools for estimating and controlling software projects. In the area of distributed systems, the work addresses problems of technology obsolescence and technology integration to meet objectives for battlefield automation in the 1980's. This research program aims at developing and demonstrating interactive automated system concepts to achieve independence from various vendor hardware, distributed configurations of microprocessions as a local area network, and advances in data base concepts for distributed environments. Support of Standard Languages addresses the absence of rigor and discipline in software development and maintenance which has produced low-quality products and high costs for maintenance and enhancements. The research approach utilizes research investments developed for embedded computer environments and extends these products to COBOL. Several tools and methods are being integrated into a COBOL tool set for direct integration into the US Army Computer Systems Command. Substantial improvement in both internal and contractor-developed software will result from this research.

G. (U) RELATED ACTIVITIES: The Army's Military Computer Family program (MCF PE and Project No. 6.37.23.A/D101) Hardware, Software, and Instruction Set Architecture Product Planning is developing a compatible computer family and a high order language, Ada, which has application in advanced information systems. The Army's Integrated Software Research and Development (ISRAD) program received support from Project 6.58.03.A/MY 29 (Integrated Software). Participating development agencies include the Office of the Chief of Engineers, US Army Research Institute, and the US Army Computer Systems Command. Research projects supported by this PE are coordinated by the DOD Management Steering Committee for Embedded Computer Resources and other DOD panels/committees. Continued liaison at the laboratory and action officer level with Navy and Air Force counterparts minimizes duplication of work. Several cooperative research projects are funded by the Rome Air Development Command (RADC) and the Naval Research Laboratory (NRL).

H. (U) WORK PERFORMED BY: University of California, Berkeley, CA; General Research Company, Huntsville, Al; Georgia

Program Element: #6.27.25.A
Title: Computer and Information Sciences
DOD Mission Area: #521 - Electronic and Physical Sciences
Budget Activity: #1 - Technology Base

Institute of Technology, Atlanta, GA; RAVEN Systems and Research, Inc., Washington, DC; Kansas State University, Manhattan, KS; Purdue University, Lafayette, IN. In-house developing agencies include: US Army Institute for Research in Management Information and Computer Sciences (AIRMICS), Atlanta, GA; and US Army Research Institute, Alexandria, VA; US Army Waterways Experiment Station (WES), Vicksburg, MS; US Army Construction Engineering Research Laboratory, Champaign, IL. Graphics Interface is performed by the in-house Corps of Engineers (COE) staff members at WES, Vicksburg, MS.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: AIRMICS-USACSC's R&D Multicommand Data Systems Project (DY10): Technological Accomplishments during FY 1977 through FY 1979 included the following key efforts: A 15-volume set of guidebooks was published for the software community describing how to do structured programing; two handbooks issued describing for government managers how to formulate and manage software development in defense programs. Demonstrated a specialized lightweight, miniature, low-power, handheld data entry/display terminal suitable for a military field environment. AIRMICS developed a cost estimation and sizing model. Although it was originally aimed at decision support applications (command and control and management information systems), initial experiments indicate it has wider applications. An Information Processing of Systems Simulator (IPSS) was used as a sketching tool for the Standard Installation Division/Personnel System (SIDPERS) in back-end, interactive configuration. Jointly, with the Federal Computer Performance Evaluation and Simulation Center (FEDSIM) and the Navy, conducted an evaluation of the suitability of IPSS for use by DOD in computer performance prediction, sizing, and design optimization. Developed complementary requirements technology called "System Sketching" to provide early feedback about system characteristics to prospective users. Evaluated a group of software management tools for integration into the smart terminal system over a two-year period; two terminals will be placed in operational development environment for early user feedback. Demonstrated the concept of a Back-End Data Base Management System (DBMS) on a minicomputer for possible application to future information systems architecture. Developed and demonstrated a hardware network of three microcomputers interconnected to a minicomputer. To preserve large previous investments, investigation efforts were made into portability of COBOL languages to multiple vendor hardware which concluded with an identification of a proper COBOL subset and mapping algorithm and in the testing area, the feasibility of testing for FORTRAN and COBOL programs, based on internal replacement of operators/operands was established. US Army Corps of Engineers (COE), Engineering Software Project (AT11): Major accomplishments during FY 1977-79 included the following key efforts: Developed a standard software system for COE's Graphics Compatibility System (GCS) - the Waterways Experiment Station (WES) ADP Center developed several applications using GCS enhanced and modified to support state-of-the-art graphics techniques. Both a two-dimensional and a three-dimensional version of GCS are available and can be used with several graphics devices on different computers. New capabilities include data structures, segmentation, pseudo-display files, and Hershey software character fonts. User base for GCS has been increased to over 50 local, state, and Federal Government (including DOD) installations. In 1980, AIRMICS effectively demonstrated the capability of Input/Output Requirement Language (IORL) to translate and analyze requirements for an Army STAMMIS; i.e., Standard Army Maintenance System (SAMS). Developed concept and

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prototype extension to Problem Statement Language (PSL) to facilitate production of a system sketch. Developed COBOL analysis program which measures complexity and provides data to verify software science theory. Enabled technology transfer of requirements engineering technology to major STAMMIS redesign effort (i.e. STAMMIS - Standard Army Financial Systems). AIRMICS investigated the feasibility of applying microcomputer technology to STAMMIS by establishing an experimental model of interactive logistics system utilizing low-speed communication network; distributed data base control and COBOL application programs implemented on microcomputer-based hardware. An advanced information systems research effort was undertaken to identify experimental development projects which would serve as "real world" vehicles for the transfer of advanced concepts and technologies to future Army systems.

2. (U) FY 1981 Program: Development of a prototype Automated Requirements System (ARS) will begin with the requirements definition and initial design of the user interface. Development of the system sketch modules will also begin and will include emulation of man-machine interface specifications and functional simulation of the systems. Validation and automation of the microresources estimating for system change packages will be concluded along with the technology transfer to STAMMIS system designers. Evaluation of the experimental Automation Project Management System and development of specifications for modification and redesign will occur. In the area of Software Product Standardization, the FY81 program includes the completion of projects leading to tools for management of software quality and software test quality; the continuation of experiments, to demonstrate, evaluate, and identify needed improvements in both tools. In the area of System Design and Architecture, assessment of data transfer among MILPERCEN and members of the personnel community will be completed. Initial requirements for an experimental model of an advanced personnel information system providing extensive access to data utilizing distributed data management concepts will be developed based on the military personnel environment. This data sharing will reduce storage maintenance costs by at least 10%. Concurrently, an experimental distributed DBMS (INGRESS) will be operational to evaluate technicial issues associated with concurrency, allocation, and update aspects of managing distributed data as well as addressing the future applicability of relational models to support high-level query capabilities.

3. (U) FY 1982 Planned Program: Continue research and exploratory development efforts in the areas of requirements analysis, metrics, and life cycle planning technology, distributed systems and standard language support. In the area of life cycle management research, the work addresses the need for an in-depth understanding of current life-cycle management policies and the needs for managing a dynamic environment. Contractor activities for FY 1982 will concentrate on development of quantitative measures of life cycle factors and the examination software life cycle. In-house activities will center on the evaluation of existing techniques and the application of these processes to Army software management problems and the development of user interface and system sketch components of the Automated Requirements Systems (ARS).

4. (U) FY 1983 Planned Program: In the area of Life Cycle Management Tools, a highly efficient intelligent user interface for the ARS will be developed. State-of-the-art methods and systems will be developed to determine the most

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promising approach for developing a designer interface which would, based on requirements, produce automatically a recommended system structure. The system structure will include a modular decomposition together with a description of all interfaces between modules. The ARS will be applied to an actual Army system to demonstrate the functional and performance sketching capabilities of the experimental requirements system. In the area of Software Product Standardization, AIRMICS will develop a software maintenance methodology, complete with tools and procedures, designed to reduce costs and expedite system changes and corrective actions. A verification and validation methodology, complete with tools and procedures, will insure that the produced software code correctly implements functional and performance requirements. In the area of System Design and Architecture, a Precise measurements of previously determined Army requirements will be implemented to provide the basis for integrating advanced system architecture into a total system design for an experimental model in a testbed environment. Technologies included will be distributed DBMS, network communications, distributed processing, and VLSI hardware. Optimization of the microprocessor network and its applicability for the network-adaptable executive operating system will be enhanced via simulation and analysis.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.27.A Title: Non-Systems Training Devices (NSTD) Technology
DOD Mission Area: #522 - Environmental & Life Sciences (ED) Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	2600	2808	3229	4295	Continuing	Not Applicable
A230	NSTD Technology	2600	2808	3229	4295	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program is the only Exploratory Development program that provides Non-System Training Devices with technical base support. Non-System Training Devices are developed to support general military training and training on more than one item/system, as compared with System Devices that are developed in support of a specific item/system. Modern weapons systems will be integrated into the force at an unprecedented rate in the 1980's. Arrival of this sophisticated, high-technology equipment will coincide with increased constraints on people, dollars, and time in a training environment where ammunition and costs continue to rise. Training devices and training simulation provide force multipliers that improve combat effectiveness and provide more realistic training at a lower total cost. The combat effectiveness of Army personnel is key to both compensating for the numerical superiority of opposing forces and for maintaining a ready force. This combat effectiveness can best be achieved by innovative, efficient, and results-oriented training. The major thrust in the development of new training devices is to develop equipment that allows a high transfer of knowledge and experience from the training situation to a combat situation. The Army must train as it is to fight. Improved training devices, now potentially available through modern technology, must continue to be developed in order to provide the training required to win in any conflict.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Requested funds will continue ongoing developmental effort and initiate exploratory development on new, promising concepts that will ultimately transition into Advanced or Engineering Development. Specific thrusts will (1) provide for continuing development of techniques for improving the effectiveness of engagement simulation exercise; (2) develop and evaluate Computer Generated Imagery (CGI) techniques appropriate for Army usage; (3) continue to improve the effectiveness of maintenance training and to explore the more effective use of realtime feedback in maintenance trainers; (4) develop and evaluate High Detail Daylight Display for Nap-of-the-Earth flight training; (5) initiate efforts on a comprehensive Area Weapons Effects Simulation program to complement the Multiple Integrated Laser Engagement System (MILES); (6) initiate a Rich Scene Visual Presentation (RSVP) effort to complement Nap-of-the-Earth task training. A program

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designed to develop simulator software maintenance guidelines will begin in FY 1982. Developmental costs reflect a valid and realistic assessment of the dollar costs necessary to continue this much-needed exploratory development effort.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	2600	2808	3229	Continuing	Not Applicable
Funds (as shown in FY 1981 submission	2955	3457	4014	Continuing	Not Applicable

Reduction in FY 1980 funding resulted from reprograming of funds into higher priority Army programs. Decrease in FY 1981 funding reflects the application of general Congressional reductions. The reduction in FY 1982 funding resulted from a redefinition of the program requirements.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.27.A Title: Non-Systems Training Devices (NSTD) Technology
DOD Mission Area: #522 - Environmental & Life Sciences (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This continuing program provides for the Exploratory Development of training devices which are developed to support general military training and training on more than one item/system. The effort under this program is directed towards providing a technology base in support of Army training device development. The cost of training with operational equipment, the lack of available training areas, and the need for high levels of proficiency to achieve full combat effectiveness require continuing examination of approaches to simulation and training devices. This program provides the necessary "front-end" analytical effort required to smoothly transition developments into Advanced Development and Engineering Development. The program is structured into five technology areas as follows:

(1) (U) Engagement Simulation: To develop technologies to support training associated with the conduct of large-scale, two-sided combined arms field exercises in typical modern battlefield environments.

(2) (U) Maintenance Simulation: To develop technologies for reducing dependency on the use of operational equipment for maintenance training.

(3) (U) Visual Simulation: To develop technologies associated with visual presentation of information, nonprogramed real-world scenes and simulated imagery.

(4) (U) Simulated Environment Applications: To develop and evaluate alternative approaches to simulating the operator, crew, and team training. To develop means of quantitatively measuring the effectiveness of training systems.

(5) (U) Electronic Simulation: To develop technologies for applications of electronic techniques associated with computer, communications, automatic control, and sensors to support and to pioneer training approaches.

G. (U) RELATED ACTIVITIES: To avoid duplication of effort, close coordination is maintained with other services through Training and Personnel Technology Conferences, Topical Reviews, Joint Service Technical Coordinating Group - Simulators and Training Devices, worldwide staffing of Training Device Requirements, and the collocation of the Office of the Army Project Manager for Training Devices (PM TRADE) and the Naval Training Equipment Center (NTEC). The technology/devices developed within this Program normally progress to Non-Systems Training Devices (NSTD) Advanced Development (PE 6.37.38.A) and/or NSTD Engineering Development (PE 6.47.15.A).

H. (U) WORK PERFORMED BY: In-house development is performed by the Project Manager for Training Devices, Orlando, FL; Naval Training Equipment Center, Orlando, FL; United State Army Armament Command, Dover, NJ; and Letterman Army Institute of Research, Presidio, San Francisco, CA. Prime contractors include Grumman Aircraft, Long Island, NY; Seville Inc., Pensacola, FL; and Sanders Associates, Nashua, NH.

Program Element: #6.27.27.A Title: Non-Systems Training Devices (NSTD) Technology
DOD Mission Area: #522 - Environmental & Life Sciences (ED) Budget Activity: #1 - Technology Base

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: The preliminary Systems Engineering designs for four (4) Army Maintenance Training and Evaluation Simulation System (AMTESS) approaches were completed and two conceptual approaches were selected to enter the breadboard prototype phase. Two contracts were awarded to provide breadboard models for evaluation of training effectiveness by the air defense and ordnance schools in 1st Quarter FY 1982. Two Automatic Weapons Effects Simulator (AWESS) exploratory development prototypes were delivered for technical feasibility and training effectiveness evaluation by troop units. Feasibility was established, and the Automatic Weapons Effects Simulator (AWESS) program will transition into full-scale Engineering Development in 3rd Quarter FY 1981. Exploratory development and testing of the Squad Weapons Analytical Trainer (SWAT) and the Tank Appended Crew Evaluation Device (TACED) was completed. Due to excessive costs, the TACED project requirement was reevaluated and terminated. Collaborative efforts with the Air Force Human Resources Laboratory in the development and evaluation of a High Detail Daylight Display for Nap-of-the-Earth flight training were initiated. The Area of Interest (AOI) investigation continued with the effort directed toward the development of technical approaches for multiple viewpoint Computer Generated Imagery (CGI) displays.

2. (U) FY 1981 Program: The preliminary systems engineering design effort of the Army Maintenance Training and Evaluation Simulation System (AMTESS) concept will conclude with the delivery of breadboard models for test and evaluation by the proponent schools. Training effectiveness analysis of the AMTESS breadboards will be conducted 1st and 2nd Quarters of FY 1981. The results of this testing will provide the technical and operational base for the generation of requirements documents and follow-on Engineering Development. The Computer Generated Imagery (CGI) effort will continue with the development of demonstratable models that adequately portray visual scenes to the level necessary for effective utilization in visual simulators. The Area of Interest (AOI) effort within the Computer Generated Imagery program will provide a model which offers a potential means to provide the high detail needed for Nap-of-the-Earth flight training at low cost. Current Computer Generated Imagery training systems cannot meet target identification requirements at far ranges and are limited in that they are often unable to process enough information to meet requirements for high-detail targets or background scenes. The High Detail Daylight Display effort will attempt to resolve these limitations for selected portions of the viewing field. Its cooperative effort with the Air Force Human Resources Laboratory will continue with emphasis on the utilization of novel techniques to provide areas of high detail. A comprehensive Area Weapons Effects Simulation will be initiated that is designed to investigate low-cost, technically feasible weapons signature effects for mine, mortar, nuclear, biological, and chemical (NBC), and cannon artillery systems. The resulting simulators will be interoperable with the Multiple Integrated Laser Engagement System (MILES). Programs are planned for the development and evaluation of feasible concepts for the simulation of the dirty battlefield effects for use in Engagement Simulation Exercises. A preliminary engineering design effort will be initiated to conceptually develop alternative approaches for characterization of thermal targets. A sensor simulation pro-

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gram will be initiated to develop techniques for portraying the characteristics of such sensors as Far Looking Infrared (FLIR), Target Acquisition Data System (TADS), and Pilot Night Visual System (PNVS). This effort will provide the base for development of simulators for training in surveillance and target acquisition. An effort to quantitatively measure the thermal images and infrared signature of threat armor weapons will be initiated. A Rich Scene Visual Presentation (RSVP) effort to experimentally determine the level of complexity required to train for Nap-of-the-Earth tasks will be initiated.

3. (U) FY 1982 Planned Program: Emphasis will be directed toward the development of technically feasible approaches for the cost-effective simulation of operational equipment for both operator and maintenance training at the unit level. Programs will be initiated to develop creditable methodology for use in predicting the fidelity, costs, and training effectiveness of conceptual training systems. Continued emphasis will be given to cooperative efforts with the Air Force, Navy, and Army Research Institute, in the development of exploratory development programs that will enhance and reinforce both individual and team training. The Area Weapons Effects Simulation effort will continue with the selection of one or more design concepts for breadboard fabrication and testing. The Army Maintenance Training and Evaluation Simulation System (AMTESS) will be carried to logical conclusion with publication of final reports and preparation of the training device requirements document for entry into Engineering Development (ED). Area of Interest (AOI) and High Detail Daylight Display efforts will continue in support of Computer Generated Imagery technology. A Computer Generated Imagery (CGI) cost data base will be published which will enhance assessment of user CGI requirements and allowable trade-offs to measure and reduce developmental costs. The thermal targets and infrared signatures for threat armor weapons effort will continue with initiation of breadboard models for fabrication. The sensor simulation program will continue. An effort will be initiated to develop guidelines for maintenance of simulator/device operational software. The savings from an effective set of software maintenance procedures would be significant and would provide a framework from which software changes could be made and documented. A study will be initiated to critically examine the high cost growth of the Synthetic Flight Training System and to determine which training skills can be accomplished by development of lower cost part task trainers. Personnel involved in this program include (9) nine professional and (2) two support personnel from the office of the Project Manager for Training Devices (PM TRADE).

4. (U) FY 1983 Planned Program: The Area Weapons Effects Simulation effort will continue. Simulators for mortars, artillery, and mines will be evaluated for application to engagement simulation. The maintenance of simulator/device operational software effort will be completed with the publication of an effective set of software maintenance procedures. The sensor simulation techniques developed in prior years will be systemized to meet the training requirements of the AH-64, Target Acquisition Data System (TADS), and Pilot Night Visual System (PNVS). Cooperative effort with the Navy and Air Force in Computer Generated Imagery will continue. Generic requirements documents for maintenance trainers will be fabricated using the Army Maintenance Training and Evaluation Simulation System (AMTESS) as an example. Preliminary engineering design

Program Element: #6.27.27.A Title: Non-Systems Training Devices (NSTD) Technology
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for selected high-payoff task trainers will be fabricated for subsequent testing at the United States Aviation Center and School. Emphasis will be placed on the development and application of simulation technology to improve training effectiveness at reduced cost.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.30.A
Title: Cold Regions Engineering Technology
DOD Mission Area: #523 - Engineering Technology (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	3895	4262	5651	6797	Continuing	Not Applicable
AT42-A	Combat Operations Support	753	954	1500	1600	Continuing	Not Applicable
AT42-B	Combat Development Support	1823	1922	2500	2697	Continuing	Not Applicable
AT42-C	Cold Regions Maintenance/ Operations of Facilities	415	546	651	1100	Continuing	Not Applicable
AT42-D	Cold Regions Design and Construction	905	840	1000	1400	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The objectives of this program are: (1) to insure that the Army combat operational capability is maintained in both winter conditions commonly encountered in a temperate zone and in an extreme cold environment; (2) to develop methods for identifying, characterizing, and evaluating how terrain, climate, and adverse environmental aspects constrain the design and performance of Army materiel; and (3) to develop cost effective techniques and engineering criteria for the construction, maintenance, and operation of permanent Army facilities in areas where cold weather presents a problem. The FY 1982 request supports development of: employment concepts and doctrine by the Army Engineer Center and School, the Combat Development Center for operational troop units, the Department of the Army Materiel Development and Readiness Command (DARCOM), and the construction, operation, and maintenance of military facilities in cold climates.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: The requirement provides a winter combat capability to insure that US forces are at least on an equal basis with forces of Eastern European countries. The requirement to support DARCOM is concerned with the design of weapons and equipment employed in winter warfare and under other adverse conditions. Priority research areas include the problem of ice build-up on rotors of combat helicopters, and other military equipment and insuring that weapon targeting systems remain effective in snow, blowing snow, and winter fog. The third objective will provide a marked reduction in the costs to operate and maintain military facilities in cold regions (northers US, Alaska, Korea, Europe). Operation and maintenance costs at Army facilities in cold climates currently average $33 million above comparable costs for

Program Element: #6.27.30.A Title: Cold Regions Engineering Technology
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temperate zone facilities, plus an estimated $50 million annually in construction to replace prematurely failed roofs, pavements, etc. Much of this "add-on" cost can be avoided by results derived from research.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	3895	4262	5651	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	3620	4601	4676	Continuing	Not Applicable

The major significant changes in funding are the decrease of $339 thousand in FY 1981 and the increase of $975 thousand in FY 1982. The decrease in FY 1981 is attributable to the application of general Congressional reductions and reductions for increased efficiency. The increase in FY 1982 is required for significant increases with level of effort in battlefield obscuration. Battlefield obscuration involves extensive field research experiments, involving DOD, Army, Navy, and Air Force participation, to determine the impact of winter battlefield conditions on electro-optical and targeting weapon systems.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.27.30.A Title: Cold Regions Engineering Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The US Army Cold Regions Research and Engineering Laboratory (USACRREL) provides centralized management for this project. Along with USACRREL, research is conducted by the US Army Engineer Waterways Experiment Station (WES) and the US Army Engineer Topographic Laboratories (ETL). Research is conducted in four areas to: (1) provide US forces with a winter combat capability so that winter conditions can be used to advantage rather than becoming a crippling disadvantage; (2) overcome environmental constraints on materiel and provide equipment that works as intended in a cold battlefield environment; (3) maintain and operate Army facilities in northern areas where winter conditions require different methods and techniques; and (4) Develop new techniques to rehabilitate existing northern Army facilities to reduce the high energy and maintenance cost penalty attributable to winter conditions. These tasks require a coordinated research approach to solve the problems that cold weather causes on Army facilities, materiel, and operations. This program represents the only Army research investment in these kinds of problems.

G. (U) RELATED ACTIVITIES: Related programs include the Civil Works Research and Investigation programs on cold regions hydrology and ice engineering. Program Element 6.11.02.A, Defense Research Sciences, AT41, Military Facilities Engineering Technology; Project A896, Environmental Quality for Military Facilities; and Program Element 6.21.11.a, Atmospheric Investigations. There is no duplication of effort within the Army programs. Coordination is maintained using reports, interlaboratory meetings and meetings of the Joint Services Civil Engineering Research Development Coordinating Group.

H. (U) WORK PERFORMED BY: Approximately 67 percent of work is performed in-house by the US Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire. USACRREL serves as the managing laboratory for this project, and is the primary performing activity. The remaining portions of the work are performed at the US Engineer Topographic Laboratories at Fort Belvoir, Virginia; the US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi; the US Army Facility Engineer Support Agency, Fort Belvoir, Virginia; and US Army Engineer District, Alaska, North Pacific Division; North Central Division; Missouri River Division; and North Atlantic Division. The performing agencies also contract for research support; contractors include the University of Alaska, College, Alaska, Colorado State University, Fort Collins, Colorado.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Reports on ballistic attenuation in snow and fragment penetration in frozen soil have been completed. Techniques for construction of snow fortifications have been developed and data distributed to the user for incorporation into manuals; they provide superior protection in shorter time than either standard US methods or current Soviet techniques. A troop test was conducted with the 172d Brigade in Alaska to demonstrate the effectiveness of snow fortifications against Soviet weapons. A new technique for the design of mortar baseplate has been developed resulting in an improved lightweight 81mm mortar baseplate of superior performance; a series of 10 environmental handbooks has been issued

Program Element: #6.27.30.A Title: Cold Regions Engineering Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

for design and testing in cold weather environments by DARCOM. Performance data have been assembled to evaluate and improve the design of intrusion sensors in cold regions. Environmental data are being tabulated so that designers of major weapons can assess the risk versus cost designing to specific performance levels in any environment. Methods are being developed for detection systems to describe the interaction between electromagnetic radiation and natural terrain materials in support of battlefield obscuration research, including cold regions. Research feedback was obtained from JACK FROST and REFORGER exercises. Laboratory tests and field trails were conducted on foundations, quick curing of low temperature concrete, utility distribution systems and pavements. This research was translated into construction criteria with the issuance of Technical Manual (TM) 5-842-4, "Arctic and Subarctic Construction, Foundations for Structures," TM 5-852-7, "Subsurface Drainage Design for Airfields and Heliports in Arctic and Subarctic Regions," TM 5-818-1, Chapter 18, "Design of Foundations in Areas of Significant Frost-Penetration" and "Cold Climates Utilities Delivery Systems." Resistivity surveys made in Alaska demonstrated the use of the technology to locate permafrost, locate underground water sources, identify soil type and bedrock, with particular emphasis on grounding and cathodic protection potential. A methodology using infrared equipment to detect moisture contaminated insulation in roofs was developed. In FY 1980, USACRREL developed the technical plan for the winter battlefield obscuration research. This is basically laboratory research interspersed with several major field tests. This work addresses the degradation of electro-optical weapon systems in an obscured visibility environment; e.g., falling snow, fog, and ice. A system was developed to eliminate the ice fog signature of field generators. A simulator was developed which permitted laboratory study of the attenuation effect of falling snow in the performance of antipersonnel mines. A calibrated vapor barrier test facility was completed for large-scale wall testing. This device can help identify the moisture in insulation material and ways to save heat loss. Completed draft guide specifications for protected membrane roof and a monograph on snow roads and seaways.

2. (U) FY 1981 Program: The first in the series of winter battlefield obscuration field experiments (SNOW-ONE) will be conducted during January-March 1981 in northern Vermont. At least 16 major Department of Defense organizations will participate to test some of the most sophisticated electro-optical equipment under winter conditions. The goal of the test is to develop an environmental data base to characterize the winter equipment against which future equipment may be tested. Emphasis in the program will be given to improving the moisture resistance criteria for military facilities to reduce the Operations and Maintenance costs in cold regions. Complete a long-range program resulting from the FY 1980 baseline study that addressed those aspects of military facilities operation and maintenance in cold regions that offer the greatest opportunity for savings achievable through research. Emphasis will be given to those areas showing immediate promise for transfer to Army using agencies. Other combat engineer-oriented studies will concentrate on the development of techniques for bridging frozen rivers and the problem with stabilizing riverbanks, techniques for the rapid repair of airfields during the periods of low temperature, the performance of mines and countermines in snow, ice, and frozen soil, and the performance of ground vehicles operating in thawing soils. Equipment to eliminate ice fog signatures of mobile and fixed field equipment will be tested.

Program Element: #6.27.30.A Title: Cold Regions Engineering Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

3. (U) FY 1982 Planned Program: The FY 1982 program will continue to emphasize the characterization of the winter battlefield environment, both natural and manmade. SNOW-TWO will be conducted using results and experience from SNOW-ONE, as well as the sophisticated instrumentation and techniques needed to provide the data and information required by approximately 16 Army, Air Force, and Navy weapon systems users participating in this field research experiment. Users are provided realistic winter battlefield data/information required to determine the extent of the impact of this environment on each specific weapon systems. These data/information are needed in the design and development of weapon systems, war games, and scenarios, systems operations, and training of troops. The program also will address the baseline study results on pavements, roofs, and utilities. Changing DOD requirements addressing the emergence of the Far North as an economic and strategic area of importance will require emphasis on research directed to meet these needs. The emphasis on problems of winter battlefields will remain very strong with continuation of river-ice bridging, mobility in thawing soil and the employment and deployment of mines in snow and in frozen ground. A study will be initiated to develop techniques for the conduct of subsurface exploration for the emplacement of weapon systems. Personnel supported with requested FY 1982 funds: professional 60, support 65.

4. (U) FY 1983 Planned Program: The primary thrust of the FY 1983 program will continue to be on combat engineering and battlefield obscuration. The series of obscuration field experiments continues into FY 1983 with natural obscurants; e.g., cold fog and ice fog, etc., being introduced into the studies. There will be an increased emphasis on the performance and detection of mines in winter environments. This research will be necessary for their successful development of a new family of mines. The Frost Effects Research Facility completed in FY 1982 should be operational and will provide a facility for the conduct of accelerated pavement, utility, and foundations research. Research in facilities engineering will continue based on the results of the baseline study. Technology will be developed to meet construction and maintenance demands of rapid deployment scenarios during cold regions/winters.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.31.A
Title: Military Facilities Engineering Technology
DOD Mission Area: #523 - Engineering Technology (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	2966	3735	3502	4200	Continuing	Not Applicable
AT41	Military Facilities Engineering Technology	2966	3735	3502	4200	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides the systems and techniques to obtain high-quality facilities for the Army in garrison required for the readiness mission. The program is essential to support the planning, design, construction, operation and maintenance of Army facilities worldwide. The thrust is to provide the technology to increase productivity and quality, at reduced cost, in the planning, design, contruction, and maintenance of Army facilities in temperate and tropical climates. The objectives are to provide technology in the form of software, design concepts and techniques, quality assessment and evaluation, resource allocation and control and the introduction of new systems and materials to support the real property maintenance and acquisition mission of the Army, to evaluate facilities construction in terms of life cycle costs, and reduce the logistics and skill levels necessary for troop construction in a theater of operations.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Requirements for this program are generated by the US Army Corps of Engineers Divisions and Districts, Major Command and Installation Facilities Engineers, and the US Army Engineer School. Funds are required for continuing development of products and systems to increase the productivity in all phases of the military construction process. Systems under development include methods for cost effective master planning, design procedures for rapidly evaluating alternative designs and building systems, nondestructive testing techniques for construction quality control, resource management and allocation systems for facilities engineers, new roofing systems and materials and methods to reduce or eliminate corrosion on military installations. System development costs have been analyzed with respect to the priority of the requirement for the system, the availability of personnel resources to accomplish the research within a prescribed timeframe and the expected cost savings when the system is in use. Specific products in FY82 are: a system for constructing life cycle cost data base and a unit to measure the quality of welds as they are being made.

Program Element: #6.27.31.A
DOD Mission Area: #523 - Engineering Technology (ED)
Title: Military Facilities Engineering Technology
Budget Activity: #1 - Technology Base

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	Additional To Completion	Total Estimated Costs
RDTE					
Funds (current requirements)	2966	3735	3502	Continuing	Not Applicable
Funds (as shown in FY 1981 submissions)	2991	4236	4288	Continuing	Not Applicable

The $25 thousand reduction in the FY 1980 funding from the FY 1981 submissions was made to support other high-priority demands in Program Element 6.27.30.A, Cold Regions Engineering Technology. The FY81 reduction is attributable to the application of general Congressional reductions and adjustments to account for a revised inflation index and projected economics in travel. A The 488 thousand reduction in FY82 was the result of increased funding required to support energy technology for military facilities and increased emphasis in characterizing the winter environmental impact on battlefield obscuration. The FY82 program was reduced $252 thousand in response to OSD direction for improved efficiency.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.31.A Title: Military Facilities Engineering Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The objectives of this program are to: (1) increase the productivity of Army resources required to master plan, design, construct, operate, and maintain permanent installations; (2) minimize the life-cycle costs of Army facilities; and (3) develop facility designs requiring less time and lower skill levels for troop construction of base facilities in a theater of operations. The research is directed to four major thrust areas: (1) systems to improve productivity and quality of military construction at minimun cost; (2) systems to maximize the effectiveness of resource allocation to operate, maintain, and repair existing facilities; (3) alternatives to high-cost construction materials, complex construction systems, current ineffective construction quality control methods and repair and maintenance techniques used in facility operations; and (4) materials and construction techniques for rapid base camp construction in a theater of operations.

G. (U) RELATED ACTIVITIES: This project is coordinated Service-wide through the Joint Service Civil Engineering Research and Advisory Group. Coordination with intergovernmental agencies is accomplished through the Joint Services Building Materials Program with the National Bureau of Standards, Modular Integrated Utility Systems with the Department of Housing and Urban Development, and participation in the National Academy of Sciences Building Research Advisory Board. Related Programs include: Program Element 6.11.02.A, Defense Research Sciences, Project AT23, Structural Systems, US Army Engineer Construction Engineering Research Laboratory, Champaign, IL; Program Element 6.27.19.A, Engineering Technology (ED), Project AT40, Mobility and Weapons Effects, US Army Engineer Waterways Experiment Station, Vicksburg, MS; Program Element 6.27.20.A, Environmental and Life Sciences (ED), Project A896, Environmental Quality Technology, US Army Engineer Construction Engineering Research Laboratory, Champaign, IL; and Program Element 6.27.81.A, Engineering Technology (ED), Project AT45, Military Energy Technology, US Army Construction Engineering Research Laboratory, Champaign, IL.

H. (U) WORK PERFORMED BY: 65 percent of project funds are used for in-house effort at the US Army Engineer Construction Engineering Research Laboratory. Primary contractors are the University of Illinois, Urbana, IL; the University of Michigan, Ann Arbor, MI; and Carnegie Melon Institute, Pittsburgh, PA.

I. (U) PROGRAM ACCOMPLISHMENT AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Improvements to the military facilities planning, design, and construction process included: (1) successful laboratory demonstration of the Computer-Aided Engineering and Architectural Design System incorporating the project description form, the architectural criteria review, and energy analysis; (2) quality control specifications for constructing built-up roof systems; (3) successful prototype tests on the Computer-Based Specification System and transfer of the system to the Corps of Engineers Huntsville Division for operation and maintenance; (4) methods to evaluate water distribution and sanitary sewer system capacities to adequately carry increased loads because of planned new construc-

Program Element: #6.27.31.A Title: Military Facilities Engineering Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

tion; (5) refined accuracy on water and cement content for predicting strength of concrete while it is in the plastic state; (6) construction of single-ply and polyurethane foamed-in-place roofs for evaluating improved roof systems, and (7) design data and site layouts for material storage facilities in Europe. Accomplishments to increase productivity in the operation and maintenance of military facilities include: (1) a master plan for automated data processing systems to serve the facility engineers, and (2) improvements in maintenance of overhead electrical distribution systems. Accomplishments in materials and construction techniques for the theater of operations includes: (1) identification of field-foamable polyurethanes for construction of protective structures; (2) four pilot programs on use of handheld calculators by engineer troop units; (3) a model for analyzing engineer troop unit functions in a battlefield environment; and (4) procedures for field welding of aluminun alloys.

2. (U) FY 1981 Program: The projected accomplishments for improving the military construction process include: (1) procedures for evaluating and selecting industrialized building systems for military construction; (2) operational test on the initial version of the Computer-Aided Engineering and Architectural Design System; (3) full-scale testing of the system for verifying that architectural designs comply with criteria; (4) final design for the life cycle costs data base; (5) selection guide on nondestructive testing techniques for construction quality control; and (6) a digital readout weld quality monitor for automatic welding. New starts in FY81 include: (1) methodology for reducing building design costs through standard designs; (2) planning and design guide for training ranges; (3) criteria for use of plastic materials in military construction. Planned accomplishments to improve operation and maintenance of military facilities include: (1) family housing operation managment system methodology, (2) preliminary model for predicting pavement performance; and (3) a field test kit to determine if paints meet specification requirements. New starts include: (1) evaluating magnetic and electromagnetic devices for removing scale from boilers, chillers, and condensors and (2) a system to minimize corrosion on military installations. Scheduled accomplishments for theater of operations construction include: (1) foam material and ballistic blanket composite construction technology, (2) model for simulation of engineer contribution on the battlefield, and (3) selection of building systems for lightweight structures to be a part of the Army Facilities Component System (AFCS). New starts include: (1) concepts for foam plastic bridging and rafting systems and (2) foam applications to heavy bridging and rafting.

3. (U) FY 1982 Planned Program: Scheduled accomplishments to improve the military construction process include: (1) concept design cost estimating module incorporated into the Computer-Aided Engineering and Architectural Design System; (2) final data base design and data collection procedures for life cycle cost data base, (3) improved roofing systems based on results of evaluation of ethylene propylene diene monomer and polyurethane foamed-in-place test roofs, (4) requirements and criteria for training ranges where new weapons syatems are employed, (5) design guides to increase the resistance of material storage facilities to chemical and biological agents, (6) prototype optoelectronic speed measurement system for the semiautomatic and manual weld quality monitor, and (7) space management criteria for determining adequacy of facilities to meet

Program Element: #6.27.31.A
DOD Mission Area: #523 - Engineering Technology (ED)

Title: Military Facilities Engineering Technology
Budget Activity: #1 - Technology Base

their mission and function. For increased productivity in operations and maintenance, planned accomplishments include: (1) evaluation tests of the family housing operation management system methodology, (2) first-generation consequence system for evaluating pavement maintenance and repair versus new pavement, and (3) test and evaluate prototype field test kit for paints. Scheduled accomplishment for theater of operations construction include: (1) development of a prototype command and control center using field-formable foams as structural support for a ballistic blanket, (2) test specifications and concept plans for flotation bridging and rafting, and (3) performance specifications for relocatable, lightweight building systems for the theater of operations. Anticipated personnel assignments to this project would be: professional-45, support-20.

4. (U) FY 1983 Planned Program: Research products addressing improvements to the military construction process include: (1) installation of initial operating Computer-Aided Engineering and Architectural Design System at a Corps of Engineers District Office; (2) facility standards for multipurpose training ranges; (3) procedures to identify industrialized building system application to military construction; (4) evaluate polyvinyl chloride single-ply roof as a roofing system alternative; (5) time-lapse videotape, optoelectronic and infrared procedures for quality assurance in construction; selected plastic materials for use in military construction. Planned accomplishements to improve operations and maintenance technology include: (1) functional specifications for the family housing operation management system, (2) prototype test the computer-sided management system concept for the facility engineer, and (3) performance requirements for the off-the-shelf paints used in maintenance and repair. Theater of operations construction scheduled accomplishments include: (1) integration of infrared camouflage into foam support for command and control center ballistic blanket, (2) foam overhead protective cover for storage of artillery ammunition at the gun-site, and (3) feasibility and need for indigenous materials information for theater of operations construction.

5. (U) Program to Completion: Improvements to military construction process: (1) fully integrated Computer-Aided Engineering and Architectural Design System, FY90; (2) habitability design information for more mission-responsive facilities, FY86; (3) seismic strengthening economic investment systems for military facilities, FY86; (4) streamlined procedures for contract modification processing, FY85; and (5) design criteria for use of polymer concrete in military construction, FY90. Increased productivity in operations and maintenance: (1) Computer-Aided Management System for the facility engineer, FY85; (2) operational pavement maintenance and repair consequence system, FY84; (3) corrosion control and mitigation system, FY86; and (4) protective coatings that comply with regulatory requirements, FY86. Theater of Operational construction: (1) foam material applications to heavy bridging and rafting, FY86; (2) foam impact cushions for air-dropped materiel, FY85; and (3) operating model for engineer operations in wargaming, engineer training, and engineer planning in the theater of operations, FY86.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.32.A
DOD Mission Area: #521 - Electronic and Physical Sciences (ED)

Title: Remotely Piloted Vehicles (RPV) Supporting Technology
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	2500	1745	2890	3000	Continuing	Not Applicable
AF34	Remotely Piloted Vehicle Supporting Technology	2500	1745	2890	3000	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The objective of this program is to develop technological capabilities in those areas which currently limit the operational potential of small RPV's for Army missions of Target Acquisition, Designation and Aerial Reconnaissance (TADAR), and for future missions. RPV's are required to extend the eyes of the Brigade and Division commanders to the range of their artillery, increase the effectiveness of their direct support firepower, and provide laser designation for laser-guided weapons. Growth capabilities, cited in the requirements document for the TADAR mission, needing further development include extended range and multiple control operations. This project will define and develop those capabilities. Other activities include development of night and all-weather sensors, automatic cuers and intelligent bandwidth compression devices, survivability/vulnerability analysis, and study of future missions; e.g., relay, electronic support measures, and radiac survey. These exploratory development efforts will enhance the mission effectiveness of small RPV's, improve system reliability, and reduce life-cycle costs, wherever possible.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Funds requested provide for fabrication of up to two prototype Wideband Adaptive Ground Antenna systems (WAGAS) permitting multimission operations for mini-RPV's, miniaturization of key components for a millimeter radar, completion of a focal plane array FLIR, mission effectiveness/survivability enhancement simulation, and initiation of development of intelligent autotrackers and bandwidth compression techniques.

Program Element: #6.27.32.A
DOD Mission Area: #521 - Electronic and Physical Sciences (ED)

Title: Remotely Piloted Vehicles (RPV) Supporting Technology
Budget Activity: #1 - Technology Base

Major Milestones	Current Milestone Dates	Milestone Dates Shown in FY 1981 Submission
Begin Fabrication of Wideband Adaptive Ground Antenna Systems (WAGAS)	February 1981	Not Shown
Start of miniaturization of millimeter radar components	October 1980	October 1980
Begin fabrication of focal plane array FLIR	December 1980	December 1980
Complete fabrication of FLIR	April 1982	Not shown
Begin development of intelligent autotrackers and bandwidth schemes	November 1981	November 1980
Begin Mission Effectiveness/ Survivability Enhancement Program MESE	February 1981	Not shown

Development of intelligent autotrackers and bandwidth compression techniques is deferred one year due to reprograming funds to higher priority Army needs. Miniaturization of ATC/IFF devices shown in the FY81 CDS has been defferred because study results show that current air traffic control procedures will suffice.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	2500	1745	2890	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	2744	2813	2976	Continuing	Not Applicable

Program Element: #6.27.32.A
DOD Mission Area: #521 - Electronic and Physical Sciences (ED)

Title: Remotely Piloted Vehicles (RPV) Supporting Technology
Budget Activity: #1 - Technology Base

Due to higher priority Army requirements, funding was reprogrammed in FY80, 81, and 82 in the amounts of $244 , $1068 , and $86 .

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.32.A
DOD Mission Area: #521 - Electronic and Physical Sciences (ED)

Title: Remotely Piloted Vehicles (RPV) Supporting Technology
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The objective of the Army RPV program is to field mini-RPV systems which have high reliability and which are cost-effective for selected missions. The first priority Army mission is Target Acquisition, Designation, and Aerial Reconnaissance (TADAR). The first-generation system will provide day mission capabilities via a fixed-wing mini-RPV under command from a Ground Control Station (GCS). The Engineering Development (ED) contract for TADAR was awarded in August 1979 and the ED contract for the GFE data link (Modular Integrated Communications and Navigation System--MICNS) was awarded in May 1979. The Engineering Development Programs are structured to accommodate growth, most notably a night mission capability Forward Looking Infrared (FLIR), multiple control and other modular payloads. Alternate missions are being considered, including electronic warfare (both communication and noncommunication jamming), relay, decoy, and radiac survey. This exploratory development program addresses the growth capabilities for the TADAR mission, as well as the future mission configurations. Analysis, simulation, and limited testing are conducted so that subsystems/payloads essential to the complete RPV system can be selected and optimized. Five areas of investigation are being pursued: Air mobility (survivability, propulsion, and launch/recovery), radar (millimeter), missions, command and control (multiple control, extended range, and out of line-of-sight), and electro-optics (low-cost FLIR's, lasers, and autotrackers).

G. (U) RELATED ACTIVITIES: Within the Army, Advanced Development is conducted under Program Element (PE) 6.37.25.A, Remotely Piloted Vehicles (RPV)/Drones, and Engineering Development of the first generation RPV is being conducted under PE 6.47.30.A, Remotely Piloted Vehicles. The Air Force RPV programs consisting of PE 6.37.39.F, Advanced RPV's, and PE 6.47.46.F, Expendable Drones, are being monitored. The Army and Air Force RPV program managers meet periodically to assure cooperation between the services. A Memorandum of Understanding (MOU) with the United Kingdom was initiated in FY 1979, and opportunities are being examined for interoperability between the two nations.

H. (U) WORK PERFORMED BY: The Research and Technology Laboratories, Headquarters, Moffett Field, CA; and the Applied Technology Laboratory, Fort Eustis, VA; US Army Electronics Research and Development Command, Fort Monmouth, NJ; Night Vision and Electro-Optics Laboratory, Fort Belvoir, VA; US Army Avionics Research and Development Activity, Fort Monmouth, NJ; and the US Army Human Engineering Laboratory, Aberdeen Proving Ground, MD. Contractors participating are: Norden, Norwalk, CT; Systems Planning Corporation, Washington, DC; Developmental Sciences, Inc., City of Industry, CA; RCA, Burlington, MA; and Calspan, Buffalo, NY.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: This was a new program in FY 1977 and the bulk of funding was directed toward the development, fabrication, and ground testing of an antijam data link, the Integrated Communication and Navigation System

Program Element: #6.27.32.A
DOD Mission Area: #521 - Electronic and Physical Sciences (ED)

Title: Remotely Piloted Vehicles (RPV) Supporting Technology
Budget Activity: #1 - Technology Base

(ICNS) built by the Harris Electronics Corporation. This system was subsequently integrated into two AQUILA RPV's and flight tested in FY 1978 at Fort Huachuca, AZ, under PE 6.37.25.A, Remotely Piloted Vehicle Drones. Two contracts were awarded to Teledyne Continental and to Bennett Aerotechnical in FY 1977 for the development of two-cylinder engines with nominal 20 hp output. Analyses by the Applied Technology Laboratory, Aviation Research and Development Command, of visual and radar signature of RPV's, as well as a study of manufacturing techniques for airframes, were completed in FY 1977. The Army Required Operational Capabilities (ROC) for the Target Acquisition, Designation, and Reconnaissance System (TADARS) stated that multicontrol was a growth consideration for the data link and that the night vision capability was a growth requirement for mission payloads. As such, in-house studies of multiple-control option within the Ground Control Station (GCS) and antenna configuration options were initiated in FY 1978. An in-house draft report of future mission opportunities for mini-RPV's was completed in FY 1979, and a contract study (cofunded with PE 6.37.25.A) was awarded to Systems Planning Corporation to better define multicontrol options. Two contracts were awarded in FY 1978 (Ford Aerospace and Honeywell) for the modification of a Honeywell POISE gimbal to include 8-12 micron FLIR's and ground testing. The sensor was subsequently modified to enhance recognition ranges. The contracts for engines (awarded in FY 1977) resulted in delivery of hardware to the Government in May/June 1978. Government performance and endurance testing of these engines plus engines from DH Enterprises was completed in FY 1979 and was cofunded with PE 6.37.25.A, Remotely Piolted Vehicles/Drones. Modifications were completed on a 95 Gigahertz millimeter surveillance radar to enable ground testing in FY 1979. Ground-based testing of the millimeter radar was performed at a contractor site and testing at a Government site and continued into FY 1980. Data has been collected on moving and stationary military targets in clutter and, insofar as is possible, in adverse weather conditions. A prototype 2.06 micron eyesafe laser rangefinder program was funded and has demonstrated greater than 2 km range performance against noncooperative targets. Refinements of the eyesafe laser transmitter, detectors, and materials were undertaken in FY 1979. In FY79, in addition to the foregoing, automatic recovery investigations were conducted and a flight demonstration of one concept was demonstrated, an alternate pneumatic launcher was ground-tested, propellers optimized for performance were fabricated, and acoustic signature characteristics of propellers were statically and dynamically tested in an effort to reduce acoustic observables and thereby increase survivability. Also study was initiated with Calspan in FY 1979 to determine if mini-RPV's need to carry Air Traffic Control/Identification Friend or Foe (ATC/IFF) equipment to avoid midair collisions as well as to enhance coordination with friendly air defenses. In FY 1980 solicitations were initiated for the design of alternative antenna configurations (planar and horn) essential to the accomplishment of the multicontrol growth capabilities cited in the Required Operational Capability (ROC) and TADARS/MICNS contracts. Limited fabrication of selected antenna elements will be included in the contracts. Future mission options for mini-RPV's were further delineated in collaboration with the user. An Electromagnetic Compatibility and Analysis Center (ECAC) study was completed in FY 1980 to determine the validity and better define the extended range growth requirements cited in the ROC for the TADARS RPV application. The millimeter radar system completed tower evaluation and plans are underway for flight testing. In-house evaluation of open and ducted propeller designs as well as in-house survey of engines suitable for growth version of an RPV were conducted by Applied Technology Laboratory.

Program Element: #6.27.32.A
DOD Mission Area: #521 - Electronic and Physical Sciences (ED)

Title: Remotely Piloted Vehicles (RPV) Supporting Technology
Budget Activity: #1 - Technology Base

2. (U) FY 1981 Program: Key components essential to the miniaturization of the millimeter radar (target weight of 50 pounds) will be fabricated. Emphasis will be placed on developing small, lightweight, low-power-drain, and inexpensive components tailored to the requirements of the mini-RPV. In particular, the following will be developed over the FY 1981-83 period: A duplexer with solid-state devices for single antenna operation on transmit and receive, a radar signal processor and receiver that will permit the use of low-power solid-state sources, a modulator and source consistent with pulse compression techniques, and digital circuitry for implementation of the fixed target enhancement algorithm. Mission Effectiveness and Survivability Enhancement (MESE) analyses/simulations will quantify advantages of alternate mission payloads and multicontrol/multimission operations. Fabrication of the multicontrol antenna essential to multicontrol requirements stated in the TADARS/MICNS contracts and the ROC will begin in early FY 1982. The antenna configuration (planar array or horn) will be selected through review of the design studies in FY 1981. Major considerations in the selection of the multicontrol ground antenna include: definition of data link requirements for non-TADAR mission, determination of navigation/range requirements, mission definition, and sector coverage requirements. The impact of multicontrol/multimission on the ground control station operations will also be investigated through simulations. A contract will be awarded in FY 1981 for the design and development of a focal plane array FLIR suitable for use in a mini-RPV. This second-generation FLIR offers size and weight reductions while providing performance improvements.

3. (U) FY 1982 Planned Program: Fabrication of prototype Wideband Adaptive Ground Antenna System (WAGAS) permitting multimission operations for mini-RPV's at extended ranges will begin. Changes to the ground control station as needed for multicontrol operations will be determined through simulation. Simultaneous control of up to 8 RPV's through a single RPV section will then be feasible. The Mission Effectiveness and Survivability Enhancement (MESE) program will continue to quantify advantages of alternate and ancillary payloads in single as well as multiple control operation simulations. Miniaturization of key components essential to the adaptation of a millimeter radar to a mini-RPV will continue. Preliminary design of intelligent autotrackers and bandwidth compression techniques/devices suitable for use with small RPV's will begin. The resulting cuers will decompose imagery into descriptors and coordinates for bandwidth compression ratios that can be adjusted adaptively up to 10,000-to-1. Intelligent tracker concepts for predicting and anticipating target signatures under changing conditions will be assessed. Exploratory development of the focal plane array FLIR will be completed. Prototype hardware for autocuers and intelligent bandwidth compression techniques will be initiated. Ancillary investigations of propulsion, launch, recovery, and survivability equipment will be conducted as warranted by the emerging future uses of these mini-RPV's.

4. (U) FY 1983 Planned Program: Fabrication of WAGAS will be completed. The GCS and MESE Investigations will be concluded. Fabrication of a prototype millimeter surveillance radar for mini-RPV's will begin. A prototype intelligent autotracker/bandwidth compression device will be built. Investigations of propulsion, launch, recovery, VTOL RPV's, and survivability equipment will be conducted as warranted to support the future users of mini-RPV's.

Program Element: #6.27.32.A
DOD Mission Area: #521 - Electronic and Physical Sciences (ED)

Title: Remotely Piloted Vehicles (RPV) Supporting Technology
Budget Activity: #1 - Technology Base

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.33.A
Title: Mobility Equipment Technology
DOD Mission Area: #523 - Engineering Technology (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	12008	11242	11389	15899	Continuing	Not Applicable
AH20	Mobility Equipment Technology	12008	11242	11389	15889	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The work under this program is Exploratory Development in the areas of fuel (fossil and synthetic), lubricants, power transmission fluids and corrosion-preventive coatings; mine detection and neutralization; advanced tactical barriers and related concepts; camouflage; power generation; bridging; water and wastewater management; environmental control for vans and shelters; marine equipment; containerization, construction equipment; expedient surfacing and soil stabilization; and physical security. These efforts are required because of the unavailability of: field fortifications and obstacles that effectively provide the ability to economize forces, exhaust an attacking enemy and provide adequate gain in time to prepare for offensive action; antivehicular barriers that require reduced logistical and support burdens; controllable barrier systems that effectively impede enemy units but permit safe passage of friendly forces; tunnel detection methods to recognize acoustic activity associated with underground activities; physical security data acquisition and analysis system to prevent stealing, sabotage, and espionage; tactical sensors to provide remote target-locating capability; highly competent means of standoff detection of surface-laid mines; a family of mine neutralizers for use by air and ground vehicles and in a manpack mode; sufficiently strong, advanced, lightweight mobile bridging structures for Class 60 and Class 70 bridges; highly efficient camouflage techniques for thermal decoys that provide low emissivity in the dark; rapid means for soil stabilization and emplacement of expedient surfacing; means for provision of rapid logistics-over-the-shore operations; high-efficiency fuel cell catalysts and electrodes for silent power generation; economical and effective air conditioning capabilities for combat vehicles and shelters; means for providing low vulnerability fuels to help generate significant improvement in combat survivability; detailed understanding of effects of alternate/synthetic fuels on combat vehicle operations and performance; adequate guidelines for reliable use of extended-internal oils and lubricants and re-refined oils; and highly reliable hydraulic fluids with improved fire resistance, low-temperature operational properties, and potential for economic use.

Program Element: #6.27.33.A Title: Mobility Equipment Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

C. (U) BASIS FOR FY 1982 RDTE REQUEST: No major new starts will be initiated in this fiscal year. Work will be concentrated on continuation and completion of major ongoing tasks initiated in FY 1981 or prior years. The following programs will be continued: Investigation of improved air conditioning systems that provide chemical, biological, and radiological protection for armored combat vehicles; continued work on low-cost fuel cells, improved tactical electric power distribution, and new air conditioning concepts. Continue programs to improve close-in buried mine-field detection and stand off surface minefield detection, close-in neutralization of minefields, stand off neutralization of minefields by means of high energy explosives and remotely controlled vehicles and advanced barrier systems. Investigate military effectiveness and perform systems analysis of field fortifications. The new major thrust will be continued on high-strength, lightweight composites for mobile bridging. Continue development of improved methods for supply distribution, excavation, camouflage, explosive and minefield detection and neutralization. Develop and evaluate reverse osmosis technology for water purification with ability to remove trace turbidity and improved water detection methods for desert environments. Complete evaluation of coatings and adhesives for seamless water supply tanks. Continue tasks to develop and evaluate improved multipurpose antifreeze, high-performance engine oils, high-energy fuels, alternate/synthetic fuels including the validation of gasohol performance in Army equipment, and nonflammable hydraulic fluid for unique Army engines. Continue program to modify ground combat fuels to satisfy the urgent need for improved fire survivability.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	12008	11242	11389	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	9981	12188	16759	Continuing	Not Applicable

The increase of $2027 thousand in FY 1980 funding was required for efforts to validate the suitability of synthetic fuels for use by Army vehicles and equipment.

The funding level decrease of $946 thousand in FY1981 reflects the application of general Congressional reductions.

The funding estimate decrease of $5370 thousand in FY1982 reflects revised scope of program efforts based on Army budget formulation decisions to fund other higher priority Army technology base requirements.

Program Element: #6.27.33.A
DOD Mission Area: #523 - Engineering Technology (ED)

Title: Mobility Equipment Technology
Budget Activity: #1 - Technology Base

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.33.A
DOD Mission Area: #523 - Engineering Technology (ED)

Title: Mobility Equipment Technology
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This program covers those efforts directed toward overcoming obstacles to mobility vehicle and ground troops, irrespective of whether the obstacles are enemy created, naturally created, or are a result of our own logistics shortcomings. Concurrently, the program explores systems for the physical security of our forces and support activities for the use of new and advanced camouflage techniques and new barriers and intrusion detection devices. It covers Exploratory Development work to detect and neutralize minefields and 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 work to determine whether 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. At the same time, new formulations are tested to significantly decrease the fire hazard of fuels, lubricants, and hydraulic fluids used in our combat and tactical vehicles. It covers the Exploratory Development of high-energy fuels to increase vehicle range and engine efficiency, and the effort toward increasing availability of conventional, alternate, and synthetic fuels including the evaluation of gasohol performance in Army equipment. Finally, it covers water purification systems, containerized, bulk cargo and fuel-handling equipment, logistics watercraft, environmental control equipment, and rapidly emplaced construction materials to provide the support needed to sustain Army mobility and logistics in a hostile environment.

G. (U) RELATED ACTIVITIES: In the fuels and lubricants technical area, active liaison and coordination is maintained with other military departments, the Environmental Protection Agency, Federal Aviation Administration, and Department of Energy. The Countermine and Barrier technical area provides 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. The fuels and lubricants technical area provides direct support for the Advanced Development Program Element, 6.31.04.A, Fuels and Equipment. The engineer/logistics support technical area provides support for related Advanced and Engineering Program Elements: 6.37.02.A, Electric Power Sources; 6. 7.26.A., Combat Support Equipment; 6.47.14.A, Tactical Electric Power Sources; and 6.47.17.A, General Combat Support.

H. (U) WORK PERFORMED BY: In-house work is performed by United States (US) Army Mobility Equipment Research and Development Command, Fort Belvoir, VA; US Army Engineer Waterways Experiment Station, Vicksburg, MS; US Army Tank-Automotive Command, Warren, MI; US Army Materiel Systems Analysis Agency, Aberdeen Proving Ground, MD; US Army Aviation Research and Development Command, St. Louis, MO; US Army Ballistics Research Laboratory, Aberdeen Proving Ground, MD; Natick Research and Development Command, Natick, MA; Contractual Support is provided by ERIM, Ann Arbor, MI; Brunswick Corp., Deland, FL; Calspan, Buffalo, NY, ENSCO Inc., Springfield, VA; Colorado School of Mines, Golden, CO; Hughes Aircraft, Fullerton, CA; MTIO Corp., Lathamgto, NY; Creative Tech, Scottsdale, AZ; University of Pennsylvania, Philadelphia, PA; BDM, McLean, VA;

Program Element: #6.27.33.A Title: Mobility Equipment Technology
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

Southwest Research Institute, San Antonio, TX; SKF Indust., Philadelphia, PA. Contracts are planned amounting to $7.7 million.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Evaluated multidisciplinary approaches to long-range detection of remote minefields and determined that electronic sensing devices on a remotely piloted vehicle is the best methodology for continued development. Initiated development of mine-clearing plow for the countérobstacle vehicle. Investigated composite materials in the design of aluminum/graphite epoxy/aluminum sandwich bottom chord for greater strength and weight reduction in the new bridge systems. Completed concept investigation of a high-speed earth excavator and evaluation of truck/trailer-mounted hydraulic tree transplanting equipment for field fortifications. Completed and tested a computer program to generate pictures complete with scenes and military targets. Tested a 100 GigaHertz (GHz) radar cross-section measurement and diagnostic imaging system. Radar analysis has begun and cross-sections have been obtained of hotspots on the M113, M60, XM1, OH-6A, Helicopter, and ROLAND. A canopy system for thermal infrared has been successfully demonstrated with the current camouflage screen to defeat visual and near infrared. An advanced airfoil was tested on turbine generators to defeat thermal detection of hot exhaust gases. Design and development of the data acquisition and analysis system for physical security has been initiated. An acoustic/seismic classifier using a combination of time and frequency domain features processed by a low-power limited-storage microprocessor system has been developed to be used in tunnel detection systems. Completed selection/instrumentation of new test site for tunnel detection. Initiated design and fabrication of waste heat powered absorption air conditioner. Completed experimental prototype 15 kilowatt (kW) integrated power module power conditioner. A prototype power conditioner has been demonstrated with a breadboad microprocessor-based controller. Pulse power thin insulation with sufficient life and appropriate thermal and electric characteristics for experimental generators was developed. Completed laboratory and engine dynamometer and ballistic testing of fire-resistant fuels. Fleet tests using synthetic artic engine oil in M60 tank engines and transmissions reported easier starting, fewer replacement starters and batteries. Field test of antifreeze extender additive has been successfully completed. Ballistic and mist-flammability tests of candidate nonflammable hydraulic fluids and mixtures have been completed and final candidate selected. Assessed impact of using flush and fill procedure in a silicone brake fluid retrofit. Develop corrosion-inhibited turbine engine oil. Published final report for predicting chemical warfare threat to Army field water supply. Published final report on second-generation load stability sensor device. Initiated feasibility of air-cushion barge system for logistics-over-the shore mission.

2. (U) FY 1981 Program: Simulated remotely piloted vehicle-borne sensor data will be obtained, and human factor/image processing tasks identified for remote minefield detection. Demonstrate the feasibility of releasing or delivering an ex-

Program Element: #6.27.33.A Title: Mobility Equipment Technology
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plosive line charge upon a minefield from an airborne platform. A foreign track width and full width tank-mounted mine-clearing plow, an adapter for the Mark 1 Mine Clearing Roller, and a cleared lane marking and proofing system will be fabricated and exploited. Complete tests of bridge sections for the all-composite graphite/epoxy traversing beam, complete tests of friction bolt and connectors. Continue study of fatigue load indicators. Develop fighting position excavator and field fortifications. Continue studies of weapons protection, and fighting and nonfighting emplacements. Continue improved multispectral techniques of camouflage with emphasis on critical and sensitive designated items/systems. Design and procure data acquisition and analysis system for physical security. Demonstrate feasibility of a kit to suppress the thermal and acoustic signatures of the diesel engine-driven generator sets associated with critical battlefield units, such as Patriot and Pershing Command Posts. Improve signature data base for tactical sensors to include longer samples and improved consistency of samples and better coverage of sites and target types. Continue evaluating tunnel detection techniques. Design, fabricate and test integrated gas heat-exchanger refrigerant generator. Continue development of lightweight electric power distribution cables; assemble prototype high pulse power supply for directed energy weapons. Design militarized free piston stirling electric power generation unit. Determine feasibility of using air cushion vehicles for the over-the-beach delivery of bulk fuels. Continue evaluation of fire-resistant fuel components, synthetic fuels, lubricants, greases, and hydraulic fluids. Investigate membrane fouling and find alternate pretreatment techniques for field water-purification units. Complete component testing of long-life engine coolant system. Evaluate technology and operational requirements which impact on rapid deployment of containerized cargo into nondeveloped areas.

3. (U) FY 1982 Planned Program: Ground station support requirements will be identified and work on new sensors development continued for remote minefield detection. Conduct experiments to determine parameters involved in air-to-surface delivery of line charge for standoff minefield breaching. Complete testing of composite traversing beam for mobile bridges. Continue study of fatigue indicators for bridge elements. Study and design of bridge anchorage system for dry-gap support bridges. Define and quantify the operational mission and performance requirements for a multiboom/multitool excavation and construction robot concept for field fortification. Continue development of high-speed excavators. Begin command post shelter development. Investigate creation of tank obstacles using rapid excavation techniques. Complete investigation of infrared suppression of fuel cell-type generators. A prototype of a kit to suppress the noise and heat of diesel generator sets will be built and tested. Evaluate prototype data acquisition system. Continue investigation of water purification membrane rejection capabilities using Chemical Warfare (CW) simulants and establish correlation. Initiate field test of nonflammable hydraulic fluid for armored equipment. Continue testing of turbine engine/transmission fluid candidates. Initiate Army-wide adoption of multiviscosity-extended drain engine oils. Develop improved coolants for advanced high-performance diesel engines. Complete limited field testing of long-life engine coolant. Continue compatibility and initiate storage testing of synthetic grease. Evaluate a closed-circuit rapid-refueling capability for combat vehicles. Parameters will be established for an air-cushioned vehicle to deliver bulk fuel across a beach. Fabricate bread-

Program Element: #6.27.33.A Title: Mobility Equipment Technology
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board 18,000 British Thermal Unit Per Hour (BTUH) air cycle air conditioner. Evaluate fleet tests on high-sulfur fuel and high-energy fuel. Evaluate synthetic and alternative fuels from oil shale and coal and determine effect on pumps, hoses, filter separators, and fuel-handling equipment. Evaluate heat pipe cooled power circuitboards in prototype power conditioning equipment. Continue development of lightweight cables for power distribution. Complete evaluation of prototype pulse power plant for directed energy weapons. Develop new components for thermally integrated methanol/air and direct oxidation hydrocarbon (alcohol) air fuel cells. Continue investigation of materials handling resupply of a containerized distribution system. Personnel involved: 57 professional; 24 support.

4. (U) FY 1983 Planned Program: Continue hardware development for remote minefield detection. Initiate study of mine/explosive detection in urban warfare. Fabricate prototype tank intertrack rake countermine device as an adjunct to the track width mine plow for the XM1 tank. Determine feasibility of magnetizing US MARK 1 tank roller to defeat magnetic influence mines. Initiate design studies of select metal-matrix composite materials bridge elements. Continue applications of fatigue indicators to bridge life. Complete technical feasibility of suppression heat and noise for diesel- and gas-driven generators. Investigate methods for air conditioner power reduction. Develop microprocessor modularization for power conditioners. Continue work on advanced acid electrolyte and direct oxidation fuel cells. Complete development of lightweight insulation for cables. Investigate potential application of hybrid electric (battery/fuel cell) power sources. Evaluate vulnerability of bulk fuel carriers in combat environments. Start fleet tests on oil shale fuels in aircraft and ground aviation fleet. Conduct performance evaluations of high-energy fire-resistant fuels. Begin full-scale engine and storage tests using fuels obtained from coal. Complete reverse osmosis water purification membrane rejection correlations for chemical warfare agents and chemical warfare simulants. Continue development of new antifreeze for diesel power plants. Develop new nontoxic and lead-free weapon lubricant and preservative for small arms, large caliber weapons, and missiles. Begin development of volatile corrosion inhibitor for fuel tank corrosion protection. Continue evaluation of greases, hydraulic fluids, transmission fluids, recoil fluids, and gear oils.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.34.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Medical Defense Against Chemical Agents
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	11484	14814	25852	19557	Continuing	Not Applicable
AH26	Medical Defense Against Chemical Agents	5999	5360	0	0	-	Not Applicable
A875	Medical Defense Against Chemical Agents	5485*	9454	25852	19557	Continuing	Not Applicable

* Previously in Project 843.

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Department of Defense has a critical and immediate need to modernize the medical defensive capability with regard to the chemical warfare environment. An integral part of this modernization effort is the development and improvement of medical materiel required for individual protection and to maintain operational capability on the chemical battlefield. The US Army Medical Department has been given the responsibility of developing all joint service medical materiel needs required to minimize deaths, disabilities, performance decrements, and patient loads, and to improve survivability, patient care, combat effectiveness, and mission accomplishment in a combat environment where hostile forces employ an array of highly lethal chemical warfare agents and incapacitating agents against US Armed Forces. This program element represents the Army's total medical exploratory development effort to meet the formidable challenges posed by the chemical warfare threat. This program includes an Integrated Medical System for Individual Protection which will provide prophylaxes, pretreatment compounds, antidotes, therapeutics, medical management, and patient decontamination for joint service use in a chemical warfare environment.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: The requested funds will be used to support: development of the Integrated Medical System for Individual Protection through continued screening, selection, safety, and efficacy testing of potential prophylaxes, pretreatment compounds, antidotes, and therapeutics for use against chemical warfare agent poisoning; development of respiratory

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resuscitative medical and life support systems to support the medical management of individual and mass chemical warfare casualties; establishment of patient decontamination technology; methods to assess the safety, efficacy, and tolerance of patient decontamination materiels and to assess the safety and tolerance of other decontamination materiels; and selection, evaluation, and development of candidate radioprotective drugs.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in Thousands)

RDTE	FY 1980	FY 1981	FY 1982	Additional to Completion	Total Estimated Cost
Funds (current requirements)	5999	14814	25852*	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	5777	5577	4420	Continuing	Not Applicable

* Increase due to the FY 1982 Budget Amendment to the Expansion of Chemical Warfare/Chemical and Biological Defense (CW/CBD) Basic Research (6.1) and Exploratory Development (6.2) Program.

Project AH26: The funding shown in FY 1981 Congressional Descriptive Summaries reflects the total funding in Project AH26 Medical Defense Against Chemical Agents, alone, which in FY 1981 was the only project in the Program Element 6.27.34.A, Medical Defense Against Chemical Agents. The differences shown in FY 1980 reflect changes due to inflation and petroleum equalization. The FY 1981 and FY 1982 figures (current requirements) reflect A875 combined with adjustments for inflation, petroleum equalization, and Congressional actions to greatly enhance the medical defense against chemical agents program.

Project A875: In the FY 1981 Congressional Descriptive Summaries, Project A875, Medical Systems in Nonconventional Environments, was a project in Program Element 6.27.72.A, Combat Casualty Treatment Technology. Effective in FY 1982, Projects A875 and AH26 will be integrated and consolidated into a single Project A875, Medical Defense Against Chemical Agents in Program Element 6.27.34.A, Medical Defense Against Chemical Agents. The current requirements funding reflect the combined funding for both Project AH26 and A875. The differences in current requirements funding in the FY 1981 and FY 1982 submissions largely reflect Project A875 funding requirements, to include Congressional actions taken to significantly expand the efforts required to meet the immediate needs of this program.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.27.34.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Medical Defense Against Chemical Agents
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The rationale for integrating and consolidating Projects A875 and AH26, as presented in the FY 1981 Congressional Descriptive Summaries, is to allow more effective management and utilization of scarce resources. FY 1982 represents the first year that this integration and consolidation will be in effect. This represents a major reorientation and reorganization of the US Army's Medical Chemical Defense Research and Development Program. This reorganization was initiated by the ad hoc review of the Chemical Warfare/Chemical Biological Defense Research and Development Program, as directed by the Deputy Chief of Staff for Research, Development, and Acquisition, and resulted in the 1 July 1979 transfer of the US Army Biomedical Laboratory and the medical chemical defense mission from the US Army Materiel Development and Readiness Command to the Army Medical Department. The Program Element 6.27.34.A/Project A875, Medical Defense Against Chemical Agents, supports the entire medical exploratory development effort for the Army, which is the Executive Agency for this mission and as such must address joint service requirements. This new research thrust for the Army Medical Department emphasizes prevention, pretreatment, antidote development, patient care, field resuscitation, life support during evacuation, field decontamination of patients, and patient management in field medical units when chemical warfare agents (nerve agents, blister agents, cyanide agents, choking agents, incapacitating agents, or combination agents) are employed by hostile forces against US military forces. The program element/project is concerned with the exploratory development necessary to provide solutions to immediate and anticipated problems in terms of the prevention, prophylaxis, treatment, and management of chemical warfare casualties. The major objectives of this exploratory development are: development of prophylaxes, pretreatment compounds, antidotes, and therapeutic drugs for the safe and efficacious prevention and treatment of the effects of chemical warfare agents while minimizing drug-induced side-effects that would degrade operational capability; development of criteria for triaging casualties on the integrated battlefield that identify the probability of survival with exposure to different chemical warfare threat agents and for deciding whether to evacuate a chemical agent casualty to a clean environment for treatment or to treat the casualty in a contaminated environment; and, development of a patient decontamination technology data base by establishing decontamination criteria, exploring new technologies, converting biomedical data to engineering criteria, and establishing the performance/physiological burden imposed by decontamination/materiel so that an effective and practical patient decontamination system can be developed. The exploratory development supported by this Program Element/Project is absolutely essential to the development of medical materiel required to prevent mass chemical warfare casualties and the U.S. losing the tactical advantage on the integrated battlefield.

G. (U) RELATED ACTIVITIES: This Program Element/Project is supported by basic research done in Program Element 6.11.02.A, Defense Research Sciences, Project BS10, Military Diseases, Injuries, and Health Hazards. Duplication of effort within the Army is avoided by central management of the program on the Medical Aspects of Chemical Defense by the US Army Medical Research and Development Command. Duplication of effort across the services is avoided by coordination and collaboration with the Air Force and Navy, as required of the Army as the Executive Agency for the DOD chemical defense effort. All work is coordinated with quadripartite nations through meetings and Data Exchange Annexes.

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H. (U) WORK PERFORMED BY: The five largest contractors supported by this effort are: Washington State University, Pullman, WA; Optical Sciences Group, Inc., San Rafael, CA; Associate Consultants, Inc., Washington, DC; Iowa State University, Ames, IA; and SRI International, Menlo Park, CA. There are 13 additional contractors supported at a total dollar value of $1,001,673. In-house research is supported at the US Army Biomedical Laboratory, Aberdeen Proving Ground, MD; the US Army Institute of Environmental Medicine, Natick, MA; the US Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, Frederick, MD; the Letterman Army Institute of Research, Presidio of San Francisco, CA; and the Walter Reed Army Institute of Research, Washington, DC.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: The ad hoc review by the Advisory Committee on Chemical Agent Antidotes resulted in the recommendation that the US field nerve agent antidote be replaced expeditiously. Consequently, a Nerve Agent Antidote Replacement Task Force was established to expedite the development, testing, and fielding of a new nerve agent antidote. As a part of this effort, a manufacturing base for the commercial production of the antidote was identified and an assessment of worldwide autoinjector technology for the administration of antidotes in man was initiated. The evaluation of the safety, efficacy, and tolerance of a potential cyanide antidote was initiated. A promising new direction in the development of a potential cyanide antidote, involving nonmethemoglobin formers is being explored. Screening studies of potential pretreatment mixtures, affording protection against nerve agent poisoning are underway with at least one candidate mixture showing promise in significantly reducing both lethality and nerve agent induced physical and mental debilitation. Computer analysis showed that anti-radiation drugs could have a significant impact on the capability of troops to withstand a nuclear attack and maintain fighting capabilities by significantly reducing the number of radiation casualties. Although important gains have been made in this one-year-old program, the program has been hampered by a less than adequate or appropriate physical plant for the conduct of research using chemical warfare agents. In addition, the program has been slowed by the shortage of scientists in a number of specific disciplines (e.g., pharmacology, toxicology, neurosciences) required to exploit and advance existing technology. These will continue to be problems in the foreseeable future.

2. (U) FY 1981 Program: The Nerve Agent Antidote Replacement Task Force will complete the exploratory development required for the initial fielding of a new nerve agent antidote. Continue assessment of the potential of methemoglobin and nonmethemoglobin forming compounds as efficacious antidotes for cyanide poisoning. Antidote development will continue with emphasis on producing antidotes that are safe, efficacious, and without deleterious side effects that impair combat capabilities. Evaluation for the Air Force of a first-generation patient decontamination shower will be completed. Evaluation of a field resuscitator vital to

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chemical warfare casualty management and a program to develop chemically hardened medical supplies will be initiated. Mass casualty computer models will be developed to evaluate mass chemical warfare casualty care and management and to predict mass casualty survival in a chemical warfare environment to assist in development of appropriate medical and non-medical doctrine. Foreign medical materiel will be evaluated for potential adoption or modification for patient decontamination, evacuation, life support, delivery systems, and use in a medical management system. Continue to develop criteria for antidotes, prophylaxes, and therapeutic compounds, patient decontamination compounds and procedures, and protective clothing/devices which specify levels of performance degradation that can be accepted and still allow mission accomplishment. Continue level of effort to develop drugs to mitigate the effects of ionizing radiation. This Program Element/Project will continue to support the entire exploratory development using a multifaceted search for medical materiel required to provide antidotes, mass chemical warfare casualty management, and patient decontamination.

3. (U) FY 1982 Planned Program: Enhanced/accelerated efforts will occur in the following thrust areas of this complex development. Complete efficacy assessment of new nerve agent antidote so that recommendations for field use can be planned when used with other compounds. Initial evaluation of a methemoglobin former as a potential antidote for cyanide poisoning will be completed. Complete initial assessment of safety of a second generation antidote for nerve agent poisoning in collaboration with Canadian Defense Research Establishment. Continue screening and in preventing lethality and minimizing behavioral/physical/mental incapacitative efforts will be continued; a mass chemical warfare casualty simulation model will be validated and the application of this model to all potential chemical warfare agent hazards will be initiated; exploration and evaluation of foreign medical materiel will be expanded for potential exploitation for the prevention, decontamination, and treatment of chemical warfare casualties; investigation of the full range of health effects following exposure to chemical warfare agents, prophylaxes, pretreatment compounds, antidotes, and therapeutics with primary emphasis on cholinolytic toxicity will be continued; tolerance to low concentrations of chemical warfare agents will be assessed; development of respiratory resuscitative systems to support mass chemical warfare casualties will be continued; the effectiveness of drugs against ionizing radiation with particular emphasis on gamma radiation will continue to be evaluated. Criteria for triaging battlefield casualties that identify the probability of survival will be developed so that unit commanders have a guide for triaging and assessing unit performance capability. Develop an overall comprehensive system of chemical warfare casualty management, to include patient decontamination, to enhance patient survivability and return to duty by maximizing capability to provide medical care in a chemical warfare environment. Enhanced funding will enable accelerated efforts in these areas via a vigorous extramural program. Personnel to be utilized: 123 professional and 184 support.

4. (U) FY 1983 Planned Program: Safety and efficacy testing of candidate chemical warfare agent antidotes, prophylaxes, and therapeutics will be continued. Synthesis and evaluation of potential radioprotective drugs will be continued. Mass chemical

Program Element: #6.27.34.A Title: Medical Defense Against Chemical Agents
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warfare casualty management procedures will be continued and doctrinal and materiel changes/requirements recommended as antidotes, patient decontamination, and medical materiel are developed and improved. Development of new materiels required to enhance chemical warfare casualty survivability and expeditious return to duty will be continued.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.46.A
DOD Mission Area: #521 Electronic and Physical Sciences (ED)

Title: Tactical ADP Technology
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	Total for Program Element	0	7370	8200	8618	Continuing	Not Applicable
A094QO	Military Computer Family	0	1154	1417	1360	Continuing	Not Applicable
A094RO	Software Techniques	0	2488	1388	1939	Continuing	Not Applicable
A094SO	Teleprocessing Design Center	0	895	995	994	Continuing	Not Applicable
A094TO	Intelligent Terminal Family	0	413	560	801	Continuing	Not Applicable
A094UO	System Management Engineering	0	220	236	374	Continuing	Not Applicable
A094VO	Test Technology	0	200	554	250	Continuing	Not Applicable
A094XO	Communicative Technology	0	1000	2050	2300	Continuing	Not Applicable
	Computer Security Consortium	0	1000	600	600	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides the technology base for new concepts and advances in technology to meet the presently unsolved problem of survivable, cost-effective, maintainable tactical command, control, and information-handling systems for the modern battlefield. This program provides exploratory development in software technology (common programing language, Ada, and software development and maintenance environment), hardware (including specific portions of the Military Computer Family consisting of computers, peripherals, and intelligent terminals), system engineering technology (protocols, data bases, operating systems), and new technology for data storage and transmission. Modern weapon systems are becoming more lethal and effective and more dependent on automation. This speed and lethality create a strong need for automated systems for command and control. This program addresses the methodology and technology which need to be developed to insure the capability of performing timely and accurate malfunction identification, isolation, diagnosis, and failure prediction of components of Army systems to be fielded in the 1980-1990 time-frame. The goals of this program are to provide the necessary technology to enhance effectiveness of automated systems, provide for technology insertion into fielded systems and reduce costs for development, maintenance, and logistic support for automated systems.

Program Element: #6.27.46.A
DOD Mission Area: #521 Electronic and Physical Sciences (ED)

Title: Tactical ADP Technology
Budget Activity: #1 - Technology Base

C. (U) BASIS FOR FY 1982 RDTE REQUEST: The funds are required to continue exploratory development for the Military Computer Family (computers, peripherals, and intelligent terminals) in order to provide technology insertion into all battlefield automation systems. The common high order computer programing language, Ada, and adequate software support tools will be exploited to reduce costs in software development and maintenance. Training materials and courses for civilian and military users of Ada will be definitized. A secure interface to the Advanced Research Project Agency Network (ARPANET) is essential to provide a means of connecting distant development centers and reduce costs and increase efficiency of handling systems which have classified software modules. Enhancement will be made to the Teleprocessing Design Center to allow test, measurement, and comparisons of new technology for weapons systems. Work will be continued to increase the measurement capabilities of Test Measurement and Diagnostic Equipment (TMDE) while reducing the physical size of the TMDE. Further work will be performed in improving policies, procedures, and standards for the management of computer resources. This program will also provide Army portion of support for Department of Defense Computer Security Consortium which is evaluating industrial security software techniques and conducting exploratory development for security software monitors and evaluation tools as well as for Department of Defense Software Technology Initiatives. The Communicative Technology effort provides for continuation of feasibility efforts to phased evolution of information delivery systems into an integrated distribution and delivery system to enhance effectiveness and significantly reduce the current cost of the production, distribution, and delivery of Army documentation. This project is a restructure from Program Element 6.27.01A, project AH92, in FY80.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	0	7370	8200	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	5300	9478	9081	Continuing	Not Applicable

The FY80 decrease reflects reprograming to higher priority technology base efforts. Decrease in FY81 is attributable to the application of general Congressional reductions. The decrease in FY 1982 is to meet a general reduction in the Army's TOA.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.46.A
DOD Mission Area: #521 Electronic and Physical Sciences (ED)

Title: Tactical ADP Technology
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Automation and communication are critical to the combat effectiveness of most battlefield systems. These technologies have been improving and expanding at an explosive rate. This rapid development rate has created standardization, testing, performance, and testing problems that must be corrected now if the US Army is to field cost-effective systems that are useable and supportable by the soldier in the field. The goal and objectives of this program are to reduce the cost of development and support of tactical automation and communication systems, to insure the availability of Test Measurement and Diagnostic equipment to diagnose and predict malfunctions in a cost-effective, timely manner, and to accelerate the fielding and improve the survivability of these systems. Problems that must be corrected are in the areas of: software cost and performance, testing, proliferation of incompatible products (computers, terminals, peripheral devices, languages, software tools), reliability and cost of input/output devices, and support of automated systems (hardware, software, people) after deployment and the ability to train personnel in the new technology effectively. The approach to correcting these problems is to provide: technologies for a common compatible family of computers, transportable software products and tools (including the common high-order language, Ada), intelligent peripheral devices, (terminals, displays, auxiliary memories, etc.) improved testing equipment and techniques; and to provide policy, procedures, standards and regulations prioritizing the utilization and implementation of these assets. Software products and tools will be developed in a time-phased manner with the initial emphasis on the Ada language and requirements tools. Subsequently these standardized and configuration managed tools will be used for the specification and implementation of multiprocessor and microprocessor system configurations. The final phase will provide techniques, procedures, and tools for the detection, control, and correction of field software failures with a reduction of required skill levels in the field.

G. (U) RELATED ACTIVITIES: This program is related to all Army battlefield automation systems as it will provide technology for a standard family of computers, software, and peripheral devices for such systems. It provides the exploratory development needed for direct support to Program Element 6.37.23.A and PE 6.47.27, Command and Control. Research and studies performed by the Air Force and Navy are also related. Coordination is accomplished by reviews conducted by Department of Defense, through the exchange of technical reports, attendance at scientific meetings and conferences, and through the Joint Service Research and Development (R&D) Technology Panel to the Office of the Secretary of Defense (OSD) Management Steering Committee for Embedded Computer Resources.

H. (U) WORK PERFORMED BY: EG&G, Rockville, MD; General Research Corp., McLean, VA; Computer Sciences Corporation, Moorestown, NJ; Control Data Dorporation, Minneapolis, MN; Softech, Inc., Waltham, MA; Teledyne Brown Engineering, Huntersville, AL; Higher Order Software, Inc., Cambridge, MA. Among the contracts to be awarded for FY81 will be the Ada Language System enhancements and Ada Program Design. In total, $4,682,000 in contracts will be awarded in FY81. In-house development is performed by the United States Army Communications Research and Development Command at Fort Monmouth, NJ, and the Army Communicative Technology Office at Fort Eustis, VA.

Program Element: #6.27.46.A
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Budget Activity: #1 - Technology Base

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS: (For FY 1980 and prior, these programs were under Program Element 6.27.01A, Department of the Army Project 1L1627Q1AH92B).

1. (U) FY 1980 and Prior Accomplishments: Military Computer Family (MCF) is an approach to effect standardization of the major hardware (computer, peripherals, and terminals) and software (language, operating systems, tools and products) components of battlefield automated systems. A contract was awarded to EG&G for hardware system architecture design and support for the MCF. A new MCF system concept was developed, requirements were delineated, and a new high-speed computer-to-computer interface was developed. Army policy has established the need and intent to converge on a common high order computer language, Ada, for post-1983 battlefield automated systems. Currently internal as well as contractual efforts are under-way to develop Ada and its related products and tools. Studies were initiated to consider implementation of the Ada language and its transition to ongoing system developments. The Advanced Research Projects Agency Network (ARPANET) Interface Processor was acquired for the Teleprocessing Design Center (TDC) which is required to connect remote tactical equipment to the TDC. The development of a digital message miniterminal was begun as part of the product line for the Intelligent Terminal family. A study of the trade-offs among software, hardware, and firmware methodologies was begun. The Center developed and tested new applications and variations of intelligent terminals and participated with other services and NATO for computer resource management.

2. (U) FY 1981 Program: In-house efforts have been devoted toward program development and planning of the communicative technology program. Development of a prototype life-Cycle Cost Model for the Military Computer Family (MCF) will be completed. Integrated logistic support planning and hardware system architecture for the MCF will be continued. Analysis and evaluation of Nebula, the MCF architecture, will be completed. MCF busses and interfaces will be tested. The concept for an MCF test simulation system will be developed. Guidance planning and support are continuing for the development, verification, and validation of the Ada language. A program begun in FY80 for concepts of how best to support battlefield automated systems over their life cycle will be continued. As a minimum, guidelines will include standards for software tools, configuration management, and quick-reaction capability for post-deployment software support. Studies will be initiated to determine the significant parameters of the interoperation of host and target systems. The Army portion of the DOD Computer Security Consortium funding will be coordinated and provided from this program element. The Ada program design contract will be initiated to produce materials for the design of training courses for the Ada programing language and to verify the ease of programing using Ada. Two characteristically different automated systems will be modeled with the Ada language to exploit the major generic functions of the language and its roll in Battlefield Automated System design. A contract will be awarded to develop a digital message miniterminal as part of the product line for the intelligent terminal family. A contract will be awarded to develop a life cycle structure for software development. A set of guidebooks

Program Element: #6.27.46.A
DOD Mission Area: #521 Electronic and Physical Sciences (ED)

Title: Tactical ADP Technology
Budget Activity: #1 - Technology Base

defining the life cycle acquisition and maintenance of computer resources will be developed along with policy documents regarding utilization and implementation of standard computer resources. A Microprogrammable Multiprocessor (MMP) currently provides emulation capability in the Teleprocessing Design Center (TDC). The MMP will be enhanced and a secure interface capability between the Post Deployment Software Support (PDSS) computer and remote sites using the Defense Advanced Research Projects Agency Network (ARPANET) communications will be developed. In-house TDC efforts will encompass support activities relative to MCF system producibility, integration, and validation. Work will be initiated to prepare a detailed Army Test Program Set (TPS) Software Development and Support Facility Plan which will address the problem of reducing the total developmental costs of TPS's.

3. (U) FY 1982 Planned Program: The multiyear Ada language systems efforts will be continued to add to the inventory of products and tools needed to support Ada and satisfy the needs of the battlefield automated system developers. Development of the MCF life-cycle cost model will be completed. Exploratory developments in hardware system architecture for the MCF will continue. A project in realtime distributed processing in support of multiprocessor efficient and survivable configurations of MCF computers will be initiated. The study of life-cycle support of battlefield automated systems will continue. The effort to identify the training needs for utilization of the automated requirements methodology will continue. Studies of the interoperation of host and target systems will continue. The Army portion of the DOD Computer Security Consortium funding will continue to be provided from this program element. Tactical computer peripherals will be advanced by using distributed techniques, improving human interfaces and achieving compatibility of interfaces. The development of the Ada language system and other software support tools will require development of specific tools for maintenance purposes. To this end, an effort will be initiated to develop a prototype-structured design diagrammer which will be used to maintain the software developed under other efforts. In the Teleprocessing Design Center. (TDC) interface between the Microprogramable Multiprocessor (MMP) and tactical systems at other locations and between the Post Deployment and Software Support (PDSS) computer and remote sites using AUTODIN II communications will be developed. Test program set software tools for the Software Development and Support Facility will be developed. The contract for the development of new automatic microwave testing techniques will be continued. Hardware will be assembled to demonstrate pin electronics capability. In the area of communicative technology, work will be performed to understand appropriate ways in which information to be maintained in a locally accessed electronic archive should be recorded both for internal retention and network distribution.

4. (U) FY 1983 Planned Program: Continue product planning and control contractual efforts for the Military Computer Family (MCF) life cycle cost model and analyses, advanced hardware system architecture, and realtime distributed processing

Program Element: #6.27.46.A
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configuration of MCP computers. A study to identify standard software tools and products to be exported to software support centers will be initiated. The host target studies will be expanded to include multiprocessor and microprocessor target systems. The Army portion of the DOD Computer Security Consortium funding will continue to be provided from this element. Packet switching concepts will be implemented, and intrasystem communication efficiency will be verified. In addition, contractual support efforts in the areas of distributed terminal/peripheral system methodologies, microprocessor/microcomputer hardware/software/firmware trade-off techniques for terminals/peripherals, as well as advanced techniques relative to extended man/machine interactive methodologies for enhancements of advanced terminal technology will be actively pursued. Emphasis will be placed on realistically evaluating the major benefits of distributed versus centralized processing, and the trade-offs involved. It is planned to initiate a contractual effort to study and evaluate methodologies for achieving optimal design criteria relative to microprocessor-driven intelligent terminals and peripherals. A contract to develop improved Computer Resource Management (CRM) documents and synthesis of requirements analysis techniques will be continued. CRM requirements will continue to be analyzed and the automated CRM data base will become operational. In the Teleprocessing Design Center (TDC) computer system architectures will be illustrated which address battlefield survivability and computer security requirements.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.70.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Military Disease Hazards Technology
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	10982	16290	17327	19227	Continuing	Not Applicable
A802	Military Preventive Medicine	7715	0	0	0	-	-
A803	Drug Development	3267	0	0	0	-	-
A870	Risk Assessment of Military Disease Hazards	0	3415	3280	3622	Continuing	Not Applicable
A871	Prevention of Military Disease Hazards	0	12875	14047	15605	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Military disease hazards technology is the core Army program for exploration of strategies which will lead to control of parasitic, bacterial, rickettsial, and viral diseases of military importance and development of an effective medical defense against biological weapons. The program fulfills a need for development of a system of vaccines and drugs for protection against biological warfare agents and diseases affecting worldwide deployment of troops.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Major new thrusts include development of drugs and antitoxins against microbial toxins, venoms and poisons of BW importance; a system of tests for rapid field identification and diagnosis of BW agents and/or disease; and exploration of newly identified drug delivery systems. Previously described multiyear efforts will be continued.

Program Element: #6.27.70.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

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D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in Thousands)

RDTE	FY 1980	FY 1981	FY 1982	Additional to Completion	Total Estimated Cost
Funds (current requirements)	10982	16290	17327**	Continuing	Not Applicable
*Funds (as shown in FY 1981 submission)	17892	17229	20366	Continuing	Not Applicable

* Funds shown in FY 1981 RDTE Congressional Descriptive Summaries submission under Program Element 6.27.70.A are a consolidation of Program Elements 6.27.70.A and 6.27.76.A The reduction in the FY 1981 estimate reflects decreased emphasis in Project A870 for epidemiological assessment of agents associated with military disease hazards, and a budgetary decision to defer exploratory development under Project A871 of drugs and vaccines.

** Reduction due to an adjustment of the Techrology Base Ramp FY 82-86.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.70.A
Title: Military Disease Hazards Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED)
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The program derives from the militarily unique impact of specific diseases which are not of general concern to the US civilian medical community. The Army has the only drug development program in the Department of Defense and the only antimalarial drug development program in the free world. The Army's efforts to produce a vaccine against malaria are confined to the merozoite (human blood form) of the organism, whereas the Navy is developing a vaccine using the sporozoite (mosquito-transmitted form) of the malaria organism. In the Department of Defense, only the Army is working on leishmaniasis. The Army has the only active program to develop drugs and vaccines effective against scrub typhus which is completely different from diseases having similar names; i.e., epidemic and endemic typhus, which are being addressed in research programs of the Navy. Diarrheal disease research in the Army is concentrated on those areas which are not important to the civilian population. The Army research involves vaccine development, whereas the Navy is investigating pathogenesis and therapy. Arboviral infections being investigated in the Army research program are limited to those with military uniqueness (high hazard, potential BW agents; i.e., Ebola, Marburg, Lassa) and are not being addressed in any other Department of Defense program. This program is also the sole Department of Defense effort in medical defense against BW agents. Duplication of effort across the services is avoided by coordination and collaboration with the Air Force, Navy and Uniformed Services University of the Health Sciences. The Air Force is not conducting any infectious disease research, but maintains close liaison with the other services to insure responsiveness to their requirements. Coordination with other intergovernmental agencies including the National Institutes of Health and Department of Health and Human Services insure information exchange at the working and administrative levels to avoid duplication of effort.

G. (U) RELATED ACTIVITIES: Related Army studies are performed under Program Element 6.11.02.A, Project BS10, Research on Military Diseases, Injury, and Health Hazards; and Program Element 6.37.50.A, Drug and Vaccine Development. Coordination with the Navy, Air Force, Uniformed Services University of the Health Sciences, and other intergovernmental agencies are accomplished early in the planning stages to prevent duplication of effort.

H. (U) WORK PERFORMED BY: Approximately 72% of the research is performed by in-house laboratories at the Walter Reed Army Institute of Research, Washington, DC, and field units in Thailand, Malaysia, Brazil, and Kenya; by the US Army Medical Research Institute of Infectious Diseases, Fort Detrick, Frederick, MD; the US Army Army Institute of Dental Research, Washington, DC; and the Letterman Army Institute of Research, Presidio of San Francisco, CA. The remaining 28% of the research is conducted under contracts with universities, non-profit organizations, and industries. The five major contracts are those with Herner and Co., Arlington, VA; University of Miami, Miami, FL; the Smithsonian Institution, Washington, DC; University of Pittsburgh, Pittsburgh, PA; and Parke Davis and Co., Ann Arbor, MI. Sixty-seven other contractors are funded in the amount of $3,573,000.

Program Element: #6.27.70.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Military Disease Hazards Technology
Budget Activity: #1 - Technology Base

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: The therapeutic efficacy of ribavirin (an antiviral drug) was demonstrated in animals experimentally infected with viruses of hemorrhagic diseases, specifically Lassa and Bolivian hemorrhagic fever; this provides the first hope for specific treatment of soldiers sick with these highly lethal BW potential agents. Two thousand liters of high-titer human anti-botulism plasma were collected from immune individuals; this represents the total US stockpile of antisera for treatment of soldiers seriously ill from botulinum toxin, a well-recognized BW threat. Food and Drug Administration (FDA) approval was obtained for using this plasma for the therapy of acute botulism. A new vaccine against the potential BW agent, Q fever, was found to be superior in animal studies. The attenuated vaccine strain of the Argentine hemorrhagic fever virus (Junin), a potential BW agent, was found to be protective, but residual neurotoxicity of the virus must be overcome for its use in humans. Ebola virus, a highly lethal agent in sub-Saharan Africa, has been adapted to tissue culture; vaccine development for this agent can now proceed. A new program was initiated to design, develop and evaluate liposome drug carriers as a delivery system for anti-parasitic drugs, which allows delivery of small amounts of highly effective, otherwise toxic drugs, to body tissues affected by Leishmania and other parasites of military consequence. A vaccine against meningococcal serotypes (Y and W-135), potential disease threats to recruits during mobilization, was tested and shown to be safe. In animal studies, a novel, orally effective anti-leishmanial drug, WR 6026, was found to be 500 times as potent as Pentostam, the standard drug which frequently fails to cure disease and is highly toxic to patients. Insect repellent compounds for use on skin have been identified which are superior to the currently stocked repellent.

2. (U) FY 1981 Program: Strains of dengue 3 virus will be isolated and tested as candidate vaccines. A tetravalent meningococcal vaccine will be tested for safety and antigenicity in volunteers. Preclinical pharmacological and toxicological studies will begin on the anti-leishmanial drug, WR 6026. Preclinical pharmacological and toxicological studies will be underway on three anti-malarials with the potential for improved effectiveness against multi-drug resistant strains. In BW defense research, the anthrax program will be expanded with the development of techniques for producing, purifying, and characterizing anthrax toxins. The high titer human anti-botulism plasma will be converted into hyperimmune botulinum immunoglobulin. Studies to develop animal models for Ebola virus will be initiated to allow meaningful vaccine and drug studies. Efforts will begin to isolate and prepare a Korean hemorrhagic fever virus suitable for vaccine development. Ribavirin will undergo a preclinical evaluation. A ribavirin-related compound will be tested for efficacy and toxicity and will be evaluated in mice infected with hemorrhagic fever viruses. Scrub typhus organisms isolated from patients and nature in selected areas of the endemic region will be antigenically characterized to confirm the finding in Malaysia that most isolates are of one antigenic type. This information is essential to the selection of strains for vaccine development. The efficacy and toxicity of new repellents will be identified.

Program Element: #6.27.70.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Military Disease Hazards Technology
Budget Activity: #1 - Technology Base

3. (U) FY 1982 Planned Program: In BW defense research, the screening of new antiviral drugs will continue with testing directed against high hazard viruses. Preparation of an experimental vaccine for Korean hemorrhagic fever will be undertaken. Each of the seven botulinum toxins will be made into vaccines and tested in animal systems. Vaccines for dengue 1 and dengue 4 serotypes will be administered to primates for efficacy and safety determinations prior to human trials. The formulation of candidate vaccines against African sleeping sickness will be developed in model systems. Candidate drugs for trypanosomiasis (African sleeping sickness) will be evaluated for efficacy. A candidate drug effective against mefloquine-resistant strains of malaria will be identified and the preclinical testing initiated. Anti-malarial drugs showing promise in screening will be tested in non-human primates. Toxicity testing of new repellents will be completed.

4. (U) FY 1983 Planned Program: An improved botulinum vaccine consisting of a pool of seven types will be available for safety and efficacy testing. Work on an experimental vaccine for Marburg virus will be initiated. Evaluation of vaccines produced by DNA recombinant technology will be initiated. The acquisition and testing of candidate anti-parasitic compounds will result in two to three drug candidates for pharmacological and toxicological studies per year. Scrub typhus vaccines will be evaluated for safety, immunogenicity and protection in non-human primates. Animal models for Korean hemorrhagic and Ebola viruses will be developed as a prerequisite to safety and efficacy testing of potential vaccine.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #A871
Program Element: #6.27.70.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Prevention of Military Disease Hazards
Title: Military Disease Hazards Technology
Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: This program is designed to develop technology for prevention and treatment of infectious diseases to minimize impact on worldwide military operations. It includes research on parasitic, bacterial, rickettsial, and viral diseases. Emphasis is placed on serious diseases which have occurred repeatedly as epidemics in military populations. The ultimate goal is to prevent illnesses which result in a depleted and ineffective fighting force. Malaria has a high attack rate; it is resurgent in many areas where the disease was considered to be under control, and has become resistant to standard and recently introduced new drugs. Leishmaniasis is incapacitating, disfiguring, widespread particularly in Africa, the Middle East, and Asia, and can only be treated currently with drugs that are toxic. Diarrhea may be caused by many different organisms, has a very short incubation period, is incapacitating, and cannot be prevented with any existing drugs. Scrub typhus is widespread in the Asiatic/Pacific region and has a high attack rate especially in military operations where 20-50% of soldiers have been affected within weeks; it cannot be prevented with existing drugs and no vaccine is available. Arboviral infections have a high attack rate and are widespread; they are incapacitating and cannot be treated specifically since, in most cases, neither vaccines nor drugs are available. This project is also designed to develop an effective medical defense against known and potential biological weapons. It forms the technological basis for formulation, advanced development, production, and testing of drugs, repellents, vaccines, and other biological means of protection against militarily important infectious diseases.

B. (U) RELATED ACTIVITIES: Related Army studies are performed under Program Element 6.11.02.A, Project BS10, Research on Military Diseases, Injury, and Health Hazards; and Program Element 6.37.50.A, Drug and Vaccine Development. Coordination with the Navy, Air Force, Uniformed Services University of the Health Sciences, and other intergovernmental agencies are accomplished early in the planning stages to prevent duplication of effort.

C. (U) WORK PERFORMED BY: Approximately 73% of the research is performed by in-house laboratories at Walter Reed Army Institute of Research, Washington, DC, and field units in Thailand, Malaysia, Brazil, and Kenya; the US Army Medical Research Institute of Infectious Diseases, Fort Detrick, Frederick, MD; US Army Institute of Dental Research, Washington, DC; and the Letterman Army Institute of Research, Presidio of San Francisco, CA. Approximately 27% of the research is conducted under contract with universities, non-profit organizations, and industries. The five major contracts are those with Herner and Co., Arlington, VA; University of Miami, Miami, FL; Parke Davis and Co., Ann Arbor, MI; Ash-Stevens, Detroit, MI; and the Gorgas Memorial Institute, Washington, DC. Fifty-one other contractors are funded in the amount of $2,357,000.

Project: #A871
Program Element: #6.27.70.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Prevention of Military Disease Hazards
Title: Military Disease Hazards Technology
Budget Activity: #1 - Technology Base

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: The therapeutic efficacy of ribavirin (an antiviral drug) was demonstrated in animals experimentally infected with viruses of hemorrhagic diseases, specifically Lassa fever and Bolivian hemorrhagic fever. Two thousand liters of high-titer human anti-botulinum plasma were collected from immune individuals. Food and Drug Administration (FDA) approval was obtained for using this plasma for the therapy of acute botulism. A new vaccine against the potential BW agent, Q fever, was found to be superior in animal studies. The attenuated vaccine strain of the hemorrhagic fever, Junin virus, was found to be protective, but residual neurotoxicity of the virus may preclude its acceptability as a virus candidate. Ebola virus, an agent endemic in Zaire and Sudan, has been adapted to tissue culture. A new program was initiated to design, develop, and evaluate liposome drug carriers as a delivery system for antiparasitic drugs. A meningococcal vaccine prepared from two serogroups (Y and W-135) was tested and shown to be safe. In animal studies, a novel, orally effective anti-leishmanial drug, WR 6026, was found to be 500 times as potent as Pentostam, the standard drug for treating the disease. Repellent compounds have been identified which are superior to the currently stocked repellent.

2. (U) FY 1981 Program: Strains of dengue 3 virus will be isolated and tested as candidate vaccines. A tetravalent meningococcal vaccine will be tested for safety and antigenicity in volunteers. Preclinical pharmacological and toxicological studies will begin on the anti-leishmanial drug, WR 6026. Preclinical pharmacological and toxicological studies will be initiated on three anti-malarials each with the potential for improved effectiveness against multi-drug resistant strains. Scrub typhus organisms isolated from patients and nature in selected areas of the endemic region will be antigenically characterized to confirm the finding in Malaysia that most isolates are of one antigenic type. This information is essential to the selection of strains for vaccine development. The efficacy and toxicity of new repellents will be investigated. In BW defense research, the anthrax program will be expanded to develop techniques for producing, purifying, and characterizing anthrax toxins. The high titer human anti-botulism plasma will be converted into hyperimmune botulinum immunoglobin. Studies to develop animal models for Ebola virus will be initiated to allow meaningful vaccine and drug studies. Efforts will begin to isolate and prepare a Korean hemorrhagic fever virus suitable for vaccine development. Ribavirin will undergo a preclinical evaluation. A ribavirin-related compound will be tested for efficacy and hematological toxicity and will be evaluated in mice infected with hemorrhagic fever viruses.

3. (U) FY 1982 Planned Program: In BW defense research, the screening of new antiviral drugs will continue with testing directed against high hazard viruses. Preparation of an experimental vaccine for Korean hemorrhagic fever will be undertaken.

Project: #A871
Program Element: #6.27.70.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Prevention of Military Disease Hazards
Title: Military Disease Hazards Technology
Budget Activity: #1 - Technology Base

Each of the seven botulinum toxins will be made into vaccines and tested in an animal system. Vaccines for dengue 1 and dengue 4 serotypes will be administered to primates for efficacy and safety determinations prior to human trials. The formulation of candidate vaccines against trypanosomiasis (African sleeping sickness) will be developed in model systems. Candidate drugs for trypanosomiasis will be evaluated for efficacy. A candidate drug effective against mefloquine-resistant strains of malaria will be identified and the preclinical testing initiated. Anti-malarial drugs showing promise in screening will be tested for their ability to cure malaria in non-human primates. Toxicity testing of new repellents will be completed.

4. (U) FY 1983 Planned Program: An improved botulinum vaccine consisting of a pool of seven types will be available for testing for safety and efficacy. Work on an experimental vaccine for Marburg virus will be initiated. Evaluation of vaccines produced by DNA recombinant technology will be initiated. The acquisition and testing of candidate antiparasitic compounds will result in two to three drug candidates for pharmacological and toxicological studies per year. Scrub typhus vaccines will be evaluated for safety, immunogenicity, and protection in non-human primates. Animal models for Korean hemorrhagic and Ebola viruses will be developed as a prerequisite to safety and efficacy testing of potential vaccines.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

7. (U) Resources ($ in Thousands):

RDTE	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
Funds (current requirements)	0	12875	14047	15605	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	13838	13768	16800	-	Continuing	Not Applicable

The reduction in funding for FY 1981 estimate results from decrements by the House Appropriations Committee.
The reduction in FY 1982 estimate is due to an adjustment of the Technology Base Ramp FY 82-86.
FY 1980 column of the FY 1981 submission reflects restructuring.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Technical Area: #01 Title: Prevention of Disease Affecting Troop Operation and Mobilization

Project: #A871 Title: Prevention of Military Disease Hazards

Program Element: #6.27.70.A Title: Military Disease Hazards Technology

DOD Mission Area: #522 - Environmental & Life Sciences (ED) Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: This research is the technological basis for formulation, advanced development, production, and testing of drugs, vaccines, and other biological means of protection against infectious diseases; it develops and enhances technology for prevention of infectious diseases to minimize impact on training and mobilization for military operations throughout the world.

B. (U) RELATED ACTIVITIES: Related Army studies are performed under Program Element 6.11.02.A, Project BS10, Research on Military Diseases, Injury, and Health Hazards; and Program Element 6.37.50.A, Drug and Vaccine Development. This is the only research for drug and vaccine development conducted specifically for the Armed Forces. Coordination with the Navy, Air Force, and Uniformed Services University of the Health Sciences, and other intergovernmental agencies is accomplished early in planning stages to prevent duplication of effort.

C. (U) WORK PERFORMED BY: Approximately 60% of the research is performed by in-house laboratories at Walter Reed Army Institute of Research, Washington, DC, and field units in Thailand, Malaysia, Brazil, and Kenya; by the US Army Medical Research Institute of Infectious Diseases, Fort Detrick, Frederick, MD; the US Army Institute of Dental Research, Washington, DC; and the Letterman Army Institute of Research, Presidio of San Francisco, CA. The remaining 40% of the research is conducted under contracts with universities, non-profit organizations, and industries. The five major contracts are those with Herner and Co., Arlington, VA; University of Miami, Miami, FL; Parke Davis and Co., Ann Arbor, MI; Ash-Stevens, Detroit, MI; and the Gorgas Memorial Institute, Washington, DC. Forty-six other contractors are funded in the amount of $1,875,000.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: A new program was initiated to design, develop, and evaluate liposome drug carriers as a delivery system for antiparasitic drugs. A meningococcal vaccine prepared from two serogroups (Y and W-135) was tested and shown to be safe. In animal studies, an orally effective anti-leishmanial drug, WR 6026, was found to be 500 times as potent as Pentostam, the standard drug used for treating the disease.

Technical Area: #01

Title: Prevention of Disease Affecting Troop Operation and Mobilization

Project: #A871

Title: Prevention of Military Disease Hazards

Program Element: #6.27.70.A

Title: Military Disease Hazards Technology

DOD Mission Area: #522 - Environmental & Life Sciences (ED)

Budget Activity: #1 - Technology Base

2. (U) FY 1981 Program: Strains of dengue 3 virus will be isolated and tested as candidate vaccines. A tetravalent meningococcal vaccine will be tested for safety and antigenicity in volunteers. Preclinical pharmacological and toxicological studies will begin on the anti-leishmanial drug, WR 6026. Preclinical pharmacological and toxicological studies will be initiated on three anti-malarials each with the potential for improved effectiveness against multi-drug resistant strains.

3. (U) FY 1982 Planned Program: Vaccines for dengue 1 and dengue 4 serotypes will be administered to primates for efficacy and safety determinations prior to human trials. Candidate vaccines against trypanosomiasis (African sleeping sickness) will be evaluated in model systems and candidate drugs for trypanosomiasis will be evaluated for efficacy. A candidate drug effective against mefloquine-resistant strains of malaria will be identified and the preclinical testing initiated. Anti-malarial drugs showing promise in rodent screening will be tested for their ability to cure malaria in non-human primates. Personnel to be utilized: 88 professional and 115 support.

4. (U) FY 1983 Planned Program: The acquisition and testing of candidate antiparasitic compounds will result in two or three drug candidates for pharmacological and toxicological studies per year. Scrub typhus vaccines will be evaluated for safety, immunogenicity, and protection in non-human primates.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	0	8707	8007	8895	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	7809	7989	9706	-	Continuing	Not Applicable

The FY 1981 estimate funding level difference is attributable to inflation, and civilian pay raises in FY 1981. The reduction in FY 1982 estimate is due to an adjustment of the Technology Base Ramp FY 82-86.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Technical Area: #02
Project: #A871
Program Element: #6.27.70.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Prevention of Biological Warfare Diseases
Title: Prevention of Military Disease Hazards
Title: Military Disease Hazards Technology
Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: This research provides the technological basis for formulation, advanced development, production, and testing of drugs, vaccines, and other biological means of protection against potential biological agents. Data are utilized to formulate a comprehensive medical approach for prevention and treatment of biological warfare casualties.

B. (U) RELATED ACTIVITIES: Related Army studies are performed under Program Element 6.11.02.A, Defense Research Sciences; Program Element 6.27.70.A, Prevention of Military Disease Hazards, Project A870, Risk Assessment of Military Disease Hazards; and Program Element 6.37.50.A, Drug and Vaccine Development. This research is the sole Department of Defense contribution to the national program for medical defense against biological agents. Coordination with the Navy, Air Force, and Uniformed Services University of the Health Sciences and other intergovernmental agencies accomplished early in planning stages to prevent duplication of effort.

C. (U) WORK PERFORMED BY: Approximately 92% of the research is performed by the US Army Medical Research Institute of Infectious Diseases, Fort Detrick, Frederick, MD. The remaining 8% of the research is conducted under contract with universities, non-profit organizations, and industries. The five contracts, totaling $477,000, funded by this technical area are with Pine Bluff Biological Products, Inc., Pine Bluff, AR; Columbia University, New York City, NY; Johns Hopkins University, Baltimore, MD; Brigham Young University, Provo, UT; and the California State Department of Health Services, Sacramento, CA.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: The therapeutic efficacy of ribavirin (an antiviral drug) was demonstrated in animals experimentally infected with viruses of hemorrhagic diseases, specifically Lassa and Bolivian hemorrhagic fever. Two thousand liters of high-titer human anti-botulinum plasma were collected from immune individuals. Food and Drug Administration (FDA) approval was obtained for using this plasma for the therapy of acute botulism. A new vaccine against the potential BW agent, Q fever, was found to be superior in animal studies. The attenuated vaccine strain of hemorrhagic fever, Junin virus, was found to be protective, but residual neurotoxicity of the virus may preclude its acceptability as a vaccine candidate for hemorrhagic fever. Ebola virus, an agent endemic in Zaire and Sudan, has been adapted to tissue culture.

Technical Area: #02
Project: #A871
Program Element: #6.27.70.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Prevention of Biological Warfare Diseases
Title: Prevention of Military Disease Hazards
Title: Military Disease Hazards Technology
Budget Activity: #1 - Technology Base

2. (U) FY 1981 Program: The anthrax program will be expanded with the development of techniques for producing, purifying, and characterizing anthrax toxins. The high titer human anti-botulism plasma will be converted into hyperimmune botulinum immunoglobulin. Studies to develop animal models for Ebola virus will be initiated to allow meaningful vaccine and drug studies. Efforts will begin to isolate and prepare a Korean hemorrhagic fever virus suitable for vaccine development. Ribavirin will undergo a preclinical evaluation. A ribavirin-related compound will be tested for efficacy and toxicity and will be evaluated in mice infected with hemorrhagic fever viruses.

3. (U) FY 1982 Planned Program: The screening of new antiviral drugs will continue with testing directed against high hazard viruses. Preparation of an experimental vaccine for Korean hemorrhagic fever will be undertaken. Each of the seven botulinum toxins will be made into vaccines and tested in animal systems. Personnel to be utlized: 88 professional and 179 support.

4. (U) FY 1983 Planned Program: An improved botulinum toxiod consisting of a pool of seven vaccines will be available for testing for safety and efficacy. Work on experimental vaccine for Marburg virus will be initiated. Evaluation of vaccines produced by DNA recombinant technology will be initiated. Animal models for Korean hemorrhagic and Ebola viruses will be developed as a prerequisite to safety and efficacy testing of potential vaccines.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not Applicable.

Technical Area: #02
Project: #A871
Program Element: #6.27.70.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Prevention of Biological Warfare Diseases
Title: Prevention of Military Disease Hazards
Title: Military Disease Hazards Technology
Budget Activity: #1 - Technology Base

7. (U) Resources ($ in Thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirement)	0	4168	6040	6710	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	4825	5717	6945	-	Continuing	Not Applicable

The reduction in FY 1981 Estimate from decrement by the House Appropriation Committee.

The reduction in FY 1982 Estimate is due to an adjustment of the Technology Base Ramp FY 82-86.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.72.A
Title: Combat Casualty Treatment Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	4563	6406	6824	7585	Continuing	Not Applicable
A813	Health Effects of Military Lasers	1191	0	0	0	-	-
A814	Military Trauma and Resuscitation	3372	0	0	0	-	-
A874	Care of the Combat Casualty	0	6406	6824	7585	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program element is the core Army exploratory development to improve methods of treatment and management of battlefield casualties from conventional and non-conventional weapons. This technology must be revised to keep pace with the increased capability of newly developed weapons to inflict wounds of greater numbers and severity. Casualties returned to duty represent a major source of individual replacements in combat; research in this program addresses new casualty treatment methods to improve the rate of return to duty.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: These funds will be directed toward research for improved treatment of casualties in order to increase the rate of rapid return to duty. A major new thrust will be undertaken to develop wound data base on high velocity missile wounds, and increased emphasis placed on the development of substitutes for blood. Previously described multi-year efforts will be continued.

Program Element: #6.27.72.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Combat Casualty Treatment Technology
Budget Activity: #1 - Technology Base

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in Thousands)

	FY 1980	FY 1981	FY 1983	Additional to Completion	Total Estimated Cost
RDTE					
Funds (current requirement)	4563	6406	6824	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	8009	17197	18076	Continuing	Not Applicable

The funds identified for FY 1981 and FY 1982 in the FY 1981 submission included increases for Project A875, Medical Systems in Non-conventional Environments, which has been transferred to Program Element 6.27.34.A, Medical Defense Against Chemical Agents. The remaining current requirements, $6406 and $6824 for FY 1981 and FY 1982, respectively, address Project A874, Care of the Combat Casualty, the single project remaining in this Program Element.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.27.72.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Combat Casualty Treatment Technology
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This program element is directed toward development of methods of combat casualty care to more rapidly return casualties to duty and reduce mortality and disability. This goal will be met by development of improved resuscitation, stabilization, evacuation, and definitive treatment techniques, and by development of simplified and refined field storable medical supplies and equipment. No such research requirement or counterpart situation exists outside the military. Specific efforts include methods to improve casualty survival by development of new oxygen carrying blood substitutes (stroma-free hemoglobin and fluorocarbons), new drugs to combat shock and infection, development of new techniques for assessment and management of high velocity missile, laser and blast overpressure injuries and development of modern field medical materiel. The program is driven by requirements of the high intensity integrated battlefield which will create an environment of exceptionally large numbers of casualties; high volume and high rate of fire weapons generate rates of missile wound injury above those of previous conflicts. This battlefield environment will shift the necessity for treatment to forward levels of care. Highly mobile operations will result in greater dispersion of casualties; an equally mobile and adaptable medical system, employing technological advances to cope with shortages of personnel and equipment, will be required.

G. (U) RELATED ACTIVITIES: This program contains, in part, items and systems that will progress to advanced and engineering development in related Program Element 6.37.32.A, Combat Medical Materiel; and Program Element 6.47.17.A, General Combat Support. Related science bases in physiology, biochemistry, physics, pharmacology, microbiology, chemistry, toxicology, pathology, and neurological sciences are provided under Program Element 6.11.02.A/Project BS10, Research on Military Diseases, Injury and Health Hazards. Coordination is maintained with the Navy, Air Force, the National Institutes of Health (NIH), and other federal agencies to prevent duplication of effort.

H. (U) WORK PERFORMED BY: Approximately 68% of the work is performed in-house at the Letterman Army Institute of Research (LAIR), Presidio of San Francisco, CA; the US Army Medical Bioengineering Research and Development Laboratory (USAMBRDL), Fort Detrick, Frederick, MD; the Walter Reed Army Institute of Research (WRAIR), Washington, DC; and the Institute of Surgical Research, Fort Sam Houston, TX. Major extramural contracts are with University of California, San Diego, CA; Yale University, New Haven, CT; Queens Hospital Center, Honolulu, HI; and University of California, San Francisco, CA. A total of 18 other contracts are supported at a total dollar value of $1,412,000.

Program Element: #6.27.72.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Combat Casualty Treatment Technology
Budget Activity: #1 - Technology Base

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Clinical trials were started on an improved liquid blood preservation system (CPDA-2) which will extend military field blood storage time to 45 days. Stroma-free hemoglobin, a blood substitute which the aidman can reconsitute in the field, was purified and freeze-dried, and preclinical preparations were completed, setting the stage for initial human studies. Efforts were begun to modify this hemoglobin so it will be more efficient and remain in the body longer. A large animal model was developed for evaluation of burn inhalation injury. Early surgical excision techniques in burn treatment were developed and refined. Burned animals were discovered to be thyroid deficient; better burn treatment methods will result. Preliminary data for the use of skin substitutes to improve survival in extensive burns were developed. Preliminary data were obtained which define the immune mechanisms which operate to control infection following burns. A small animal model to evaluate antishock drugs was developed and development of a large animal model was begun. Studies were begun on a group of substances normally present in the body (kallikreins) which are active in shock; counteracting these substances may improve shock management. Facilities were established for investigating high velocity missile fragment wounding and high energy laser wounds. Criteria were defined for development of a low energy, sharp imaging portable rugged x-ray unit for field use. Conversion kits and a litter loader for use in the M113 tracked vehicle were evaluated. Preliminary development of a portable field surgical scrub sink was completed. Preliminary design for a container to protect sensitive medical equipment from vibration was initiated. A small, highly portable, rugged blood chemistry determination unit for field use was evaluated. Development and assessment of pesticide dispersal units for ground and air use were continued.

2. (U) FY 1981 Program: Studies will continue to improve treatment of missile wounds, burns, and shock casualties to accelerate return to duty. Efforts will begin to develop methods to rapidly characterize the extent and depth of burns, a presently non-existent technology. Efforts will continue to develop and assess skin substitutes to improve survival of burn casualties. Studies will begin to identify and develop a non-ocular laser injury animal model. Definition studies will begin on lung and gastrointestinal injury from artillery blast overpressure to develop treatment measures. Burn inhalation injury studies will continue to evaluate surface coating protective substances (surfactants). Studies will continue to develop a nontoxic and encapsulated blood substitute and a blood component preservation system for field use. Development of small and large animal shock models will continue and work on antishock drugs will be intensified. Studies will continue on high velocity missile wounds with emphasis on the effects of delayed casualty evacuation. Development of sophisticated, rugged field medical materiel such as x-ray units, water purifiers, refrigerators for blood and drug preservation and medical kits will continue.

Program Element: #6.27.72.A
Title: Combat Casualty Treatment Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED)
Budget Activity: #1 - Technology Base

3. (U) FY 1982 Planned Program: Medical studies of mechanisms of injury and treatment with emphasis on high velocity missile wounds, laser wounds, and artillery blast overpressure injuries will be expanded. Development and evaluation of antishock drugs, to be used by paramedical personnel in emergency shock management, will be continued. Development will begin on a new type of oxygen carrying resuscitative fluids, the fluorocarbons, as a safer and improved alternative to stroma-free hemoglobin. Development of improved treatment methods for rapid return to duty of acute psychiatric battle casualties will begin. Studies will continue on hormone alteration from wounds, particularly burns, and development of prevention/treatment measures for burn inhalation injury. Development of methods to improve the management of burn wounds, prevent and treat burn infections and understand wound healing processes will continue. Development and/or improvement of field medical materiel such as laboratory instruments, vital sign monitoring devices in high-noise environments, non-gravity dependent intravenous fluid infusing equipment, a new family of wheeled ambulances, and other materiel required to enhance the capability to care for combat casualties will continue. Total personnel utilized: 184 professional and 124 support.

4. (U) FY 1983 Planned Program: Development will continue to refine field capability for combat casualty care at all echelons and in all environments. Emphasis will continue on development of improved blood substitutes and resuscitative fluids, prevention and treatment of burns and other injuries, shock and infection and organ failure resulting from these wounds. Emphasis will focus on solutions for the management of these injuries under delayed evacuation conditions. Field medical materiel will continue to be developed and refined as new technology becomes available. Efforts will continue to refine treatment methods for psychiatric battle casualties.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.75.A
Title: Combat Maxillofacial Injury
DOD Mission Area: #522 - Environmental and Life Sciences (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	1253	610	1494	1653	Continuing	Not Applicable
A825	Combat Maxillofacial Injury	1253	610	1494	1653	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This Program Element is the core Army development base which develops methods to prevent, treat, and manage combat maxillofacial injuries and to develop a system of field dental care designed to minimize lost time due to dental emergencies.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Major new thrusts will be definition of the types of combat maxillofacial wounds caused by high velocity fragments and development of protective devices to prevent these wounds. Previously described multi-year efforts will be continued.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in Thousands)

	FY 1980	FY 1981	FY 1982	Additional to Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	1253	610	1494	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	1253	762	812	Continuing	Not Applicable

The reduced level of funding in FY 1981 results from decrements by the House Appropriations Committee.
The FY 1982 requirements reflect major management redirection and initiation of new studies within this Program Element.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.27.75.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Combat Maxillofacial Injury
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: An analysis of data collected from World War II, the Korean Conflict and the Vietnam War indicates there is an increasing incidence of head and neck wounds. During World War II, 19% of the killed-in-action (KIA) had maxillofacial wounds while 46% of the KIA in Vietnam had related head and neck wounds. Of the casualty producing maxillofacial wounds sustained in Vietnam and Korea, 50 to 70% were inflicted by primary fragments and secondary debris from hostile mortar and artillery fire. It has been reported that 10 to 24% of wounded-in-action admissions in Vietnam were due to maxillofacial wounds, and of these nearly 65% required evacuation for further therapy. An analysis of dental emergency statistics during the Vietnam War shows that, at any one time, a field commander could predict that 8 to 14% of his personnel would require emergency treatment of dental diseases. The objectives of research in this program are to improve the management of combat maxillofacial injuries and the treatment of dental emergencies in combat. Areas requiring concentrated effort are: (1) rapid diagnosis and simplified treatment of combat maxillofacial injuries, (2) development of new materials, implants and/or prostheses for treatment of maxillofacial wounds and dental emergencies, (3) prevention of dental emergencies in the combat environment, and (4) protection of the maxillofacial complex.

G. (U) RELATED ACTIVITIES: Army efforts related to this program are performed under Program Element 6.11.02.A, Defense Research Sciences, Project BS10, Military Diseases, Injury and Health Hazards. Related, but nonduplicative research is conducted. Coordination of research with the US Navy, US Air Force, and the National Institute of Dental Research is achieved by consultations between participants, project officer visits, review of research and technology summaries, periodic program reviews, and reviews of scientific publications. In addition, liaison memberships are held on the National Advisory Dental Research Council and the Oral Medicine and Biology Study Section, National Institute of Dental Research.

H. (U) WORK PERFORMED BY: Approximately 55% of the work is conducted by the US Army Institute of Dental Research, Washington, DC. Another Army laboratory providing assistance is the Chemical Systems Laboratory, Aberdeen Proving Ground, MD. The remaining funds are used for extramural contracts. The top five contractors are: Battelle Memorial Institute, Columbus, OH; Biotek, Inc., Wilmington, MA; University of Alabama, Birmingham, AL; Dynatech R/D Co., Cambridge, MA; and the Southern Research Institute, Birmingham, AL. Four additional contracts are supported representing $187,000.

Program Element: #6.27.75.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Combat Maxillofacial Injury
Budget Activity: #1 - Technology Base

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Types of wounds caused by high velocity missiles in tissue simulants demonstrated the value of computer-based wound prediction. These studies demonstrated that a reassessment of current management procedures for maxillofacial injury is required; new weapons technology can create massive injuries requiring extensive surgical repair. A micro-encapsulated slow-release preparation of the antibiotic, ampicillin, was produced and a single-dose treatment of infected muscle crush-wounds in experimental animals showed control of the infection for 14 days. Improved microcapsules using two additional antibiotics were completed and animal testing initiated; medical workload can be significantly reduced while increasing the return to duty rate of the wounded. Biodegradable hollow organ replacements were used to successfully replace segments of the esophagus and trachea; the use of artificial organ replacements improves state-of-the-art surgical technology for combat zone use. A partially biodegradable polymer device was developed to repair mandibular fractures. Bone healing compounds were successfully tested in experimental animals demonstrating the potential to reduce bone grafts in combat surgery. The feasibility of a maxillofacial wound dressing which include antiseptic, anesthetic, anti-inflammatory and hemostatic properties was established and dressings were produced for animal testing. A system of polymeric cell-like materials were developed for repair of maxillofacial wounds; definitive restorative surgery can be performed with minimal post-operative disfigurement. A simplified method for evaluating occupational nickel and beryllium hazards in dental production laboratories was developed. A spoon-toothbrush combination was fabricated and evaluated in the field as an aid to oral hygiene; initial tests indicated high troop acceptance. Feasibility of combining granular tricalcium phosphate as a bone expander for destroyed maxillofacial bone was established. Continued evaluation of ceramic tooth implants in humans indicated significant potential for the alignment and function of dental restorations following maxillofacial injury.

2. (U) FY 1981 Program: Biodegradable/biocompatible materials developed for treatment of maxillofacial combat wounds and hollow organ replacement will be chemically, physically, and mechanically characterized. Tricalcium phosphate ceramic employed as an augmentation material in bone defects resulting from wounding will be evaluated. New moldable, biodegradable polymeric surgical materials will be prepared and their potential evaluated for temporarily splinting and subsequently repairing maxillofacial wound defects. Non-biodegradable implant materials developed for fracture fixation and tooth replacement will continue to be evaluated in human trials. Slow-release micro-encapsulated antibiotics and anesthetics will continue to be evaluated in animals for their potential in the initial treatment of maxillofacial wounds. Effectiveness of CO_2 laser in debridement of oral/maxillofacial wounds will be examined. Host factors involved in bone resorption will be identified to control bone destructive processes in maxillofacial wounds. Damage studies in simulated tissues from high velocity missiles will be used to

Program Element: #6.27.75.A Title: Combat Maxillofacial Injury
DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

predict secondary fragment injuries. Improved restorative materials with characteristics conducive to rapid, simple field utilization will be developed. The field tested prototype spoon-toothbrush oral hygiene device will be proposed for inclusion in military field rations. The following studies will be initiated: portable systems for detecting foreign materials and nonvital tissue in maxillofacial wounds will be studied; the value of maxillofacial protective devices will be determined; storage stability of dental materials and medicaments under the wide range of climatic conditions in potential deployment areas will be investigated; and biodegradable/biocompatible tissue adhesives will be investigated for application in the initial treatment of maxillofacial combat wounds.

3. (U) FY 1982 Planned Program: Investigation of portable systems to detect foreign materials in maxillofacial wounds will be continued. Biodegradable/biocompatible materials developed for the treatment of maxillofacial combat wounds and hollow organ replacement will continue to be evaluated. Ceramics redesigned to be in consonance with normal healing processes will be evaluated in animal models. New moldable biodegradable polymeric surgical materials will be studied in animals for potential application in stabilizing maxillofacial wound defects. Nondegradable implant materials developed for fracture fixation and tooth replacement will continue to be monitored in human recipients. Methods of inhibiting or controlling bone resorption in healing maxillofacial wounds will be evaluated. Biodegradable/biocompatible tissue adhesives will be investigated for their potential to treat maxillofacial combat wounds. Evaluation of the effectiveness of the CO_2 laser in debridement of maxillofacial wounds will be completed. On the basis of data developed from studies concerning storage stability of dental materials, redesign or improvement of materials to withstand climatic extremes and long storage will be initiated. Design approaches to increased protection of the maxillofacial complex in combat will be initiated. Personnel to be utilized: 41 professional and 27 support.

4. (U) FY 1983 Planned Program: New thrusts will include: (1) investigation of polymeric materials which can be applied to teeth for long-term disease prevention; (2) development of penetrating anesthetics which can be applied directly to tooth or bone surfaces; and (3) evaluation of the feasibility of incorporating bone-forming, anti-inflammatory and antibiotic agents in biodegradable polymeric materials to treat maxillofacial wounds. Research thrusts initiated in prior years will be continued or concluded as appropriate.

5. (U) Program to Completion: This is a continuing program.

FY 1982 CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.77.A
Title: Systems Health Hazard Prevention Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED)
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	6572	12209	15529	TBD	Continuing	Not Applicable
845	Military Environmental Stress	2799	0	0	0	-	Not Applicable
846	Toxic Hazards of Military Environments	3773	0	0	0	-	Not Applicable
A878	Health Hazards of Military Materiel	0	6025	8879	TBD	Continuing	Not Applicable
A879	Factors Limiting Soldier Effectiveness	0	6184	6650	TBD	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: In order to conduct combat operations there must be a successful interfacing of man and machine. This combination can be no stronger than its weakest link. Operational parameters of new weapon systems and other materiel, the adverse health impact of extreme climates or environments, and the requirements for rapid deployment and sustained operations often determine that man will be that weakest link. In addition, the Army has the moral and legal obligation to protect the health of civilian workers engaged in the production of militarily unique chemical compounds, the health effects of which are of little concern to civilian agencies and industries. The goal of this research is to assess the magnitudes of these various problems; to provide the information required by Army planners and developers to produce combat effective man/machine combinations; and to provide medical information so that other Army agencies can determine exposure and design standards to protect the health of employees at Army production facilities.

Program Element: #6.27.77.A
Title: Systems Health Hazard Prevention Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED)
Budget Activity: #1 - Technology Base

C. (U) BASIS FOR THE FY 1982 RDTE REQUEST: The funding of the FY 1982 program is required to provide information necessary to protect soldiers and DA civilian employees from adverse health impacts during production and use of military materiel. Efforts are directed toward quantifying and preventing adverse health effects due to blast overpressure, noise, vibration, electromagnetic radiation, toxic chemicals and climatic extremes associated with military operations; quantifying and preventing psychiatric problems associated with rapid deployment, sustained operations and all other facets of military life and operations which impact upon the readiness and capability of Army personnel; and providing occupational safe exposure criteria to protect the health of civilian employees in Army munitions plants and to contribute to cost effective design of such plants.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in Thousands)

RDTE	FY 1980	FY 1981	FY 1982	Additional to Completion	Total Estimated Cost
Funds (current requirements)	6572	12209	15529	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	15001	13258	13861	Continuing	Not Applicable

This program was reatructured in the FY 1981 Congressional Descriptive Summary by consolidating the following Program Elements/Projects: 6.27.71.A, Military Psychiatry/Microwave Injury; 6.27.73.A, Helicopter, Combat Crew and Airborne Medicine; 6.27.77.A/845, Military Environmental Stress; 6.27.77.A/846, Toxic Hazards of Military Environments; and 6.27.72.A/813, Health Effects of Military Lasers. In order to show continuity of funding, the figures for FY 1980 were also adjusted, as though the restructuring had taken place earlier. The decrease in FY 1980 resulted from adjustments made near the end of the fiscal year to make maximum utilization of available funds. The funding level differences in FY 1981 and FY 1982 are attributable to the amended budget request and the application of higher fuel, inflation, and civilian pay pricing indices than were applied last year.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.27.77.A Title: Systems Health Hazard Prevention Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Existing and developing doctrine and materiel generate conditions, other than the normal dangers of combat, which are hazardous to the health of Army military and civilian personnel, or make physical and mental performance demands which military personnel cannot attain. As a result of efforts to extend their range, weapons systems have become so powerful that the pressure wave generated when they are fired is great enough to destroy the hearing or collapse the lungs of crewmembers. The increasing implementation of laser technologies in training and combat have dramatically increased the probability of eye injuries under both conditions. Development of armored vehicles with increased size, speed and firepower has led to concomitant increases in noise, vibration and toxic gas exposure of crewmembers. The objective of the research in this program element is to provide the data base necessary so that military planners and materiel developers can assess the magnitudes of these hazards and develop safe design criteria to protect the health of the soldier or civilian employee. Specific research areas include: systemic and auditory effects of blast overpressure, noise and vibration hazards of combat vehicles; the effects produced by clothing ensembles and crew compartments upon performance and the ability to sustain it; requirements for life support systems within crew compartments; the effects of impact during crashes and as associated with the use of body armor; the effects upon the eye and skin of lasers employing various wavelengths; the effects upon the entire body of exposure to micro- and millimeter waves generated by communication and radar equipment; the effects of toxic chemical exposures upon Army munition plant workers, soldiers utilizing smokes and obscurants, occupants of armor vehicle crew compartments, soldiers employing refined synthetic fuels and soldiers drinking field water supplies contaminated with the normally occurring pathogens and trace minerals, with chemicals discharged during normal industrial operations or as a result of destruction during combat, and with chemical and biological warfare agents; the psychiatric effects upon combat readiness and performance caused by rapid deployment and sustained operations and by the general stresses associated with military life; the effects of climatic extremes such as heat, cold, and high terrestrial altitude upon soldier deployability and sustained operations; the physical requirements associated with selection of personnel to perform particular tasks within the Army; and the effects upon military operations employing various types of sensory enhancement devices.

G. (U) RELATED ACTIVITIES: Toxic chemical hazard assessment is complemented by Program Element 6.11.02/BS04, Identification and Health Effects of Military Pollutants; and 6.27.20.A/835, Military Medical Environmental Quality. Basic science research is performed under Program Element 6.11.02.A/BS10, Research on Military Diseases, Injury and Health Hazards. Technology transfer, research coordination and collaboration, and minimization of duplication of effort is achieved through intra-Army and tri-service agreements, regulations and informal meetings.

H. (U) WORK PERFORMED BY: Approximately 2/3 of the research within this program is performed in-house and the remaining 1/3 is performed under contract. In-house research is conducted by the US Army Aeromedical Research Laboratory, Fort Rucker, AL; Letterman Army Institute of Research, Presidio of San Francisco, CA; Walter Reed Army Institute of Research, Washington, DC; US Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, Frederick, MD; US Army Research Institute of

Program Element: #6.27.77.A
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Environmental Medicine, Natick, MA. The top five contractors include: Battelle Pacific North West Laboratories, Richland, WA; IIT Research Institute, Chicago, IL; Oak Ridge National Laboratories, Oak Ridge, TN; University of Texas at Dallas, TX; and University of New Mexico, Albuquerque, NM. In FY 1980 $2,246,511 was provided to 42 additional contractors to conduct research in this program.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Assessment of pulmonary injury in sheep exposed to blast overpressure from the M198 howitzer was completed as a prerequisite to determining acceptable protective equipment and crew safe firing positions. A human use protocol was developed to allow necessary testing to man-rate the VIPER shoulder-fired anti-armor weapon, a system which exceeds current impulse noise exposure criteria. Methods were developed to significantly reduce the severity of acute mountain sickness, a disease that incapacitates most troops deployed without prior acclimatization to high altitude areas. A problem definition study (assessment of problem magnitude, extent of current data base, and requirements for additional research) of health effects of four gases (carbon monoxide, oxides of nitrogen, sulfur dioxide and ammonia) present in combat vehicle crew compartments yielded sufficient information to recommend safe exposure standards for all but carbon monoxide and to identify the gaps in the current data base regarding health effects of that gas. A problem definition study was initiated to determine the extent of the current data base and to identify additional research requirements to establish standards for the amount and quality of drinking water required to sustain troop performance under all types of combat conditions, including all possible climatic conditions and the possibility of water supply contamination due to employment of BW/CW agents and/or destruction of industrial chemical holding facilities. Aviator performance was assessed during simulated sustained flight operations as a prerequisite to recommending aviator/aircraft staffing ratios during such operations. Cooling effects of liquid and air cooled undergarments designed for wear by combat vehicle crewmen during desert operations were measured in order to estimate the improved crew performance which can be expected under such conditions when internal temperatures may reach 140°F. Lens membrane defects were demonstrated which could not be duplicated by thermal or chemical means of cataract production, leading to the hypothesis that the mechanism of action of such microwave ocular damage may be something other than the simple production of heat within the eye. The evaluation of the health hazards associated with the use of the Multiple Integrated Laser Engagement System (MILES) was completed and necessary recommendations for the safe use of the equipment were made, helping to clear the way for the utilization of this system to improve the realism of training and to increase the readiness of US troops for combat. A problem definition study was initiated to assess Army requirements for toxicological testing and to determine the optimal means of satisfying these requirements during the next decade, a time in which the requirements for such testing are expected to increase much faster than the availability of the facilities and the specially trained personnel needed to satisfy them. Equipment and procedures were developed and evaluated for physical fitness profiling of inductees at Armed Forces Entrance and Examining Stations, a prerequisite

Program Element: #6.27.77.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Systems Health Hazard Prevention Technology
Budget Activity: #1 - Technology Base

to matching necessary job qualifications with physical capabilities. An assessment was made of the long term effects of Army physical fitness training on female US Military Academy cadets to determine the extent to which their physical capabilities had been increased by such training. Research on the health effects of lasers operating at three specific wavelengths was completed, yielding sufficient information to recommend human permissible exposure levels to the US Army Environmental Hygiene Agency, the National Institute of Occupational Safety and Health, and the American National Standards Institute. An epidemiological study was initiated to determine the effects upon Army munition plant workers of exposure to chemical substances during the past 20 years which have recently been shown by related Army environmental research to be potentially carcinogenic.

2. (U) FY 1981 Program: Human studies to validate the effectiveness of double hearing protection and to determine crew safe areas for the M198 howitzer and to man-rate the VIPER anti-armor weapon will be conducted. The problem definition study to determine requirements for field water supply will be completed. An evaluation of the effects on body temperature and heart rate of solar heat loads as a function of ambient temperature, wind, and clothing ensembles will be completed. A study of the interactive effects of cold and high altitude will be initiated. The interactive effects of noise, light flash, and the high intensity of anticipated engagements upon target discrimination and firing accuracy will be evaluated. The study to determine the best means of meeting the Army's requirements for toxicological testing during the 1980's will be concluded. A study to select optimal auxiliary cooling systems for protection of combat vehicle crewmen will be conducted. Development of necessary equipment to measure the relative absorption of microwaves by various organs and within organs in order to predict physiological effects will be completed. Chemical characterization of propellant used in the 120mm shell proposed for use in the M-1 tank will be initiated. An auditory/communication test sequence and standard for aviator retention will be developed for inclusion in aviation certification physicals. Analysis of data from a week-long simulated flight operations experiment and data on aviator fatigue during flight operations produced by use of night vision goggles will be completed. A study will be initiated to determine safe soldier exposure levels for lasers operating at frequencies where skin burning rather than ocular damage will be the determining factor.

3. (U) FY 1982 Planned Program: Studies of ocular effects of exposures to millimeter waves will be initiated. Shock tube artillery simulation studies will be conducted with small animals to assess recovery from exposures to blast overpressure. Assessment of biological effects of wearing chemical protective clothing for extended periods while conducting military operations will be initiated. Development of hearing protection requirements for all combat vehicle systems in the Army inventory will begin. Hazards studies for new generation lasers using other wavelengths will be initiated. Further testing of a variety of plasma expanders to rapidly and inexpensively induce the benefits of heat acclimatization will be conducted. The epidemiological study of munitions plant workers exposed over the past 20 years to 2,4-DNT, which recent studies have shown to be potentially carcinogenic, will be completed. Personnel to be utilized: 200 professional and 223 support.

Program Element: #6.27.77.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Systems Health Hazard Prevention Technology
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4. (U) FY 1983 Planned Program: Damage risk criteria will be formulated and promulgated to prevent auditory and pulmonary injury due to exposure to blast overpressure. Factors such as age, levels of hydration and solar heat load will be incorporated into existing personnel heat stress models. The impact of dehydration on body temperature regulation and soldier performance in the cold will be determined. Studies of effects of simultaneous visible and infrared laser exposure upon both protected and unprotected eyes and skin will be initiated. Toxicological testing of new generation marking/signalling smokes will begin. Efforts will be expanded to develop prophylactic measures against stress and performance degradation in personnel engaged in high levels of cognitive functioning and decision making. Guidance and comparative heat transfer assessments will be provided to clothing designers as development programs continue. Efforts will be continued to establish damage risk criteria for soldiers exposed to blast overpressure. Development of methods of improved hearing protection and voice communication will be continued. Begin operations at the proposed new toxicological testing facility.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #878 Title: Health Hazards of Military Materiel
Program Element: #6.27.77.A Title: Systems Health Hazard Prevention Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: Within the military community there is an ongoing effort to improve the quality and power of Army weapon systems and materiel. In the process of such development, it is easy to forget that the soldier must work as an integral part of complex man/machine combinations if they are to be effective on the battlefield. This realization is critical, as technology has long since reached the stage that the soldier is often the weakest link in the combination. The purpose of this program is to assess the potential health hazards associated with operation of Army weapon systems and materiel and production of Army munitions and to provide the required information to other agencies (particularly DARCOM) to enable them to determine exposure standards which will allow safe production and use of such materiel. Research areas include: determination of human tolerance limits associated with exposures to blast overpressure generated by Army artillery weapons; evaluation of the effects of noise and vibration in combat vehicles upon the health and performance of crewmembers; evaluation of the thermal effects in the microenvironments created within military clothing ensembles and compact vehicle crew compartments; evaluation of proposed auxiliary breathing devices and other crew life support and impact protection equipment for Army vehicles and of the ballistic and crash impact protection provided by personal body armor; assessment of the health effects of exposure to lasers used as training devices, rangefinders and target designators; determination of the mechanisms of action and health effects of micro- and millimeter waves generated by military radars, communication devices and proposed new weapon systems; and evaluation of the toxic hazards associated with exposure of Army munition plant workers to chemical compounds and of soldiers to the chemicals contained in the battlefield smokes/obscurants, propellant combustion products, field water supplies and synthetic fuels used in training and in combat.

B. (U) RELATED ACTIVITIES: This is a restructured program which was consolidated to best utilize existing technologies. Efforts for this project were previously funded under Program Elements, 6.27.71.A, Military Psychiatry and Microwave Injury, Project 805; 6.27.72.A, Recovery From Injury, Project 813, Health Effects of Military Lasers; 6.27.73.A, Project 819, Helicopter, Combat Crew and Airborne Medicine; 6.27.77.A, Systems Health Hazard Prevention Technology, Projects 845, Military Environmental Stress, and 846, Toxic Hazards of Military Environments. Related Army research is performed under Program Elements 6.11.02.A, Defense Research Sciences, Project BS10, Research on Military Diseases, Injury and Health Hazards; and 6.27.77.A, Systems Health Hazards Prevention Technology, Project 879, Medical Factors Limiting Soldier Effectiveness. Portions of the program directed at assessment of toxic chemical hazards are closely coordinated and complemented by Program Element 6.11.02.A, Defense Research Sciences, Project BS04, Identification and Health Effects of Military Pollutants; and 6.27.20.A, Environmental Quality Technology, Project 835, Military Medical Environmental Quality. Technology transfer and research coordination exist through intra-Army and tri-service agreements, regulations, and informal meetings to mutually complement joint requirements. Medical research is keyed to DARCOM weapon systems

Project: #878 Title: Health Hazard of Military Materiel
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Project Manager milestones. Army Medical R&D Command laboratories furnish representatives to the Tri-Service Aeromedical Research Program (TARP), Aerospace Standardization Coordination Committee (U.S. tri-service plus major English speaking nations), Helicopter Research Coordination Panel (HRCP) and NATO's Advisory Group for Aerospace Research and Development to ensure collaborative efforts and minimize duplication. A memorandum of understanding between the US Army Medical Research and Development Command and the Army Human Engineering Laboratory ensures adequate medical/human factors input into the Army Systems Acquisition Review Council (ASARC)/Defense Systems Acquisition Review Council (DSARC). The Army, Navy, and Air Force have established a tri-service Electromagnetic Radiation Plan under the guidance of the Under Secretary of Defense for Research and Engineering. The plan is updated periodically and is intended to ensure the proper allocation of limited resources to the highest priority tasks identified by all three services. To this end the three services emphasize the sharing of laboratory facilities whenever possible. Army maintains a formal facility use agreement with the Bureau of Radiological Health, Environmental Protection Agency, and the Armed Forces Radiobiology Research Institute. In addition, Army maintains a program with DOD/Electromagnetic Compatibility Analysis Center to keep apprised of Army special utilization and operational system configurations.

C. (U) WORK PERFORMED BY: The work effort in this program is split evenly between in-house and laboratory research and contractual efforts. In-house research is conducted by the US Army Aeromedical Research Laboratory, Fort Rucker, AL; Letterman Army Institute of Research, Presidio of San Francisco, CA; Walter Reed Army Institute of Research, Washington, DC; US Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, Frederick, MD; US Army Research Institute of Environmental Medicine, Natick, MA. The top five contractors include: Battelle Pacific North West Laboratories, Richland, WA; Illinois Institute of Technology Research Institute, Chicago, IL; Oak Ridge National Laboratories, Oak Ridge, TN; University of New Mexico, Albuquerque, NM; and University of Texas at Dallas, TX. During FY 1980 there were 33 additional contractors at a cost of $1,821,886.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Assessment of pulmonary injury in sheep exposed to M198 artillery blast overpressure was ompleted. Human use protocol was obtained to conduct testing necessary to man-rate the VIPER anti-armor weapon. Blast overpressure field maps for M198 and M109 artillery systems were completed and revised to provide recommended safe crew areas. A problem definition study and a literature review of health effects of crew compartment gases (carbon monoxide, oxides of nitrogen, sulfur dioxide and ammonia) were completed and exposure criteria were recommended for all but carbon monoxide. A

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problem definition study was initiated to determine research needs associated with field water supply. Cooling effects were measured for liquid and air-cooled undergarments designed for combat vehicle crews. Ocular lens membrane defects peculiar to exposure to microwaves were demonstrated. Evaluation of the health hazard of the Multiple Integrated Laser Engagement Simulation/Training System (MILES) was completed. A problem definition study was initiated to determine Army requirements for toxicological testing during the next decade. Functional and protective capabilities of a propylene-fired, heated liquid, casualty, evacuation bag liner were evaluated. Heat transfer characteristics of prototype combat vehicle helmets and infantry battle dress uniforms were determined prior to standardization. Noise attenuation characteristics of the Integrated Helmet Display Sighting System for use in the Advanced Attack Helicopter were improved. Impulse noise produced by several weapon systems was measured to develop attenuation criteria for the new combat vehicle crew helmet. Specification requirements were provided for talk-through hearing protector design. Data were collected on the health effects of vibration associated with a supine seat for tank operators and provided to the Program Manager of Armored Combat Vehicle Technology. The steady phase study of a helicopter onboard oxygen enrichment system was completed. A program to determine required helmet shell toughness criteria was initiated through use of dynamic tests. Human permissible exposure levels for various laser wavelengths were recommended to the US Army Environmental Hygiene Agency, the National Institute of Occupational Safety and Health, and the American National Standards Institute. Preliminary results on the effects of flash countermeasures upon gunner tracking ability were reported. Studies of the effects of pulsed and continuous wave microwaves on the eye lens were initiated. Development of circular wavelength exposure system for microwave behavioral effects studies and development of electronically scanned antenna for noninvasive dosimetry of microwave exposures were completed. A new toxicological quality assurance program was established to study health effects of antidotes and therapeutic compounds used by the Army.

2. (U) FY 1981 Planned Program: Effectiveness of double hearing protection will be validated in humans. Crew safe areas for firing M198 howitzer will be determined. A problem definition study to determine medical/health research requirements for field water supply will be completed. Interactive effects of noise, light flash and high intensity engagements upon target discrimination and accuracy will be studied. Feasibility and design studies for creation of a Government Owned, Contractor Operated Toxicological testing facility will be concluded. Optimal auxiliary cooling systems for protection of combat vehicle crewmen will be evaluated. Equipment development to enable measuring effects of microwaves on various organs to predict physiological effects will be completed. Hearing protection effectiveness will be evaluated for operators of the M109 howitzer. The propellant used in 120mm shells proposed for the M-1 tank will be chemically characterized. Data on the effect of solar radiation obtained with copper manikins will be used to improve capability and accuracy of a heat casualty prediction model. Human subject testing and air contamination phases of the helicopter onboard oxygen enrichment will be completed. New techniques will be used to measure vibration-induced damage to bone joints. A study will be conducted to define the interaction of vibration

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and noise in producing hearing threshold shifts. A study will be completed to determine shell toughness criteria for flight helmets. A program will be initiated to determine secondary impact effects of 12.7mm body armor. The dose required to cause a surface burn from lasers operating at wavelengths which constitute reduced ocular hazard will be determined.

3. (U) FY 1982 Planned Program: Studies of the ocular effects of millimeter waves will be initiated. Development of hearing protection requirements for all combat vehicle systems in the Army inventory will begin. The modifying effects of human body motion and wind on the heat and evaporative characteristics of military clothing systems will be studied to improve the reliability of heat stress predictors. Laser hazard studies for new generation lasers will be initiated. Recommendations for vibration criteria update of the Military Standard on Human Engineering (1472) will be provided. Lateral acceleration/deceleration human tolerance testing will be initiated in a collaborative effort with the Air Force. An epidemiological study will be completed of munition plant workers exposed over the past 20 years to 2,4-DNT, shown to be potentially carcinogenic. Studies will be completed of the effects of pulsed and continuous wave microwave radiation on the eye lens and studies of thermoacoustic expansion of the lens when exposed to microwaves. Methods to screen and train soldiers using lasers in low-light environments will be developed. A study of microwave effects on blood-brain barrier permeability will be initiated. Personnel to be utilized: 79 professional and 88 support.

4. (U) FY 1983 Planned Program: Studies will begin on the therapeutic potential of microwaves; e.g., acceleration of wound healing and reduced inflammatory response. Toxicological testing of new generation battlefield marking/signalling smokes will be initiated. Guidance and comparative heat transfer assessment will be provided to clothing designers as development program continues. Efforts to establish damage risk criteria for unprotected ears exposed to artillery blast overpressure, and development of methods to improve hearing protection and voice communication will continue.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

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7. (U) Resources ($ in Thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	9375	6025	8879	TBD	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	9430	6586	6881	-	Continuing	Not Applicable

This program is being restructured in FY 1981. In the FY 1981 submission the funding levels for FY 1980 were adjusted to reflect this restructuring as though it had already taken place. Actually, these funds were drawn from Program Elements 6.27.71.A, Military Psychiatry and Microwave Injury, Project 805, Microwave Injury; 6.27.72.A, Recovery From Injury, Project 813, Health Effects of Military Lasers; 6.27.73.A, Project 891, Helicopter, Combat Crew and Airborne Medicine; 6.27.77.A, Systems Health Hazard Prevention Technology, Project 845, Military Environmental Stress, and Project 846, Toxic Hazards of Military Environments. Reduced values for FY 1980 in this submission reflect end of year reallocations to make more effective use of funds. The difference in funding level for FY 1981 and part of the difference for FY 1982 are attributable to the amended budget request and the application of higher fuel, inflation, and civilian pay pricing indices than were applied last year. In addition, $4200 thousand has been requested as incremental funding above core level for toxicological testing of militarily unique chemical compounds to protect the health of military personnel and munitions plant workers exposed to such compounds.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Technical/Scientific Area: #878C
Project: #878
Program Element: #6.27.77.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Toxic Hazards of Military Environments
Title: Health Hazards of Military Materiel
Title: Systems Health Hazards Prevention Technology
Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: The goal supported by this Technical Area is development of exposure criteria for protection of Department of the Army military and civilian employees against toxic and hazardous substances other than chemical warfare agents. The principal objective is to construct the minimum toxicological data base necessary and sufficient to support that goal. The principal strategy rests upon acquisition of acute, sub-acute and chronic mammalian toxicological information on compounds of interest. Tactics include extensive searches of available literature, in-house and extramural execution of mammalian toxicological testing, application and evaluation of new or alternative toxicological testing technologies, and evaluation of data as a basis for exposure criteria recommendations. Target chemical compounds investigated within this Technical Area are those Army-unique substances which are not under study nor are planned for study by the National Institute for Occupational Safety and Health, Food and Drug Administration, the Environmental Protection Agency or other public or private agencies, foundations or firms inside or outside the United States. Identification of work within this Technical Area is motivated by Army industrial facilities and weapon systems which generate substances harmful to human health. Requirements for research within this Technical Area are generated Army-wide and include but are not limited to smoke and obscurant compounds, new fuels and fuel additives, munition combustion products, munition demilitarization products, Army-unique pesticide formulations, industrial chemical emissions to the work space of munition plants, and industrial chemical contaminants in Army field water supplies.

B. (U) RELATED ACTIVITIES: Science Area BS10/C, Systems Health Hazard Research, within Program Element/Project 6.11.02.A/BS10, Research on Military Diseases, Injury and Health Hazards, supports this Technical Area. The principal Army user agency for information and recommendations generated in this Technical Area is the Army Environmental Hygiene Agency which makes final recommendations to The Army Surgeon General for human exposure criteria. Secondary user agencies include but are not limited to National Institute for Occupational Safety and Health, Food and Drug Administration, Environmental Protection Agency, US Army Corps of Engineers, US Army Toxic and Hazardous Materials Agency, US Army Program Managers for Smoke/Obscurants, and for Training Devices and Equipment, and the DARCOM Surgeon. Several of the Army user agencies fund work within the scope of this Technical Area on a reimbursable basis when organic funding is insufficient. All Army user agencies generate requirements. Joint efforts with other services are routinely executed when compounds of mutual interest are under study. Coordination is maintained with other services through mutual participation on Source Selection Boards for contracted research, mutual preparation of technical coordination papers and memoranda, mutual participation in Defense Directorate of Research and Engineering topical reviews on occupational health, and other jointly supported reviews and actions.

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C. (U) WORK PERFORMED BY: In-house research and contract monitoring are performed at the US Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, Frederick, MD; and the Letterman Army Institute of Research, Presidio of San Francisco, CA. The top five contractors are: Battelle Pacific North West Laboratories, Richland, WA; Illinois Institute of Technology Research Institute, Chicago, IL; Oak Ridge National Laboratories, Oak Ridge, TN; Naval Surface Weapons Center, Silver Spring, MD; and Arthur D. Little, Inc., Cambridge, MA. During FY 1980 there were six additional contractors at a cost of $244,942. Twenty-three percent of the work in this Technical Area is accomplished through in-house research and seventy-seven percent is contracted.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: A problem definition study on known biological effects, chemistry and exposure conditions on smoke/obscurant groups including zinc chloride, fog oils, diesel fuel, phosphorous smokes, urea formaldehyde resins and cetyl alcohol was completed. Detailed laboratory physical/chemical characterization of hexacholoroethane (HC) smoke to include principal constituent groups and combustion products in support of toxicological evaluations was completed with the result that the developer decided to replace HC smoke based on its toxicity and carcinogenic potential. Long-term mammalian inhalation toxicologic evaluations of white phosphorous-felt inventory smoke was initiated. Industrial toxicology studies on BZ chemical munitions were completed and exposure criteria for safety standards were developed for BZ demilitarization. The problem definition study to propose health criteria and/or future research requirements on short-term, high-level exposure to the four gases: oxides of nitrogen, carbon monoxide, sulfur dioxide and ammonia was completed and will result in design recommendations for tanks and other fully closed Army vehicles. A problem definition study was initiated to identify specific and unique health hazards associated with the use of refined synthetic fuels from shale oil, coal, and biomass.

2. (U) FY 1981 Program: Long-term toxicology studies will be initiated on the developmental smoke/obscurants including colored smoke replacements. Problem definition evaluation studies on developmental infrared screening smoke and laboratory chemical/physical characterization study on large area screening developmental smoke will be initiated. Characterization of combustion products from military propellants in armored vehicles (including the XM-1 tank and MLRS crew compartments) will be completed. A study will be completed to develop occupational health criteria for the four munitions: TNT, HMX, RDX, and tetryl. A study will be initiated to determine the health effects of refined synthetic fuels from coal, shale oil, and biomass sources. Army use of some of these energy sources will begin several years prior to civilian use, but current civilian health effects research is only limited to the study of crude oils and doesn't include analysis of these proposed new energy sources.

Technical/Scientific Area: #878C
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A study will be initiated to develop potable water quality criteria for combat operations in industrial societies, assuming contamination from destroyed facilities, and in hot climates, assuming that increased water consumption will require reductions in the allowable concentrations of all chemicals to maintain the allowable accumulated dosage. A problem definition study for Command-wide toxicology testing to include options for off-shore contract operations and government owned, contractor operated facilities in-house will be initiated.

3. (U) FY 1982 Planned Program: Long-term toxicological studies of certain developmental smokes/obscurants for use on the battlefield and in training will continue and problem definition and production evaluation studies on developmental infrared screening will be completed. Laboratory physical/chemical characterization studies on developmental large-area-screening smokes will be completed. Investigations into development of emergency water quality criteria for field water supplies will be continued. One or more options will be exercised for executing mammalian toxicology testing within national constraints of limited professional personnel and limited testing facility capacity; one option may include establishing a government owned, contractor operated toxicology testing facility installed at one of the Command's laboratories or at an alternate site. Problem definition studies on chemical/physical characterization and initial toxicological evaluation of synthetic fuels specified for Army research by DOD will be completed. Then toxicological studies necessary for development of health-related criteria for DOD designated refined synthetic fuels will be conducted. Recommended short-term, high-level exposure criteria will be published for toxic gases found inside armored vehicles.

4. (U) FY 1983 Planned Program: Acute, chronic and sub-chronic toxicological testing of synthetic fuels, smoke/obscurant candidates, munition-manufacturing chemicals, demilitarization products and by-products from conventional munitions, and industrial chemical contaminants of field water supplies will continue based on findings from a series of problem definition studies completed in prior years. Compounds will be selected for investigation on the basis of test results produced during FY 1981 and 1982. Selection criteria will depend upon maximizing information to be gained per dollar spent and upon user demands at the time. Slightly less return per dollar is anticipated in the FY 1983-88 timeframe due to increased operating costs imposed by compliance with the Good Laboratories Practices Act. Technology transfer of recommended emergency water quality standards for field water supplies, usable by troop units like the Rapid Deployment Force, is anticipated through the office of The Surgeon General to the US Army Logistics Center, Fort Lee, VA.

Technical/Scientific Area: #878C
Project: #878
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Budget Activity: #1 - Technology Base

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

7. (U) Resources ($ in Thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	3786	2584	4364	TBD	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	*	*	*	*		

* In FY 1980 the project funding for this Technical Area was less than $5 million, so no separate Congressional Descriptive Summary was submitted.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #A879 Title: Medical Factors Limiting Soldier Effectiveness
Program Element: #6.27.77.A Title: Systems Health Hazard Prevention Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

A. (U) DETAILED BACKGROUND AND DESCRIPTION: This program accomplishes exploratory development of medical factors limiting soldier effectiveness in order to assess soldiers' physical/physiological/psychological capabilities to function effectively under environmental and operational stress, and to prevent adverse effects of stress on health, safety and performance by means of selection criteria, protective equipment and operational measures. Emphasis is placed on (1) neuropsychiatric factors associated with continuous/sustained high intensity battlefield conflict, rapid mobility deployment and translocation, military unique drug and alcohol abuse, first term enlistment attrition and female soldier maladjustment, (2) combat crew performance enhancement factors related to the impact of environmental extremes on performance and enhanced physiologic/psychologic acclimatization to heat, cold, and altitude; development of task performance measures, workload criteria and physiologic indices of helicopter aviator alertness/fatigue, assessment of visual problems involved in integrating equipment operators (e.g., tankers, artillery crews, pilots, etc.) with electro-optical systems, head-up displays, complex weapon systems and night operations, and (3) development, validation and refinement of physical fitness and selection standards for all military occupational specialties, particularly establishment of Army aircrew selection, and physical performance retention criteria.

B. (U) RELATED ACTIVITIES: Related Army research is performed under Program Element/Projects 6.11.02.A/BS10, Research on Military Diseases, Injury and Health Hazards, and 6.27.77.A/A878, Health Hazards of Military Materiel. The neuropsychiatry program is closely coordinated with that of the Army Research Institute for the Behavioral and Social Sciences (ARI). The US Army Medical Research and Development Command performs research on the medical and biological aspects of common interest areas such as unit cohesion, combat stress and human performance in continuous operations. The Commander, US Army Medical Research and Development Command is a member of the Board of Directors of the Army Research Institute for the Behavioral and Social Sciences. A Memorandum of Understanding for coordination of complementary and/or cooperative research is being prepared between the US Army Medical Research and Development Command and the Army Research Institute for the Behavioral and Social Sciences. The Commander, US Army Medical Research and Development Command (USAMRDC) is also a member of the Department of Defense Drug and Alcohol Abuse Advisory Committee, whose purpose is to coordinate tri-service activities and avoid duplication of effort. Representatives of the Division of Neuropsychiatry, Walter Reed Army Institute of Research, act as members of various military panels including: Human Dimensions Task Force, Soldier Support Center at the US Army Training and Doctrine Command (TRADOC); North American Treaty Organization (NATO) Ad Hoc Working Group on Biomedical Aspects of Continuous Land Combat, AD 2000; US Army War College; and Skills Requirement Action Planning Group, US Army Training and Doctrine Command. USAMRDC furnishes representatives to the Department of

Project: #A879 Title: Medical Factors Limiting Soldier Effectiveness
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Defense Drug and Alcohol Abuse Research and Development Liaison Group. This Liaison Group interacts with the National Institutes of Health's Alcohol Drug Abuse and Mental Health Administration (ADAMHA) which oversees the activities of the National Institute on Drug Abuse (NIDA) and National Institute on Alcohol Abuse and Alcoholism (NIAAA). An extensive network of formal and informal relationships with other government agencies and Army medical laboratories is maintained. For example: USAMRDC's Aeromedical Research Laboratory furnishes representatives to the Tri-Service Aeromedical Research Program (TARP), the Aerospace Standardization Coordination Committee and the Helicopter Research Coordination Panel (HRCP) to exchange research results, to ensure efforts are collaborative when appropriate and to minimize duplication of effort. US Army Medical Research and Development Command scientists participate in international study groups such as NATO's Advisory Group for Aerospace Research and Development and The Technical Coordination Program (TCP). Personnel in the environmental medicine research program at the Institute of Environmental Medicine maintain extensive coordination of both formal and informal nature with Navy, Air Force, Marine Corps, NASA and various National Research Council committees in order to conduct collaborative projects and to minimize duplication of effort.

C. (U) WORK PERFORMED BY: In-house research is conducted by the US Army Aeromedical Research Laboratory, Fort Rucker, AL; US Army Research Institute of Environmental Medicine, Natick, MA; and the Walter Reed Army Institute of Research, Washington, DC. The top five contractors are: University of Massachusetts, Amherst, MA; Midwest Research Institute, Kansas City, MO; Texas Tech University, Lubbock, TX; University of Florida, Gainesville, FL; and the University of California, LaJolla, CA. Three additional contracts totaled $149,000 in FY 1980. The FY 1981 in-house research will be approximately 85 percent and the extramural contracts will amount to 15 percent of the funding for this project.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Psychophysiologic data were collected on emergency operation center workers to determine physiologic changes produced by high intensity stress in natural settings as a partial representation of combat stress. A field assay of the relationship between overseas deployment and illness behavior was conducted. A study of contributions of drill sergeant stress to dysfunctional behavior in basic trainees pointed out relationships between difficulties in stress adaptation and the Army's attrition problems. A study of the relationships between social organization, incentives, physiologic, hormonal and performance indications of stress provided predictors of unit cohesion, population health status and probabilities of psychiatric casualty. Extensive briefings were conducted on drug and alcohol abuse, cohesion and health status of female soldiers for all levels of Army and DOD secretariat. Equipment and procedures for physical fitness profiling for Military Occupational

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DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

Specialties qualification at Armed Forces Entrance Examination Stations were developed and evaluated. Long term effects of military physical training programs on female US Military Academy cadets were assessed. A model to study biomedical effects of climatic stressors on artillery forward observers was developed. Effects of various TV display phosphors were evaluated on tactical vehicle operator visual thresholds to provide biomedical data to equipment designers. Bifocal night vision goggles were assessed to determine safety and performance aspects of alternative models for low-level helicopter night flight operations. Methodology was established for recording auditory signals as actually heard by aviators in a plan to clarify audio retention standards for flight physical renewals. A study assessing helicopter aviator performance as a function of extended flight requirements and aviator fatigue was completed. Biomedical performance modeling of helicopter aviator-to-aircraft staffing ratios for sustained flight during combat operations was completed for DA manpower planning agencies. Dose-response curves were established for heat-induced mortality on the battlefield and in military training operations. The effectiveness of prehydration volume replacement and prior heat acclimatization were demonstrated to prevent and forestall heat injury and death. The impact of mild dehydration on hand cooling rates in soldiers exposed to cold environments was determined. Performance decrements were measured at high terrestrial elevation and methods were developed for significantly reducing the severity of acute mountain sickness to lessen its impact on military operations in mountainous terrain.

2. (U) FY 1981 Program: The impact of military family problems on deployability and performance/illness of service members on unit cohesion and the impact of drug and alcohol use on crew cohesiveness will be studied. The effect of continuous operations, unusual work/rest cycles and fragmented sleep on individual stress and team performance will be assessed. A field study of stress and performance degradation from rapid deployment will be conducted in collaboration with Canadian Armed Forces. Historical review of factors predisposing to psychiatric battle casualties will be continued with emphasis on organizational factors. A field study of the relationship between drill sergeant stress and trainee behavioral dysfunction and attrition will be conducted. Studies with lower animals will include research on neuroendocrine and neurochemical mechanisms in stress, cardiovascular and gastrointestinal aspects of stress, and behavioral disturbances during and after stressful events. A study of solar heat load in terms of internal temperature and heart rate will be completed with various climatic heat levels, wind and clothing ensembles. Interactive relationships between altitude and cold exposure will be determined. A study of dynamic visual acuity in the presence of vibration will be performed. Clinical trials will be performed with a new extended-wear soft contact lens prepared for use by combat vehicle/aircraft crewmembers. Data analysis on simulated sustained flight operations experiment will be completed. Data will be analyzed on aviator fatigue attributed to extended wear and use of night vision goggles during flight operations.

Project: #A879 Title: Medical Factors Limiting Soldier Effectiveness
Program Element: #6.27.77.A Title: Systems Health Hazard Prevention Technology
DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #1 - Technology Base

3. (U) FY 1982 Planned Program: Retrospective studies of cohesion, psychiatric casualties and health and field study of drill sergeant stress and trainee attrition will be completed. Coordinated research on fragmented sleep and performance will continue with the US Navy Health Research Center. Collaborative studies will be continued in areas of continuous combat capability and deployment with Canadian Defense Civil Institute of Environmental Medicine. Studies of cohesion, illness and performance will be continued with special emphasis on the study of indicators already present in Army reporting systems. Studies on the interrelationship between task demands, time of day and soldiers' gastrointestinal activity and pathology will be initiated. Studies for instilling preventive coping behaviors and skills during military training will be initiated. Neuroendocrine and performance changes will be assessed in a simulation of transmeridian desynchronization. Optical analyses of visors, protective eyewear and aircraft transparencies (e.g., windscreens and crew compartment blast shields) will continue. Biomedical assessment techniques concerning factors of unit self-deployment and sustained operations, crewmember workload and interactive stress parameters will be developed further. The number of in-house research personnel involved includes: 95 professional and 161 support.

4. (U) FY 1983 Planned Program: Factors such as age, levels of hydration and solar heat load will continue to be incorporated into existing heat stress models. Tasks predictive of soldiers' ventilatory response at high terrestrial altitude will be developed. The impact of dehydration on peripheral temperature regulation and soldier performance in the cold will be determined. Psychophysical studies of the effects of military operational environments on visual performance will be conducted. Design criteria will be identified for human visual parameters with electro-optical/visual systems. Auditory test forms for hearing tests for Army aviators will be standardized. Efforts to develop prophylactic measures against stress and performance degradation for personnel engaged in high levels of cognitive functioning and decision making will be expanded. Intervention programs to enhance group membership, cohesion and social supports will be developed to minimize stress related illness. Effective soldier rest doctrine will be developed to extend the functional capabilities of personnel involved with cognitive tasks during extended operations. In FY 1983, a major portion of the combat psychiatry program dealing with the treatment of psychiatric battle casualties will be transferred for management and funding to PE 6.37.72.A, Combat Casualty Care.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

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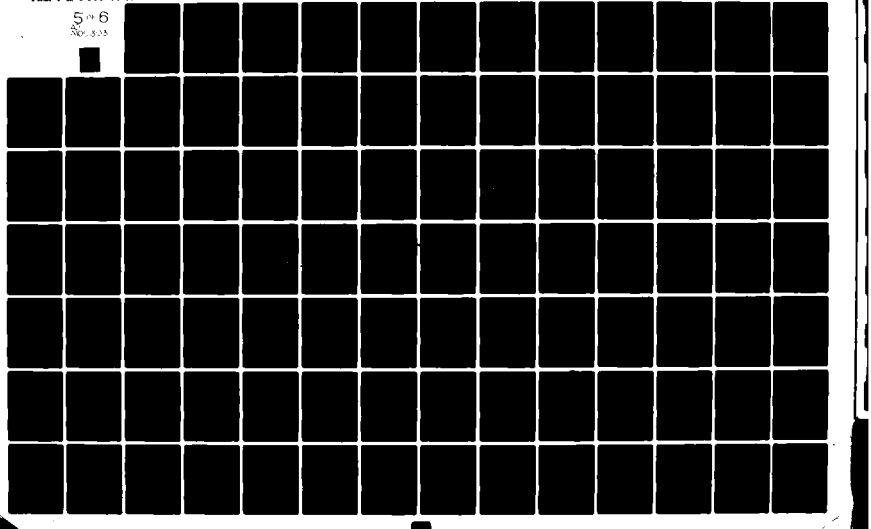

Project: #A879
Program Element: #6.27.77.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Medical Factors Limiting Soldier Effectiveness
Title: Systems Health Hazard Prevention Technology
Budget Activity: #1 - Technology Base

7. (U) Resources ($ in Thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	5566	6184*	6650	TBD	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	5571	6672	6980	-	Continuing	Not Applicable

* Reduction due to Congressional decrement.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.27.81.A
DOD Mission Area: #523 - Engineering Technology (ED)

Title: Energy Technology Applied to Military Facilities
Budget Activity: #1 - Technology Base

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	1435	1579	1890	Continuing	Not Applicable
AT45	Military Energy Technology	0	1435	1579	1890	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program is based on the energy goals established in Executive Order 12003 and amplified by the Army Energy Plan. The long-range goals to reduce energy consumption by 40% and natural petroleum fuels consumption by 75% in Army buildings and other facilities by the year 2000 will be difficult without major research and development in energy technology areas such as alternative and synthetic fuels. The Army views coal, biomass- and refuse-derived fuel, and solar energy as contenders for reducing consumption of critical fuels and will rely on the Department of Energy (DOE) and industry to develop advanced technology necessary to commercialize these energy sources. Since DOE and industry are not directing their efforts specificially toward Army energy problems, this Army program is aimed at assessing emerging technologies in terms of economic and reliability impacts on Army energy systems, providing for rapid utilization of new technology, and developing means for controlling energy consumption.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Those energy technologies which are assessed to have a significant potential to impact on Army energy consumption and sources will require design and construction tools and criteria. The operations and maintenance impact also needs to be identified and assessed. The Army can design conservation into buildings to achieve the short-term goals of reducing facilities energy consumption by 20% by 1985, but advanced energy management and control systems must be developed to insure that design performance is achieved. The Army has unique constraints in facility design, construction, maintenance, and operation in the context of total community operations. Research in energy conservation will develop tools to adapt technology developed by others to Army needs or develop the necessary technology which is unique to Army operations. These tools are essential for (1) rational formulation of future goals, (2) analysis and evaluation of alternative strategies for the Army's energy conservation investment programs, and (3) establishment of priorities for existing facility retrofits and proposed new construction to meet current energy consumption goals. Research in alternative

Program Element: #6.27.81.A Title: Energy Technology Applied to Military Facilities
DOD Mission Area: #523 - Engineering Technology (ED) Budget Activity: #1 - Technology Base

energy sources will be directed to: (1) the application of solar energy as mandated by Congress for the Military Construction Program, (2) the evaluation of waste-derived and biomass-derived fuels to take advantage of these fuel sources on Army installations, and (3) the use of coal as a primary energy source at military facilities to permit conversion from oil and gas as primary fuels in central plants. The major objectives include: (1) the establishment of standards for energy use in facilities and installations, (2) the development of performance and acceptance criteria to permit the evaluation and procurement of solar energy heating and cooling systems, (3) systems and procedures for the use of waste-derived fuel and biomass-derived fuel, and (4) criteria and techniques for cost-effective conversion to coal as a primary energy source on military installations.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	0	1435	1579	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	0	1607	1614	Continuing	Not Applicable

The decrease in FY81 is attributable to the application of general Congressional reduction and adjustments to account for a revised inflation index and projected economics in travel. The FY82 program was increased $86 thousand to increase emphasis on energy technology for military facilities; it was then reduced $121 thousand in response to OSD direction for improved efficiency.

E. (U) OTHER APPROPRIATION FUNDS: ($ in thousands): Not Applicable.

Program Element: #6.27.81.A
Title: Energy Technology Applied to Military Facilities
DOD Mission Area: #523 - Engineering Technology (ED)
Budget Activity: #1 - Technology Base

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This research addresses the reduction of military facilities energy consumption and the minimization of the impact on Army operations because of the increasing cost of petroleum fuel. The prime thrust is to develop tools to evaluate technology being developed by the Department of Energy and the civilian sector to permit adaptation of the applicable technology to Army use. The thrust includes development of analytical methods and management techniques to provide facility engineers, installation commanders, and the Department of the Army with the techniques and methods to assess energy alternatives and develop long-range plans for energy management and alternate fuel utilization compatible with the Army mission.

G. (U) RELATED ACTIVITIES: This program is coordinated on an inter-Service basis with both the Navy and the Air Force through the activities of the Tri-Service Energy R&D Group, Joint Services Civil Engineering Research and Development Coordinating Group, and the DOD-DOE Workshops. Joint programs with the Air Force include the Energy Audit Program and Technology transfer of the Building Loads Analysis and Systems Thermodynamics (BLAST) Program. Related Projects are: Program Element 6.11.02.A, Defense Research Sciences, Project T23, Structural Systems, Construction Engineering Research Laboratory, Champaign, IL, Program Element 6.27.31.A, Military Facilities Engineering Technology, Project T41, Military Facilities Engineering Technology, Research Laboratory, Champaign, IL; and Program Element 6.27.20.A, Environmental Quality Technology, Project 896, Environmental Quality Technology - US Army Engineer Construction Engineering Research Laboratory, Champaign, IL. In cooperation with the Department of Energy, the US Army has been assigned lead responsibility for coordinating the DOD energy activities in solar heating and cooling, computer programs to determine energy characteristics of buildings, wood-fired boilers, energy storage and distribution, energy conservation, and advanced heating and air conditioning systems.

H. (U) WORK PERFORMED BY: Approximately 65 percent of project funds will be used for in-house effort at the US Army Engineer Construction Engineering Research Laboratory with participation by the US Army Facility Engineer Support Agency, Ft. Belvoir, VA.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Not Applicable.

2. (U) FY 1981 Program: The planned research in the area of energy conservation includes: (1) Evaluating responsiveness of the Army military programs to define energy decisions needed at each stage of the Military Construction planning

Program Element: #6.27.81.A
DOD Mission Area: #523 - Engineering Technology (ED)
Title: Energy Technology Applied to Military Facilities
Budget Activity: #1 - Technology Base

and design phases, (2) cataloging energy analysis algorithms to provide energy analysis tools for use in facility concept design, (3) defining factors contributing to energy use base load for development of an Energy Use Handbook for facilities engineers, (4) developing standardized retrofit designs for standard Army buildings, and (5) evaluating the effectiveness of retrofit energy conservation projects. The planned research in the area of Alternate Fuels includes: (1) improving procurement procedures for purchase of solar system equipment, (2) evaluation and testing of British Thermal Unit (BTU) meters for measuring Solar System performance, and (3) determining feasibility and developing design criteria for direct combustion of solid fuels at central heating plants.

3. (U) FY 1982 Planned Program: The planned research in the area of energy conservation includes: (1) development and field testing of computerized tools to enable Army engineers to more effectively lay out and design facilities for minimum energy use during the early stages of the military construction design process, (2) methodology for improving thermal efficiency of steam distribution systems at Army installations, (3) development of cost-effective energy conservation retrofit options for standard Army buildings, (4) development of a computerized information retrieval system to allow quick evaluation of energy conservation devices. The planned research in the area of Alternate Fuels includes: (1) adaptation of existing coal technologies to other solid fuels such as waste-derived fuel, to allow use of these alternate fuels in Army heating plants by retrofitting existing equipment or in new constructon, (2) evaluation of fluidized bed combustion techniques for firing coal, peat, waste-derived fuel, and biomass in Army facilities. Anticipated personnel assignments to this project would be: professional-16, support-7.

4. (U) FY 1983 Planned Program: The planned research in the area of energy conservation includes: (1) development of a manual to enable Army engineers to perform a more thorough evaluation of alternative energy systems during facility concept design stage, (2) guidance and remodeling Army facilities to emphasize energy conservation, (3) a test method for Army engineers to evaluate energy monitoring and control systems for their installation, and (4) development of the data base design for an energy conservation technical information analysis center. The planned research in Alternate Fuels includes: (1) investigation of minimum performance specifications for heat pumps, (2) design criteria for biomass-fired heating plants, and (3) investigation of use of wind energy systems in the Army.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.31.02.A Title: Materials Scale-Up
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	2904	2825	5535	9966	Continuing	Not Applicable
DG71	Materials Scale-Up/ Structures Demonstration	2904	2825	5535	9966	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The work under this program is nonsystem advanced development for the scale-up, evaluation, and demonstration of new and advanced materials for components and structure of Army weapon systems. The objective is to fully characterize scaled-up materials to the extent necessary to permit confident, reliable, and cost effective use by Army weapon system design engineers. Army mission need is reflected in requirements for materials to meet increasing demands for faster, stronger, lighter, more maintainable, and cheaper weapon systems. New and advanced materials, when developed, lack the levels of characterization, demonstrated reliability, maintainability, and cost effectiveness necessary for confident use in new weapon systems and for product improvement of weapon systems in inventory. Lack of scaled-up demonstrated performance and demonstrated cost effectiveness of new materials causes use of outdated materials for the increasingly demanding requirements of advanced weapon systems with resultant costly overdesign, costly and sometimes catastrophic weapon failures, and frequently unacceptable levels of cost overruns in development. Specific mission need is reflected in limitations of span length and stiffness of current mobile bridging structures due to absence of the necessary performance evaluation and characterization of advanced composites bridging materials; high operation costs and energy use of combat and tactical ground vehicles due to the need for incorporation and performance evaluation of lightweight resin matrix structures and components; excessive wear and erosion in guns which could be reduced by evaluation and demonstration of composite gun barrels; limitations in performance of standoff tactical antenna systems which would be improved by fabrication and testing of antennas made of metal-matrix composite materials; unacceptable levels of lethality suffered by ground combat vehicle crews and personnel due to need for full evaluation and demonstration of composite crew compartment liner materials assemblages to defeat wide-angle backface spall generated by antiarmor munitions; and high maintenance/operations costs of advanced helicopter drive-train systems components due to unavailability of demonstrated high modulus-lightweight materials.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: The work to be conducted will be advanced stages of four tasks started in the previous year or years. Work will be continued to scale up, evaluate, and fully demonstrate performance, reliability, maintainability, and cost effectiveness of advanced metal-matrix materials for the Army CH-47 helicopter drive train

Program Element: #6.31.02.A Title: Materials Scale-Up
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

systems. The fabrication and mechanical testing of full-scale metal-matrix transmission housings will be completed. Metal-matrix composite doubler plates for reinforcement of helicopter transmission housings will be flight tested. The work will be continued to evaluate and demonstrate effectiveness of scaled-up components for portable lightweight bridging, Kevlar spall suppression liners for ground combat vehicles will undergo final tests and the project will be terminated. Work will continue to fabricate, evaluate and demonstrate advanced armor to defeat kinetic energy penetrators. A program will be initiated to fabricate, evaluate, and demonstrate advanced concept resin-matrix composite components and structures for ground combat and tactical vehicles, composite gun barrels and metal-matrix composites for standoff tactical airborne antenna systems.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	2904	2825	5535	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	3300	3034	6598	Continuing	Not Applicable

The decrease in funding of $396 thousand in FY 1980 is attributable to results from reprograming to higher priority Army technology base requirements.

The funding level decrease in FY 1981 of $209 thousand reflects the application of general Congressional reductions.

The funding level decrease of $1063 thousand in FY 1982 reflects revised scope of program efforts based on Army budget formulation decisions to fund other higher priority Army requirements.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.31.02.A Title: Materials Scale-Up
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Knowledge is being continually produced through exploratory development of new materials compositions, specifications, and characterization of new materials in test specimen configurations. A critical gap exists between the knowledge of these new materials in specimen configurations and the knowledge required for use of advanced material in engineering development of Army weapon systems. This program, designed to fill that gap, was initiated with the objective of fully characterizing advanced materials in geometric shapes and structures used in Army systems to avoid cost overruns in engineering development, prove superiority of advanced material by competitive evaluation to avoid poor materials choices in weapon system development, provide scaled prototypes from advanced materials to minimize scale-up surprises, and to demonstrate cost effectiveness advanced materials hardware to minimize cost overruns. Deficiency in knowledge of scaling factors of superior high-strength properties of metal-matrix composites prevents near-term application in advanced Army weapon systems.

G. (U) 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 the Office of the Deputy Under Secretary of Defense for Research and Engineering's Apportionment Reviews and Ad Hoc Services Materials Laboratories Council meetings. Coordination with the nonmilitary 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, New Zealand, 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.

H. (U) WORK PERFORMED BY: In FY 1982, it is planned that approximately 60 percent of the work be accomplished in-house at the US Army Materials and Mechanics Research Center, Watertown, MA; US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA; US Army Armament Research and Development Command, Dover, NJ; US Army Aviation Research and Development Command, Fort Belvoir, VA; and the US Army Aviation Research and Development Command, Fort Eustis, VA. Typical contractors are AVCO, Lowell, MA; Battelle-Columbus, OH; Lockheed Aircraft Corp., Sunnyvale, CA; NETCO, Long Beach, CA.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Magnesium elements of a subscale CH-47 transmission case (bearing housing) were successfully reinforced by aluminum oxide fibers using a casting process demonstrating that such fibers can be used to reinforce transition zones. Work has been completed to fabricate and flight test Graphite/Aluminum doubler plates for the CH-47 helicopter. Experimental graphite fiber-reinforced doubler plates for the aluminum tubes have been fabricated by centrifugal casting. Tubes have potential for lightweight, high-stiffness aircraft drive shafts. Unidirectionally reinforced graphite structural shapes (rod and bar) have been made by protrusion assemblies of aluminum precursor wire. In the development of organic matrix composite bridging components, structural tests were conducted on a half-scale graphite-epoxy

Program Element: #6.31.02.A Title: Materials Scale-Up
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

box beam along with the design, analysis, and testing of a box beam integral joint concept. Analytical and experimental studies were conducted on an aluminum-graphite sandwich plate in connection with development of a suitable bolted joint connection for the selectively reinforced bottom chord or flange of the bridge. Major barriers to the production of uniform, reproducible, high-quality depleted uranium and tungsten core materials have been identified and corrected. The relationship between fracture toughness, temperature, strength level and elongation of depleted uranium and high-density tungsten alloys has been determined. A ballistic test facility for evaluating scale model penetrators has been established. A data package has been generated toward developing optimal ballistics-protection liner systems for the M113 class of armored personnel carriers. Ballistic data with kinetic energy fragments and antipersonnel projectiles has confirmed the effectiveness of Kevlar liners in greatly reducing the number, dispersion, and velocity of behind-the-armor fragments. In addition, preliminary data and computer analysis has shown the beneficial effects of Kevlar liners for radiological protection and reduction in vaporifics (pressure and temperature reduction) following kinetic energy round penetration.

2. (U) FY 1981 Program: Works will be conducted to fabricate, evaluate, and demonstrate advanced armor to defeat penetrators; use powdered metal compositions for cores of advanced high-density penetrator munitions; and fabricate and evaluate metal-matrix composite components for portable bridging. Full-scale prototype bridge components will be fabricated from selected metal-matrix composite materials. Particular components, material systems, and fabrication methodology will be determined from materials screening tests, design and analysis trade-off studies and the fabrication studies conducted in earlier years.

3. (U) FY 1982 PLANNED PROGRAM: It is planned to continue the scale-up, evaluation and demonstration of reinforced metal matrix composite components for helicopter and gap-crossing applications. It is planned to fabricate, flight test, and evaluate a full-scale selectively reinforced CH47 transmission housing and to fabricate prototype airframe and rotor system components. The goals are: to reduce life cycle costs by increasing serviceability life through increasing life of components and reducing number of spares; to reduce noise and vibration, thereby reducing pilot hearing loss and reducing detectibility; and to increase energy efficiency by reducing weight. The bridging program will be directed to producing low cost metal matrix composite structural components such as launch beams, module joints, bottom flanges, top deck and launch vehicle equipment, by various processing methods and joining concepts. The use of metal matrix composites will permit greater span links, increase the load capacity/reliability, and improve mobility through lower weight, and will lower life cycle costs. The Standoff Observation Target Acquisition System (SOTAS) effort will be to build and evaluate a full-scale antenna from graphite fiber-reinforced metal matrix composites. The advantages of metal matrix composites in SOTAS is good radar feed performance (low thermo-structural and thermodynamic responses), reliability in severe environments, reduced weight and manufacturing advantages such as ease of welding, brazing, and mechanical fastening. Two new programs will be initiated. One is to design, fabricate, and test a fiber-reinforced resin matrix composite hull for the Infantry Fighting Vehicle (IFV) to save weight and to increase ballistic protection. Tests will include stress analyses, impact damage susceptibility, and ballistic impact characteristics. The other new program is to demonstrate the feasibility of using composite materials as reinforcing members of large caliber (75- and 90-mm) gun barrels. The accuracy can be increased by reducing the barrel "whip" phenomenon caused by the accelerating projectile down the tube.

Program Element: #6.31.02.A Title: Materials Scale-Up
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

4. (U) FY 1983 Planned Program: The work on a classified limited access program as well as the program to demonstrate metal-matrix composites for Army helicopter drive train systems, for bridging components and for standoff target acquisition system-type airborne antennas will be continued. The programs for fabrication and testing of composite gun barrels and for demonstration of high-strength, lightweight resin composites for use in a family of lightweight Army ground vehicles will be continued. New programs will be initiated to incorporate flame-resistant and laser-hardened barriers and design concepts for composite components of the 75mm smoothbore repeating cannon; for high-density, long-rod penetrator materials of uniform quality, superior ballistics and low cost; for tank liner systems for protection from penetrator threats and for resin matrix composite drive wheel/sprocket and track wheels for Army ground combat vehicles.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.31.04.A
DOD Mission Area: #553 - Engineering Technology (ATD)

Title: Fuels and Lubricants Advanced Development
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	3865	948	2349	2912	Continuing	Not Applicable
D150	Fuels and Equipment	3865	948	2349	2912	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Army's research, development, test and evaluation program has been lacking in an adequate capability to conduct advanced development of component subsystem necessary for use of new fuels and lubricants and capability to execute field/user evaluation and testing prior to issuing new products. The purpose of this program is to conduct the necessary advanced development for new fuels, fluids and subsystems, and to conduct field user evaluation to verify the acceptability of these fuels and lubricants for use in military vehicles and other items of materiel.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Initiate advanced development and evaluation of low vulnerability fuels that will significantly increase survivability of ground combat vehicles encountering fuel system fires. Conduct advanced development of a total field system for mixing, handling and storage of low vulnerability fuels for use in combat environments. Continue qualification testing/evaluation of synthetic mobility fuels mixing, handling and storage.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY1982	Additional To Completion	Total Estimated
RDTE					
Funds (Current requirements)	3865	948	2349	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	2000	1018	2279	Continuing	Not Applicable

The FY 1980 increase of $1865 thousand in funding reflects reprogramming for Fleet Test for validation of synthetic fuels for

Program Element: #6.31.04.A Title: Fuels and Lubricants Advanced Development
DOD Mission Area: #553 - Engineering Technolgy (ATD) Budget Activity: #2 - Advanced Technology Development

Army vehicles. The funding level decrease of $70 thousand in FY1981 reflects the application of general Congressional reductions. The increase in funding of $70 thousand in FY1982 is the result of higher fuel, inflation, and civilain pay pricing indices than were applied last year.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.31.04.A Title: Fuels and Lubricants Advanced Development
DOD Mission Area: #553 - Engineering Technolgy (ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This program covers those efforts directed towards overcoming obstacles to mobility and increased survivability of ground combat vehicles caused by present low probability of survivability of crews and costly damage to vehicles beyond the point of salvage due to fuel system fires of ground combat vehicles. Multiple lethal effects of intense heat, exploding ammunition and disabling atmospheric environment are the threats that must be overcome. One of the objectives of this project is to develop a low-vulnerability fire-safe fuel that will significantly increase the survivability of combat vehicles. The approach taken is to to optimize an emulsion of diesel fuel, water, emulsifiers, and antimist additives to achieve the required properties. Laboratory and fleet tests will be performed to ensure compatibility with the appropriate Army ground combat vehicles. A field mixing unit and modified pumping/ filtration equipment is being developed to prepare and handle the fuel. The program includes the planning and execution of the advanced fleet testing and qualification of synthetic mobility fuels for Army vehicles and equipment, including Gasohol, shale oil fuel and fuel processed from coal.

G. (U) RELATED ACTIVITIES: In the fuels and lubricants technical area, active Liaison and coordination is maintained with the other Military Departments, the Environmental Protection Agency, Federal Aviation Administration and the Department of Energy.

H. (U) WORK PERFORMED BY: In-house work by U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, VA; and the U.S. Army Fuels and Lubricants Research Laboratory, Southwest Research Institute, San Antonio, TX.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Four Gasohol fleet tests were initiated. Work was started on validation of diesel/alcohol blends. A gasohol purchase description has been issued. A 100 gallons per hour mixing unit for fire resistant fuel components has been constructed. Laboratory tests have shown that stable emulsives of fire resistant fuel can be made with impure water containing 300 Parts Per Million (PPM) dissolved solids.

2. (U) FY 1981 Program: Complete gasohol fleet tests at four Army posts. Field test heater/stove equipment on gasohol. Complete gasohol engine tests, inspect components and determine performance of fluid. Complete testing of 100 gallons per hour prototype mixing unit for fire-resistant fuel and prepare batches of fuel. Make recommendation on gasohol use by the Department of Defense.

3. (U) FY 1982 Planned Program: Conduct and monitor engineering fleet tests of fire resistant fuel in Army combat and tactical equipment. Complete any remaining field validation of gasohol and gasohol-diesel blends. Plan field validation of

Program Element: #6.31.04.A Title: Fuels and Lubricants Advanced Development
DOD Mission Area: #553 - Engineering Technolgy (ATD) Budget Activity: #2 - Advanced Technology Development

shale oil mobility fuel. Conduct full scale engine tests with high energy fuel. Conduct development and operational tests on fuel quality and engine lubricant quality.

4. (U) FY 1983 Program: Primary thrust will be directed towards field testing of shale synthetic fuels. These tests will involve selected fleets being used to demonstrate the feasibility for using these new fuels. Evaluations will be conducted on prototypes of engine oils, multipurpose fluids, and adiabatic engine oils. Work will be continued on fire-resistant fuel and fuel mixing field validation/ demonstration.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.32.01.A
Title: Aircraft Power Plants and Propulsion
DOD Mission Area: #553 - Engineering Technology (ATD)
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	8440	4351	3019	26761	Continuing	Not Applicable
DB72	Propulsion Components	0	291	832	1662	Continuing	Not Applicable
D447	Demonstration Engines	8440	4060	2187	25099	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The program objective is to demonstrate the integration and performance potential of advanced turbomachinery components and drive train technology through confirmatory tests of engines and transmissions. This advanced engine and transmission technology is available for use in advanced airmobility systems and provides for reductions in fuel consumption, weight, maintenance requirements, vulnerable areas, production costs, and reductions in leadtime for future developmental hardware.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Demonstrator Engines (D447): Contracts were awarded in February 1977 for design, fabrication, and testing of two 800 shaft horsepower (shp) Advanced Technology Demonstrator Engine (ATDE) designs. Initial performance testing, begun in FY 1980 and to be completed in FY 1981, will demonstrate substantial achievement of design goals of 20-percent reduction in specific fuel consumption (SFC), 30-percent increase in specific power (SHP per pound of airflow), and 50-percent reduction in vulnerable area. Testing in FY 1982 will evaluate engine capabilities while operating on synthetic fuels (shale-based) and JP-8 and include endurance and abrasive testing intended to more thoroughly explore the aircraft usage potential of the two designs. It is further expected to order certain long-leadtime material (e.g., forgings, castings, blades) to provide a capability for an expanded test program in FY 1983 and FY 1984. Very modest funds are also provided for a joint Army-Navy program for exploration of the design and component requirements of an engine in the 4500 SHP class with a potential for 28-percent reduction in fuel consumption and a 43-percent increase in range (or helicopter miles per gallon). Propulsion Components (DB72): This project includes funds in FY 1982 to initiate design efforts to integrate the many advanced helicopter transmission components that have been developed in preceding years into complete transmissions for test. The improved components will include advanced gear designs, high hot-hardness materials, high-speed clutches, lightweight steel and composite housings. These designs will be evaluated against objectives of increased life and reliability, and decreased noise, weight, and life cycle costs. Selected designs will be fabricated and tested in subsequent years.

Program Element: #6.32.01.A Title: Aircraft Power Plants and Propulsio
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	8440	4351	3019	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	8282	4657	18447	Continuing	Not Applicable

The increase in FY 1980 funds is a result of the approved FY 1980 supplemental budget request. The decrease in FY 1981 funds reflects the application of general Congressional reductions. The reduction in FY 1982 funds is due to funds being shifted to higher priority Army programs.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.32.01.A
DOD Mission Area: #553 - Engineering Technology (ATD)

Title: Aircraft Power Plants and Propulsion
Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is to demonstrate the integration and potential of advanced turbomachinery components and drive train technology through full-scale tests of engines and transmissions. The program provides for design, fabrication, and testing of advanced propulsion systems. In recent years the need for improvements in technology has become more pronounced, not only in the areas of vehicle performance, but also in areas of cost, reliability, maintainability, safety, and survivability. Advanced component technology from Army exploratory development and other Government- and industry-sponsored programs is applied to advanced gas generators, engines, and drive trains in demonstration and validation tests. Primary emphasis is placed on those areas that will benefit near-term aircraft development programs. D447: Complete engine subsystems are integrated and tested under the Advanced Technology Demonstrator Engine (ATDE) program. DC72: The Helicopter Advanced Drive Train (HADT) program provides the systems approach for a multidisciplinary effort and places drive train technology on a par with the many advances made in aircraft turbine engines.

G. (U) 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 semiannual meetings, a Tri-Service Aircraft Propulsion Technology Coordinating Paper, an informal Tri-Service Coordination Group, and visits to industry. Related Program Elements are 6.11.02.A, Air Mobility; 6.22.09.A, Aeronautical Technology; and 6.42.06.A, Blackhawk; 6.22.03.F, Aerospace Propulsion; 6.32.06.F, Advanced Turbine Engine Gas Generator; 6.32.02.F, Advanced Propulsion Subsystems Integration; 6.32.10.N, Advanced Aircraft Propulsion.

H. (U) WORK PERFORMED BY: Detroit Diesel Allison Division, General Motors Corporation, Indianapolis, IN; and AVCO Lycoming Division, Stratford, CT. The program is the responsibility of the Applied Technology Laboratory of the US Army Research and Technology Laboratories, US Army Aviation Research and Development Command, Fort Eustis, VA.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Historically, two successful efforts that have been completed were the 1500 shaft horsepower Demonstrator Engine program and the Small Turbine Advanced Gas Generator (STAGG) program. The 1500 Demonstrator Engine program identified the capabilities and limitations of an engine in that size class and has since transitioned through full engineering development as the T700 engine which is the power plant for the Army's UH-60A BLACK HAWK helicopter and AH-64 Advanced Attack Helicopter (AAH). During 1977, the Navy selected a derivative of the T700 engine for use in the Light Airborne Multipurpose System (LAMPS) MK III (SH-60B) Seahawk helicopter. The successful STAGG program validated significant engine performance improvements in the critical gas generator section. Technology validated under STAGG has been integrated into Air Force secondary power systems, commercial helicopters, and ongoing Army helicopter

Program Element: #6.32.01.A Title: Aircraft Power Plants and Propulsio
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

development programs. In reviewing the Army's future propulsion needs it has been determined that the greatest improvement in future aircraft systems can be realized through technology verification in an engine of approximately 800 shaft horsepower. The technology demonstrated in this program provides the basis and opportunity to move into an engineering development program for future applications including current inventory aircraft derivatives. Also under this program element, several new and/or unique approaches to helicopter transmission design have been or are being validated through experimental hardware testing. Some of the designs and approaches which are now incorporated in production and/or developmental helicopters are: (1) use of ZE41 magnesium as a transmission housing material in civil applications and in the Army's UH-60A Blackhawk helicopter, AH-64 Advanced Attack Helicopter (AAH), CH47D helicopter, and the Navy's SH-60B Seahawk helicopter; (2) high-speed spiral bevel gears in the UH-60A and SH-60B helicopters; and (3) cylindrical roller bearing in the UH-60A and SH-60B helicopters. During FY 1978, the Advanced Transmission Component program resulted in: (1) manufacturing of high-contact ratio test gears; (2) advanced design thrust-carrying cylindrical roller bearing fabricated and tested for over 200 hours; (3) design of a modified tapered roller bearing; (4) completed fabrication of magnetic seals; and (5) defined heat treatment required for new X-53 gear material contained in the 800 shaft horsepower Advanced Technology Demonstrator Engine (ATDE) program with the two related contractors, AVCO Lycoming and Detroit Diesel Allison. The design, fabrication, component testing, and gas generator testing have been successfully completed and full engine demonstration testing is underway. Horsepower and fuel consumption goals (reduction of specific fuel consumption by 20 percent and increase in specific horsepower of 25-35 percent) have been successfully demonstrated. Under a cofunded program with the Navy an all-ceramic bearing was installed in a J402-CA-700 engine and successfully run for 50 minutes without lubrication, with bearing temperatures stabilizing at 575 degrees F.

2. (U) FY 1981 Program: D447: Final demonstration testing of the two 800 shaft horsepower Advanced Technology Demonstrator Engines (ATDE) will be completed. Final drawings and reports will be submitted by contractors. Award contracts for follow-on to the 800 ATDE to perform using alternate/synthetic fuels and evaluate components not validated in basic program. Finalize with the Navy a Memorandum of Understanding (MOU) and a Memorandum of Agreement (MOA) for a joint 4500 engine program. Refine Army requirements and review the requirements with the Navy for this joint 4500 Modern Technology Engine (MTE). Continue in-house analysis to define program specific objectives, scope, hardware requirements and test requirements. DB72: Initiate program on transmission input module design for AH-64 and UH-60 Blackhawk aircraft.

3. (U) FY 1982 Planned Program: D447: Complete work on 800 shaft horsepower Advanced Technology Demonstrator Engine (ATDE) follow-on program. Determine the capability of the engine to perform using alternate/synthetic fuel. Complete validation testing of critical components. Initiate procurement for long-leadtime hardware for use in the Prototype Preliminary Flight Rating (PPFRT) program. Complete definition of requirements for the 4500 Modern Technology Engine (MTE) program. DB72: Continue program which will incorporate outside development efforts. The helicopter main transmission

high-speed input module will be the target. Concepts to be considered are advanced gear design, high-speed clutches, lightweight/high-strength housings, high hot-hardware materials and bearings calculated to reduce system weight and cost.

4. (U) FY 1983 Planned Program: D447: Award contracts for the Prototype Preliminary Flight Rating (PPFRT) program for the Advanced Technology Demonstrator Engine (ATDE). Initiate contracts on thermally controlled shrouds and cooled radial turbine. Award contracts for the 4500 shaft horsepower Modern Technology Engine (MTE) program and initiate component design and hardware fabrication. The flight rating program for the 800 ATDE will procure sufficient hardware to permit completion of all component and engine testing required for experimental flight release and will conduct all required analyses and demonstrations for components and engines. All hardware designs will incorporate improved features defined during the basic ATDE program and the follow-on effort as well as those improvements defined as a result of the detailed analysis required for flight rating. The thermally controlled shroud effort will include completion of design, analysis, and initiation of hardware fabrication. The cooled radial turbine effort will consist of contract award and initiation of component design. In the 4500 MTE program component design and fabrication will be completed and component testing will be initiated. D872: The designs completed in FY 1982 will be evaluated and the best design for the hardware fabrication and test phase will be selected. Long-leadtime materials and other hardware will be ordered. Initiate manufacturing drawings and begin fabrication of hardware.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: # 6.32.06.A
Title: Aircraft Weapons
DOD Mission Area: #553 - Engineering Technology (ATD)
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	770	2540	10511	24790	Continuing	Not Applicable
D039	Mast Mounted Sight	0	33	0	0	Not Applicable	Not Applicable
D043	Aircraft Weapons Fire Control	770	2507	9992	23846	Continuing	Not Applicable
D044	Aircraft Gun-Type Weapons	0	0	519	944	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program supports the advanced development and testing of new aircraft weapon subsystems to improve the capability of aircraft weapon systems under conditions of day/night adverse weather. New concepts in target acquisition and fire control will be developed to satisfy the need for improved system accuracy, terminal effects, airframe compatibility, and overall system reliability. Program objectives will be accomplished through the design, fabrication, and testing of advanced development experimental hardware of fire control devices for aircraft weapon systems on attack and scout-type helicopters. The approach is to consider the several factors that make first-round hits difficult; i.e., increased performance, a wide variety of weapons with their corresponding variations in ballistics, operation at long range and low altitude, and adverse visibility environments such as night/bad weather/vegetation/background clutter.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Design and fabrication of an advanced development model adverse environment target acquisition and fire control system utilizing millimeter wave radar technology will be continued. Integration design of the pod-mounted radar to the AH-64 test aircraft will be completed, which will include interface/integration with the Target Acquisition Designation System (TADS) and the aircraft fire control. Continue effort initiated in FY81 to select a contractor to develop a Helicopter Automatic Targeting System (HATS) that will automatically acquire targets when used in conjunction with electro-optical remote view systems. Initiate a program to incorporate an active recoil mechanism to current helicopter turreted cannons in order to achieve substantial reductions in cannon recoil forces and vibrations induced into the airframe.

Program Element: # 6.32.06.A
DOD Mission Area: #553 - Engineering Technology (ATD)

Title: Aircraft Weapons
Budget Activity: #2 - Advanced Technology Development

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirement)	770	2540	10511	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	470	6466	19360	Continuing	Not Applicable

FY 1980 increase reflects under threshold reprograming to complete the Mast-Mounted Sight Demonstration efforts. The FY 1981 decrease is due to Congressional action directing the Army to consider future Mast-Mounted Sight Development under the Army Helicopter Improvement Program (AHIP). The FY 1982 decrease reflects reprograming to higher priority Army requirements. As a result, Project D318 is not funded during the current Five-Year Defense Plan (FYDP).

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: # 6.32.06.A Title: Aircraft Weapons
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is to continue advanced development of airborne weapon subsystems for future use in helicopters. Proven concepts from exploratory development of new or improved aircraft weapon subsystems are evaluated and directed towards general aircraft use and towards specific aircraft application. The primary efforts for this program are to design, fabricate, test, and evaluate breadboard and brassboard models and prototype hardware of airborne weapons and associated equipment for use in the helicopters. The approach is to consider the several factors that make first-round hits difficult; i.e., creased performance, a wide variety of weapons with their corresponding variations in ballistics, operation at long range and low altitude, and adverse visibility environments such as night/bad weather/vegetation/background clutter. The components and system efforts of this project consider operations under these conditions. The types of fire control hardware being developed will include, but not be limited to, computers; passive and active automatic trackers; mast-mounted sight systems; acoustic sensors; fiber optic guided missiles; night, adverse environment, all-weather acquisition and targeting systems; radar, forward-looking infrared (FLIR) and stabilization systems. Foreign state-of-the-art trends and potential threats to present and future materiel or systems are being considered.

G. (U) RELATED ACTIVITIES: Project personnel maintain close liaison with other military services and with industry to avoid duplication of effort. The Army participates in the Department of Defense Tri-Service Joint Technical Coordinating Group for Munitions Development. Army personnel working within this program participate in the North Atlantic Treaty Organization Air Armament Working Party and the Air Standardization Coordinating Committee, Working Party 20. These groups and working parties provide a medium for exchange of technical information and determination for joint use and standardization of airborne weaponization items. An Army representative serves on the Air Munitions Requirements and Development committee (AMRAD), 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 under Program Element 6.42.02.A, Aircraft Weapons.

H. (U) WORK PERFORMED BY: Contractors are General Electric Company, Binghamton, NY; Electronic Communication Industries, St. Petersburg, FL; Bell Helicopter Company, Fort Worth, TX; Rockwell International, Columbus, OH; Honeywell Inc., Minneapolis, MN. In-house: US Army Aviation Research and Development Command, St. Louis, MO; US Army Armament Research and Development Command, Dover, NJ; US Army Missile Command, Huntsville, AL; US Army Test and Evaluation Command, Aberdeen Proving Ground, MD; US Army Electronics Research and Development Command, Fort Monmouth, NJ.

Program Element: # 6.32.06.A
DOD Mission Area: #553 - Engineering Technology (ATD)
Title: Aircraft Weapons
Budget Activity: #2 - Advanced Technology Development

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Work performed with the goal of improved target acquisition has covered technological areas including electro-optics, infrared, millimeter wave radar, and improved stabilization. Specific efforts include the development and flight testing of airborne laser rangefinders (both galium arsenide and neogynium yag) as well as moving target indicator radars. Infrared technology has been evaluated for weapon sighting systems at low-light levels and under adverse weather conditions. Automatic target tracking from an airborne platform was demonstrated using a special-purpose electronic processing unit operating from television and Forward Looking Infrared (FLIR)-type video formats obtained from remote sighting systems. In the area of improved weapon subsystem effectiveness, the feasibility of 30mm and 40mm airburst fuzes and 30mm aluminum-cased ammunition was established. The feasibility of heliborne antiradiation missiles and use of semiactive lasers for guidance of point target weapons was demonstrated. Shallow Cone-Shaped Charge (SCSC) technology for high-energy, dual-purpose rounds was developed and is being incorporated into ammunition development programs. With respect to weapon system integration problems, specifications for external stores suspension equipment for Army aircraft were evaluated and are currently being used for the AH-1S and Advanced Attack Helicopter (AAH) systems. Fire control computers were evaluated on the Multiweapon Fire Control Testbed and specification input prepared for the AH-1S and the AAH fire control systems. To assist the AH-1S program, the feasibility of an integrated laser rangefinder with input to the rocket fire control subsystem was demonstrated on the XM-65 sight, and this hardware is now being incorporated into the AH-1S. In the area of recoil attenuation, a modified 20mm turret with a flight-qualified hydraulic constant recoil mechanism was integrated and flight tested. A breadboard model of a mount for the development of a high-impulse recoil attenuation device was completed. Based on the data obtained from medium-impulse recoil tests, a detailed mathematical model of the recoil mechanism was programed to simulate burst firings. Data from this simulation were used to further design a recoil mechanism that will be applicable to current attack helicopters and were used to compare present recoil mechanism forces with mechanism forces of a new hydraulic constant recoil concept. To assist in the area of reducing detectability of a helicopter, and hence increasing survivability, fabrication and flight testing of a mast-mounted sight feasibility demonstrator were initiated. A contract was awarded to Bell Helicopter for the design and fabrication of a nonrotating platform for a feasibility demonstration of the Mast-Mounted Sight on the OH-58C helicopter.

2. (U) FY 1981 Program: Selection of contractors for the development of an adverse environment target acquisition and fire control system will be completed. Design of the system will be initiated, which will be capable of performing the following functions: furnish fire control data for missiles, guns, and rockets; detect vehicles and air defense systems, moving and stationary; determine position of targets; classify and prioritize targets; ground mapping; and provide information for navigation update. An in-house effort will be initiated to develop requirements and a request for quotations (RFQ)

Program Element: # 6.32.06.A Title: Aircraft Weapons
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

to industry to develop a helicopter automatic targeting system which will function with electro-optic devices to automatically detect, classify, and prioritize targets in the area of search.

3. (U) FY 1982 Planned Program: Continue development of the adverse environment target acquisition and fire control system. During this year, critical radar components will be fabricated and tested, design of the system will be finalized, and long lead hardware procured. Helicopter (AH-64) interface hardware will be designed and fabrication initiated. A contract will be awarded early this year to initiate the development of a Helicopter Automatic Targeting System (HATS). This effort will involve the further advancement of the automatic target-cueing technology developed under Program Element 6.22.01.A, Aircraft Weapons Technology. The automatic target-cueing technique was investigated under this exploratory development effort, and it was determined that the technique can be applied to systems utilizing infrared and television sensor acquisition principles. The ability to track and identify up to thirty targets will be investigated. Intelligent tracking, automatic on-board target handoff, and passive ranging functions will be investigated. Design integration will be initiated to incorporate HATS into the AH-64 TADS for flight test evaluation. A program will be initiated to incorporate an active recoil mechanism into the AH-1S 20mm cannon turret in order to achieve substantial reductions in cannon recoil forces and vibrations induced into the airframe. This will permit an increase in the rate of fire for the cannon in order to enhance the aircraft's air self-defense capability. The system will improve cannon accuracy, acquisition system performance through reduced vibration/blurring during fire, and aircraft stability through reduced force while firing.

4. (U) FY 1983 Planned Program: Fabrication of the airborne adverse weather target acquisition system utilizing millimeter wave technology will continue. The pod-mounted radar will undergo tower performance test, AH-64 simulator test, and integration of the radar system into the AH-64 test aircraft for initial total system evaluation. The detail design of the Helicopter Automatic Targeting System will be completed; algorithms for both TV and FLIR will be developed. The AH-1S turreted cannon with the active recoil mechanism will undergo simulator testing. Initiation of a second-generation mast-mounted sight will begin to provide an increase in range performance and reduction of sight weight above the helicopter rotor head. A program will be initiated to combine the millimeter wave radar MICOM-developed missile RF seeker onto the AH-64 for system definition and evaluation. A program will be initiated to apply a fiber optic guided missile to a helicopter for evaluation. This program will utilize missile and guidance technology derived from current ongoing efforts by MICOM to develop a surface-to-surface fiber optic guided missile. This is an approach which will be similar to that used in the surface-to-surface wire-guided TOW missile for aircraft application. The airborne application of acoustics technology will be investigated.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: D043 Title: Aircraft Weapons Fire Control
Program Element: #6.32.06.A Title: Aircraft Weapons
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

A. (U) DETAILED BACKGROUND AND DESCRIPTION: This program is needed for the advanced development and testing of new aircraft fire control subsystems to improve the capability of aircraft under conditions of day/night adverse environment. Currently planned and available systems do not have adverse visibility capability and are limited in range. New concepts in target acquisition and fire control will be developed to improve system accuracy, terminal effects, airframe compatibility, and overall system reliability. Program objective will be accomplished through the design, fabrication, and testing of advanced development experimental hardware of fire control devices for aircraft weapon systems on attack and scout-type helicopters. The approach is to consider the several factors that make first-round hits difficult; i.e., operation at long range and low altitude, and adverse visibility environments such as night/bad weather/vegetation/background clutter. The types of fire control hardware being developed will include, but not be limited to: computers; passive and active automatic trackers; mast-mounted sight systems, acoustic sensors; fiber optic guided missiles; all-weather acquisition and targeting systems; radar, and stabilization systems. Foreign state-of-the-art trends and potential threats to present and future materiel or systems are being considered.

B. (U) RELATED ACTIVITIES: Project personnel maintain close liaison with other services and with industry to avoid duplication of effort. The Army participates in the Department of Defense Tri-Service Joint Technical Coordinating Group for Munitions Development. Army personnel working within this program participate in the North Atlantic Treaty Organization Air Armament Working Party and the Air Standardization Coordinating Committee, Working Party 20. These groups and working parties provide a medium for exchange of technical information and determination for joint use and standardization of airborne weaponization items. An Army representative serves on the Air Munitions Requirements and Development committee (AMARD), 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 #6.22.02.A, Aircraft Weapons Technology, and engineering development under Program Element #6.42.02.A, Aircraft Weapons.

C. (U) WORK PERFORMED BY: Contractors are: General Electric Company, Binghamton, NY; Electronic Communication Industries, St. Petersburg, FL; Bell Helicopter Company, Ft. Worth, TX; Hughes Helicopter Company, Culver City, CA; Rockwell Internationl, Columbus, OH; Honeywell Inc., Minneapolis, MN, and three other companies or prospective bidders accounting for $15 million of the effort. In-house: US Army Aviation Research and Development Command, St. Louis, MO; US Army Armament Research and Development Command, Dover, NJ; US Army Missile Command, Huntsville, AL; US Army Test and Evaluation Command, Aberdeen Proving Ground, MD; US Army Electronics Research and Development Command, Ft. Monmouth, NJ.

Project: #D043 Title: Aircraft Weapons Fire Control
Program Element: #6.32.06.A Title: Aircraft Weapons
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Work performed with the goal of improved target acquisition has covered technology areas including electro-optics, infrared, millimeter wave radar, and improved stabilization. Specific efforts include the development and flight testing of airborne laser rangefinders (both galium arsenide and neodynium yag) as well as moving target indicator radars. A low-light-level television was evaluated on the AH-1G in conjunction with the night fire control system. Results indicated that this was not a sound technical approach. Infrared technology has been evaluated for weapon sighting systems at low-light levels and under adverse weather conditions. Automatic target tracking from an airborne platform was demonstrated using a special-purpose electronic processing unit operating from television and Forward Looking Infrared (FLIR)-type video formats obtained from remote sighting systems. The feasibility of heliborne antiradiation missiles and use of semiactive lasers for guidance of point target weapons was demonstrated. Current programs are underway to further develop and field this technology. Airborne computers were evaluated on the Multiweapon Fire Control testbed and specification input prepared for the AH-1S and the Advanced Attack Helicopter fire control systems. To assist the AH-1S helicopter program, the feasibility of an integrated laser rangefinder with input to the rocket fire control subsystem was demonstrated on the XM-65 sight, and this hardware is now being incorporated into the AH-1S. Hardware has been developed and flight tested to evaluate Closed Loop Fire Control Systems concepts. Results have indicated that refinements are required to make significant improvements in system performance. To assist in the area of reducing detectability of a helicopter, and hence increasing survivability, fabrication and flight testing of a mast-mounted sight feasibility demonstrator were initiated. A contract has been awarded to Bell Helicopter for the design and fabrication of a nonrotating platform for a feasibility demonstration of the Mast-Mounted Sight on the OH58C helicopter.

2. (U) FY 1981 Program: Selection of contractors for the development of an adverse environment target acquisition and fire control system will be completed. Design of the system will be initiated, incorporating the following functions: furnish fire control data for missiles, guns, and rockets; detect vehicles and air defense systems, moving and stationary; determine position of targets; classify and prioritize targets; ground mapping; and provide information for navigation update. An in-house effort will be initiated to develop requirements and a request for quotations (RFQ) to industry to develop a helicopter automatic targeting system which will function with electro-optic devices to automatically detect, classify, and prioritize targets in the area of search.

Project: D043 Title: Aircraft Weapons Fire Control
Program Element: #6.32.06.A Title: Aircraft Weapons
DOD Mission: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

3. (U) FY 1982 Planned Program: Development of the adverse environment target acquisition and fire control system will be continued. During this year, critical radar components will be fabricated and tested, design of the system will be finalized, and long-lead hardware procured. Helicopter (AH-64) interface hardware will be designed and fabrication initiated. A contract will be awarded early this year to initiate the development of a Helicopter Automatic Targeting System (HATS). This effort will involve the further advancement of the automatic target-cueing technology developed under Program Element #6.22.01.A, Aircraft Weapons Technology. It has been determined that the technique can be applied to systems utilizing infrared and television sensor acquisition principles. The ability to track and identify up to thirty targets will be investigated. Intelligent tracking, automatic onboard target handoff, and passive ranging functions will be investigated. Design integration will be initiated to incorporate HATS into the AH-64 Target Acquisition Designation System for flight test evaluation.

4. (U) FY 1983 Planned Program: Fabrication of the airborne adverse weather target acquisition system utilizing millimeter wave technology will continue. A pod-mounted radar will undergo tower performance test, AH-64 simulator test and integration of the radar system into the AH-64 test aircraft for initial total system evaluation. The detail design of the Helicopter Automatic Targeting System will be completed; algorithms for both TV and FLIR will be developed. Initiation of a second-generation mast-mounted sight will begin to provide an increase in range performance and reduction of the sight weight distributed above the helicopter rotor head. A program will be initiated to combine the millimeter wave radar with a MICOM-developed missile RF seeker onto the AH-64 for system definition and evaluation. The airborne application of acoustics technology will be investigated. A program will be initiated to apply a fiber optic guided missile to a helicopter for evaluation. This concept has the potential for firing missiles in an indirect fire mode, automatic target tracking and lock on after launch for rapid, multiple target engagements.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

Project: D043 Title: Aircraft Weapons Fire Control
Program Element: #6.32.06.A Title: Aircraft Weapons
DOD Mission: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirement)	770	2507	9992	23846	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	470	2985	14134	--	Continuing	Not Applicable

The FY 1980 increase reflects under threshold reprograming to complete the mast-mounted sight feasibility demonstration effort. The FY 1981 and the FY 1982 decreases reflect reprograming to higher priority requirements at both Department of Defense and Army levels.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.32.07.A
Title: Aircraft Avionics Equipment
DOD Mission Area: #551 - Electronic & Physical Science (ATD)
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	1065	2301	5120	7300	Continuing	Not Applicable
DB97	Avionics Equipment	1065	2301	5120	7300	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: In order to survive the hostile environment created by the Warsaw Pact's massive air defenses, Army aircraft must have the improved capability to operate at nap-of-the-earth (NOE) altitudes while supporting ground combat forces around the clock at night and during adverse weather. This program element supports this requirement by providing technology demonstration and advanced development leading to engineering development of cockpit instruments, communication equipment and navigational items necessary for NOE combat. Emphasis is on hardware which will provide a capability for day/night, adverse weather aviation operations in a mid- to high-intensity war environment.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Testbed research aircraft will be used to test advanced development hardware including an electronic map, a digital communications package, and improved cockpit displays. Computer modeling of total aircraft systems vulnerability to physical and electronic attack will be used to design improved avionics survivability and reliability. Increased funding requests from FY80 to FY81 and from FY81 to FY82 are necessary to undertake previously deferred work in built-in test equipment and integrated weapons and flight sensors.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	1065	2301	5120	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	745	2471	4731	Continuing	Not Applicable

Program Element: #6.32.07.A Title: Aircraft Avionics Equipment
DOD Mission Area: #551 - Electronic & Physical Science (ATD) Budget Activity: #2 - Advanced Technology Development

(U) FY80 increase is the result of internal Army reprograming to investigate integration of cockpit lighting with recently developed night vision devices for aviators. FY81 funds show a slight decrease due to funding of higher priorities. FY82 has been increased by $400K to fully fund the Army portion of the Tri-Service Aircraft Flat Panel Displays and Integrated Controls Program according to the schedule reported to OSD in February 1981.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.32.07.A Title: Aircraft Avionics Equipment
DOD Mission Area: #551 - Electronic & Physical Science (ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Army aviation needs are addressed under this effort in the areas of effective electronic counter-countermeasures (ECCM) for aircraft radios, an all-digital aircraft avionics system to provide flexibility and backup for aircraft electronics systems, airborne digital data transfer systems to unclutter radio frequencies and improved antennas to allow long-range (non-line-of-sight) and jam-resistant communications. These systems will be flight tested in the Systems Testbed for Avionics Research (STAR) aircraft belonging to the Avionics Research and Development Activity (AVRADA). Development also includes improving the man-machine interface between pilot and helicopter to reduce the effort spent on repetitive flying requirements so that aircrews can concentrate on their tactical mission and the combat environment. Key considerations in all designs are improvements in cost, reliability, survivability and compatibility with the expected battlefield environment.

G. (U) RELATED ACTIVITIES: Related programs of the Air Force (Program Elements #6.32.03.F, Project 666A, Advanced Aircraft Navigation; and 6.32.30.F, Project 2472, Synergistic Strike System), Federal Aviation Agency (Helicopter Instrument Flight Rule Research program), and other organizations are monitored by the Army through committees and working groups. An interservice Memorandum of Agreement was signed on 5 December 1980 to establish a joint committee to determine appropriate new avionics developments for triservice development and application. Cost reduction is pursued through joint developments and hardware standardization. This program element is related to Army Program Element #6.22.02.A, Aircraft Avionics Technology, and 6.42.01.A, Aircraft Avionics.

H. (U) WORK PERFORMED BY: Avionics Research and Development Activity, Fort Monmouth, NJ. Contractors include American Electronic Laboratory, Colmar, PA; Bell Northern Research Corp., Ottawa, IA; E. Systems, Greenville, TX; Sikorsky, Stratford, CT; Raycomm, Freehold, NJ; United Technologies Research Center, E. Hartford, CT; Analytical Science Corp., Reading, PA; ANACAPA Sciences, Santa Barbara, CA.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Flight tested system for tactical hover using already developed sensors. Indications are that tactical hover may be accomplished with Lightweight Doppler Navigation System (LDNS) and that a dedicated position sensor is not required. Conducted nap-of-the-earth (NOE) communication test/evaluation program for a system that operates effectively during NOE flight in an electronic counter-countermeasure (ECCM) environment. Fabricated and integrated programmable symbology generator and multifunction display into the Digital Modular Avionics Program (DIMAP). Analyzed acoustical and electrical noise data and developed specifications for audio unit (utilizing auto correlation noise-canceling techniques) to reduce pilot's headset noise. Investigated use of liquid crystal displays for helicopter instrumentation. Evaluated conventional flight director systems to allow helicopter instrument landings. Accomplished

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computer modeling of aircraft vulnerability, survivability, performance, and avionics reliability. Completed development of voice gating circuitry. Evaluated cockpit lighting techniques. Completed investigation of state-of-the-art low-airspeed sensing system. Demonstrated single-frequency transmission system. Developed and installed integrated target location and navigation system for Optic IV OH-6A helicopter which provides evaluation of automatic target location, offset navigation update and night hover capability. Conducted steady state hover tests of night navigation and pilotage system. Completed concept formulation package for nap-of-the-earth communications system.

2. (U) FY 1981 Program: Complete the installation of the Integrated Avionics Control System (IACS) and the Night Navigation Pilotage System (NNPS) in the Systems Testbed for Avionics Research (STAR) aircraft. Flight test a digitally generated electronic map, computer-generated landing symbology, and the improved terrain correlation navigation software in the STAR. Initiate a program to develop an Electronic Master Monitor Display System (EMMADS) for attack, scout, and utility helicopters. Continue developing improvements in aircraft speech communications in the nap-of-the-earth (NOE)/Electronic Warfare environment. Transition Electronic Master Monitor Advisory Display System from 6.2 (Technology Base) and award contract for two (2) flyable systems. Furnish input for a Letter of Agreement (LOA) for a solid state programable multiformat (graphics) display aimed at simplified cockpit layout and reduced aircrew workload. Complete fabrication, and bench test two (2) Airborne Data Transfer Systems.

3. (U) FY 1982 Planned Program: The goal is to develop an avionics system with integrated sensors, processors, control and displays and target handoff capability. Faced with more sophisticated aircraft systems which are required to perform difficult missions in the night nap-of-the-earth (NOE) environment, the pilot must have an integrated cockpit and avionics system. The second step in the development of this integrated avionics system will be the installation of the ADAS (Army Digital Avionics System) using a Digital Data Bus Controller. This system will result in increased survivability, reduced pilot workload, and improved mission performance for day NOE operations. Continue incrementally funded programs to develop an Electronic Master Monitor Advisory Display System. Continue efforts on a programmable solid state multiformat graphics display. Install Army Digital Avionics System (ADAS) and Phase II multifunction CO2 NOE sensor in the Systems Testbed for Avionics Research (STAR).

4. (U) FY 1983 Planned Program: Complete the installation of the Army Digital Avionics System (ADAS) in the Systems Testbed for Avionics Research (STAR). Perform flight tests and certify the ADAS/STAR for safety of flight. Flight test promising configurations resulting from exploratory development tasks. Begin Electronic Master Monitor Display System (EMMADS) flight test program. Award a contract for systems development of the solid state multiformat (graphics) display. Initiate a system development effort for a control display unit. Initiate development of Ground-Passive Secondary Radar processor/display system to improve Air Traffic Control/Air Defense capabilities. Develop decelerating steep approach and

Program Element: #6.32.07.A Title: Aircraft Avionics Equipment
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landing equipment for experimental use in support of tactical landing system developments. Continue Attitude Heading Reference System (AHRS) effort based on the results of the 6.2 Program. Complete testing of the target handoff system and award contract for low-rate initial production units. Initiate engineering effort to formulate an advanced state-of-the-art aircraft communications package featuring digital communication techniques for both voice and data transfer and data bus compatibility.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.32.09.A
Title: Air Mobility Support
DOD Mission Area: #553 - Engineering Technology (ATD)
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	302	1856	1842	3201	Continuing	Not Applicable
DB31	Manufacturing Technology	0	381	300	1177	Continuing	Not Applicable
DB33	Cargo Handling Equipment	0	332	538	838	Continuing	Not Applicable
DB45	Aviation Life Support Equipment	150	395	1004	1186	Continuing	Not Applicable
D103	Helicopter Anti/De-icing	152	748	0	0	0	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program supports the advanced development and testing of air-mobility prototype support equipment and needed concepts through the use of advanced systems hardware demonstrations. The needed concepts being developed are designed to enhance the efficiency, safety, and survivability of air crewmembers operating in a hostile tactical environment. The proliferation of ground support equipment is reduced by the development of standardized items applicable to more than one aircraft system.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Manufacturing Technology: Production techniques will be developed for producing spiral bevel gears with analytically determined tooth forms. Objectives are to reduce fabrication costs, improve loadcarrying and reduce vibration and noise characteristics. Cargo Handling Systems (CHS): Based on the requirement for increased cargo capability for the utility helicopter, advanced development will be initiated to enhance the productivity of the UH-60 Blackhawk utility helicopter in both the internal and external delivery of cargo. Specific items include a utility helicopter adaptation of the Internal Cargo Handling System (ICHS) developed for the CH-47 Chinook. The ICHS reduces both loading times and the critical cargo space required for in-flight restraint by use of floor rollers, stressed end barriers and tiedown points; an 8x8x10-foot Helicopter External Gondola System (HEGS-10) provides a means of fast loading-unloading of aggregated or bulk external loads; and a Tandem Two-Hook Beam (TTHB) concept for enhancing the flight stability of external loads suspended from single-hook helicopters in nap-of-the-earth flight. Advanced development will also be initiated on new lightweight, long-life external slings using advanced materials such as Kevlar. Solutions for load acquisition problems and hazards will be the objective for both a Low Visability Load Acquisitions Systems (LOVLAS) and a Static Electric Discharge System (SEDS). Aviation Life Support Equipment (ALSE): Development will continue on priority items to enhance

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aircrew efficiency and crash survivability. Joint Army/Navy automatic crash-activated Inflatable Body and Head Restraint System (IBAHRS) will complete validation testing. The principal application is to attack helicopters since the IBAHRS forces the occupant back in his seat to prevent him from impacting on weapon sighting systems or other structural cockpit equipment. An Advanced Development contract will be awarded for a new Integrated Aircrew Helmet System (IAHS) which will provide a single helmet that is compatible with Chemical/Biological (CB) equipment, oxygen masks, aircraft sighting systems and night vision goggles. Concept development will be initiated to define the optimum approach to allow current Army aircraft systems to operate in a Chemical-Biological (CB) environment. Helicopter Anti-de-icing: Project D103 has been terminated with the helicopter anti-de-icing programs reverting to an exploratory development effort under Program Element (P.E.) No. 6.22.09.A, Aeronautical Technology, Project AH-76.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	302	1856	1842	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	650	1969	2382	Continuing	Not Applicable

The differences in FY 1980 funds reflect a general reprograming to higher priority Army requirements. The decrease in FY 1981 funds is attributable to general Congressional reductions. The decrease in FY 1982 funds reflect a reprograming within the Army to higher priority requirements.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.32.09.A Title: Air Mobility Support
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is to continue advanced development of conceptual prototypes that allow new items of mission support equipment to enter engineering development. Efforts underway in this program will lead to development of hardware needed to support current and future aircraft systems and to enhance the safety and survivability to the aircrew/aircraft. The projects under this program have transitioned from exploratory developments. The following projects comprise the program element: Manufacturing Technology: This project was initiated in FY 1981 to develop new manufacturing techniques primarily to reduce production cost, but enhanced performance can often also result. Operational and Maintenance Support Equipment: New multipurpose ground support equipment (GSE) concepts are to be validated to support engineering development or procurement of commercial items. This multipurpose GSE can reduce the proliferation of support items and enhance aircraft maintenance and servicing, especially austere forward sites. This project is unfunded through FY 1983. Cargo Handling Systems: New concepts and techniques for movement of cargo both internally and externally by helicopter are developed. These systems enhance the mobility of Army and Marine Corps field units by tactical deployment of priority equipment, supplies, and munitions. This project has been unfunded in FY 1979 through FY 1981. Aviation Life Support Equipment (ALSE): Equipment is developed to provide safety to the aviator and increase his survivability in the aircraft and on the ground. Equipment must also be developed to allow the aviator to effectively perform the function required by his mission in a Nuclear, Chemical, and Biological environment. Significant portions of these efforts have been accomplished by joint programs with the US Navy. Helicopter Anti-de-icing: Analysis of the helicopter adverse weather capability has led to advanced development of electrothermal anti-de-icing systems for rotor blades and other critical components. Applications of ice phobic coating techniques offer a means of providing a simple, cheap, easy-to-apply ice protection to Army helicopters.

G. (U) RELATED ACTIVITIES: Aeronautical Technology Program Element 6.22.09.A, Air Mobility Support Equipment; Helicopter Anti-de-icing efforts are coordinated with NASA, FAA, USAF, and USN by participation in joint working groups. Related Cargo handling equipment engineering development is conducted under PE 6.42.04.A (Air Mobility Equipment). Cargo handling equipment developments are closely coordinated with airdrop developments through the Joint Technical Coordinating Group for Airdrops. Project personnel maintain close liaison with other military services and industry as well as participate in Joint Working Groups.

H. (U) WORK PERFORMED BY: Naval Air Development Center, Warminister, PA; Natick Research and Development Command, Natick, MA; US Army Aviation Research and Development Command, St. Louis, MO; Thiokol Chemical Company, Inc., Brigham City, UT; Technar, Arcadia, CA.

Program Element: #6.32.09.A
DOD Mission Area: #553 - Engineering Technology (ATD)

Title: Air Mobility Support
Budget Activity: #2 - Advanced Technology Development

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Aviation Life Support Equipment (ALSE): Joint Army/Navy development of an Inflatable Body and Head Restraint Systems (IBAHRS) has been initiated. Preliminary efforts have been initiated to develop an Integrated Aircrew Helmet System (IAHS). Helicopter Anti-de-icing: Project started in 1977 with analysis of ice protection requirements for Army helicopters. Design, fabrication, and installation of ice-protected components for UH-1H test demonstration helicopters were initiated. Initial flight tests in both natural and simulated icing conditions have been completed. The objectives of these tests were to expand the icing test envelope and to gather additional data on ice protection system design and performance characteristics. This project has been transferred to exploratory development effort under Program Element 6.22.09.A, Aeronautical Technology, Project AH-76.

2. (U) FY 1981 Program: Aviation Life Support Equipment (ALSE): The Naval Air Development Center will award an advanced development contract for design and fabrication of the Inflatable Body and Head Restraint System (IBAHRS). A separate contract will be awarded by the Aviation Research and Development Command for systems integration of this restraint system first in the AH-64. Development Test I (DT I) will be initiated. Statement of work will be completed for an advanced development contract for the Integrated Aircrew Helmet System (IAHS). Manufacturing Technology: Initiate development of new techniques for producing spiral bevel gears to increase item life expectancy and reduce costs. Cargo Handling Equipment: Continuation of evaluation and resolution of container lift adapter helicopter problems from development and operational testing.

3. (U) FY 1982 Planned Program: Aviation Life Support Equipment (ALSE): The Inflatable Body and Head Restraint System (IBAHR) validation will be completed, and a production decision will be made for its incorporation in the AH-64. Program will transition to engineering development for qualification for multiple aircraft application. Advanced development contract will be awarded by the Natick Research and Development Command for the Integrated Aircrew Helmet System (IAHS) prototypes. Investigations will be conducted to define the specific needs of Army aircraft in a Nuclear, Biological, and Chemical (NBC) environment. Aircraft-mounted equipment such as positive pressure/filtration systems and airborne alarms will also be addressed. Cargo Handling Systems (CHS): Internal Cargo Handling System (ICHS) hardware configuration applicable to utility helicopter and an 8x8x10 helicopter external gondola system will be procured for Development Test/Operational Test I (DT/OT I). A flight test program will be completed on a Tandem Two-Hook Beam (TTHB) to demonstrate the enhanced performance provided the UH-60 when carrying external cargo. A 25,000-lb capacity helicopter sling consisting of Kevlar rope sling legs, Kevlar bonded strand-apex fitting and an improved lightweight chain leg/grab hook assembly will be procured for DT/OT I. Advance development will be initiated on a low-visibility, advanced load acquisition system. Manufacturing Technology: Development of techniques for producing advanced spiral bevel (ASB) gears will be continued with establishment of critical characteristics and projected performance and fabrication cost for ASB gears.

Program Element: #6.32.09.A Title: Air Mobility Support
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

4. (U) FY 1983 Planned Program: Aviation Life Support Equipment (ALSE): Advanced development of the Integrated Aircrew Helmet System (IAHS) will be completed, and the effort will transition to engineering development. The concept formulation effort on Nuclear, Biological, and Chemical (NBC) protection will be continued. Cargo Handling Systems (CHS): Acquisition of an Integrated Cargo Handling System (ICHS) for utility helicopters will be completed upon Development Test/Operational Test I (DT/OT I) conducted with the UH-60. Acquisition of selected advanced cargo handling systems components will be completed and DT/OT I initiated. Contract will be awarded for External Load Acquisition System Prototype for DT/OT I. Advanced development will be initiated on an active Static Electric Discharge74 System (SEDS) for helicopters to provide for safe and efficient external cargo operations. Manufacturing Technology: Fabrication costs and performance of advanced spiral bevel gears as compared with conventional spiral bevel gears will be analyzed and appropriate trade-offs made. Additionally, manufacturing techniques will be developed to insure producibility at reduced costs, of composite rotor hubs for application to developmental and future helicopter systems. Techniques will also be developed for wet filament winding of contoured aircraft structured elements and components.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.32.11.A
DOD Mission Area: #553 - Engineering Technology (ATD)

Title: Rotary Wing Controls, Rotors, and Structures
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	5067	12792	28520	TBD	Continuing	Not Applicable
DB41	Advanced Structures	1970	6571	16282	TBD	Continuing	Not Applicable
D313	Research Aircraft Systems	475	465	775	971	Continuing	Not Applicable
D314	Advanced Rotor Systems	226	864	2161	10022	Continuing	Not Applicable
D315	Advanced Flight Controls	2396	4892	9302	10562	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Army needs these Advanced Technology Programs in order to be able to field future aviation systems that are less expensive, more reliable, more maintainable, and more survivable. These programs represent investments in order to maximize Army aviation's future availability to perform its combat mission. This Program Element provides for the Advanced Development and Demonstration of Full-Scale Aircraft Components and Subsystems. As such, the work supported by this program element directly addresses these critical needs essential to future operational effectiveness through full-scale flight testing and demonstration of advanced state-of-the-art components and subsystems. Recently, major emphasis has been placed on advanced composite rotary-wing structures for lower weight, lower costs, longer life, and improved survivability; on advanced rotors for improved performance and ballistically tolerant materials at lower cost and with reduced maintenance requirements; and on advanced flight controls for reduced weight and cost, improved survivability, and reduced pilot workload and initial training requirements. Support costs for maintaining the experimental research and test aircraft used in the above programs are carried under a separate project line (D313) as shown above.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Project DB41: Continues the Army's Advanced Composite Airframe Program (ACAP) to demonstrate that composite materials can be used as primary structural components at reduced cost and consistent with the environment expected for Army aircraft. Project D313: Continues support for research aircraft used in exploratory and advanced development. This is necessary to permit flight demonstrations of emerging new concepts. Research aircraft include the Rotor Systems Research Aircraft (RSRA), the UH-1H in-flight simulator, XV-15 Tilt Rotor, and other aircraft participating in joint Army/NASA projects. Project D314: Continues the Army's advanced rotor system demonstration program. Project D315: Continues the Army's advanced digital-optical flight control demonstration program for rotary-wing applications.

Program Element: #6.32.11.A
DOD Mission Area: #553 - Engineering Technology (ATD)
Title: Rotary Wing Controls, Rotors, and Structures
Budget Activity: #2 - Advanced Technology Development

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in Thousands)

RDTE	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
Funds (current requirements)	5067	12792	28520	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	5890	13779	31553	Continuing	Not Applicable

The FY 1980 decrease is the result of reprograming action to higher priority Army programs. The FY 1981 decrease reflects the application of general Congressional reductions and decreases for improved efficiencies. The FY 1982 decrease reflects program restructuring due to reallocation of funds to higher priority Army programs.

E. (U) OTHER APPROPRIATION FUND: Not Applicable.

Program Element: #6.32.11.A
DOD Mission Area: #553 - Engineering Technology (ATD)

Title: Rotary Wing Controls, Rotors, and Structures
Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This advanced development program provides for the development, verification, and demonstration of technology in areas currently restricting Army airmobile systems. This continuing program is formulated on the basis that advances in state-of-the-art technology will be made only if technology is validated and technical confidence is gained through component or system demonstration in actual or simulated flight conditions. The program includes efforts in advanced rotors and flight control systems and in the application of advanced structures. Foreign state-of-the-art trends and potential threats to the present and future materiel systems have been considered.

G. (U) RELATED ACTIVITIES: The technology being developed and demonstrated in this program is closely coordinated and related to work being conducted by the Navy, Air Force, and National Aeronautics and Space Administration (NASA).. Duplication of effort is avoided through coordination with these agencies and on a continuing basis through joint program reviews, exchange of information and reports, the Technical Cooperation Program, NASA Research and Technology Committees, North Atlantic Treaty Organization (NATO) Standardization Agreements (STANAG's), and the NATO Advisory Group on Aerospace Research and Development (AGARD). 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, as well as to other major Army aircraft systems currently under development (AH-64-Advanced Attack Helicopter). The Tilt Rotor Research Aircraft program is jointly funded by the Army, Navy, and the National Aeronautics and Space Administration (NASA), and the rotor research program utilizing the Rotor Systems Research Aircraft is jointly funded by NASA and the Army only. Numerous tasks in this program had their origin within efforts performed in Program Element 6.22.09.A, Aeronautical Technology.

H. (U) WORK PERFORMED BY: This work is performed by the Research and Technology Laboratories of the US Army Aviation Research and Development Command located at Moffett Field, CA; Fort Eustis, VA; and Hampton, VA. Work in related activities is also performed by the National Aeronautics and Space Administration (NASA) Ames and Langley Research Centers, located at Moffett Field, CA, and Hampton, VA. The top five contractors are: Hughes Helicopters, Culver City, CA; Sikorsky Aircraft, Stratford, CT; Boeing Vertol Company, Philadelphia, PA; Kaman Aerospace Corporation, Bloomfield, CT; and Bell Helicopter Textron, Fort Worth, TX. Much of the contract work is competitive, and the contractors are to be determined. The total anticipated contract dollar value for FY 1982 is approximately $20,000,000.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:
1. (U) FY 1980 and Prior Accomplishments: Project DB41: The Advanced Composite Airframe Program (ACAP) was initiated in FY 1979. A preliminary design was conducted which included trade-off investigations and concept selections. This effort was concluded in FY 1980. In FY 1980 a Request for Proposal (RFP) was released and proposals received for Phase I (detailed design and support testing) and Phase II (full-scale fabrication and ground/flight tests). The proposals are being evaluated

Program Element: #6.32.11.A Title: Rotary Wing Controls, Rotors, and Structures
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with an expected award in early 2nd Quarter FY 1981. Project D313: This project was initiated to allow support cost for research aircraft to be identified separately from the cost of research conducted on/with the aircraft. Separation of research and support cost will facilitate tracking expenses. In FY 1980 these funds supported the UH-1H V/STOLAND aircraft involved in the controls program; the YO-3A aircraft,which was used for AH-1S (Ogee Tip) in-flight acoustic measurements; the Rotor Systems Research Aircraft (RSRA) being readied for testing an S-61 rotor system; and the Tilt Rotor Research Aircraft currently completing concept validation. Project D314: Advanced rotor work was previously accomplished under project D157. The most recent effort completed was the feasibility demonstration of the Bearingless Main Rotor (BMR) concept. In FY 1980 the Integrated Technology Rotor (ITR) Program was initiated, although at a limited level due to funding reductions, to demonstrate and validate the application of advanced rotor technology. Funds from the project were also used in support of the S-61 rotor flight research efforts to establish a data base for the ITR. Project D315: All work in this area, was conducted under the Advanced Digital/Optical Control System (ADOCS) program. Primary emphasis has been on the contractual development of various digital/optical components to include control media mechanization, fiber optic transducers, optical servovalves, nonconventional electric power supplies and advanced rotor actuation concepts.

2. (U) FY 1981 Program: Project DB41: The Advance Composite Airframe Program (ACAP) is currently in the proposal evaluation phase. Source selection procedures and contract award are scheduled to be completed 2nd Quarter FY 1981. FY 1981 efforts will focus on detail design of the airframe structure with consideration given to structural integrity, manufacturing methods, crashworthiness, and ballistic tolerance. Project D313: Noise measurements on a Hughes 500D with standard and four-bladed tail rotor will be conducted using the YO-3A aircraft. The UH-1H will be used for performance and icing tests both with and without an icing boot. Flight testing will begin with an AH-1G instrumented helicopter during FY 1981. This test will provide simultaneous blade pressure and in-flight noise measurements. Tilt Rotor concept testing and aircraft engineering documentation will continue to be supported. Project D314: Although possibly being delayed due to funding reductions, competition is still planned to be held and multiple contracts awarded in the Last Quarter FY 1981 to conduct concept definition of the Integrated Technology Rotor (ITR). This phase will examine various concepts, geometric constraints, approximate stress analysis, component sizing, and control system layouts to identify an optimum structural configuration on which to base a preliminary design. Project D315: Component development programs initiated in FY 1980 will be completed and fabrication will be initiated. A contract will be awarded for development of an advanced controller and related flight control system. The Advance Digital/Optical Control System (ADOCS) flight demonstrator Request for Proposal (RFP) will be issued 1st Quarter FY 1981 with planned award 3rd Quarter FY 1981.

Program Element: #6.32.11.A
DOD Mission Area: #553 - Engineering Technology (ATD)

Title: Rotary Wing Controls, Rotors, and Structures
Budget Activity: #2 - Advanced Technology Development

3. (U) FY 1982 Planned Program: Project DB41: The Advanced Composite Airframe Program (ACAP) detail design will be completed along with the critical design review. Testing of specimens and test fixtures will be undertaken. Manufacturing techniques will be assessed. Project D313: The Rotor Systems Research Aircraft (RSRA), configured in the helicopter mode, will continue S-61 helicopter rotor testing. A four-bladed rotor will be selected and readied for installation. Concept validation and engineering documentation will be completed on the Tilt Rotor Research aircraft. Support for research activities with the YO-3A, UH-1H, AH-1G, and CH-47 will continue. Project D314: Results of the concept definition phase will be evaluated and multiple contracts awarded 3rd Quarter FY 1982 for the Integrated Technology Rotor (ITR) preliminary design which will extend the concept definition to the entire rotor system including blade design, controls/interface with flight vehicle, aerodynamic stability, loads, and handling qualities. Project D315: Emerging results from the advanced controller/flight control effort will be briefed and incorporated in the Advance Digital/Optical Control System (ADOCS) flight demonstrator preliminary design. Advanced rotor actuation concepts will be completed with submission of the final report. Recommendations will also be included in the preliminary design which will be completed 1st Quarter FY 1982. Detailed design of the ADOCS demonstrator will be completed 2nd Quarter FY 1982 and fabrication approximately half completed by the end of FY 1982.

4. (U) FY 1983 Planned Program: Project DB41: During the first half of FY 1983, Advance Composite Airframe Program (ACAP) design support tests will be completed and proposed manufacturing methods assessed. An in-process review will be held to evaluate contract efforts to date and provide final approval of complete aircraft detail design. On or about 3rd Quarter FY 1983, contractual efforts will be initiated for detailed tooling designs, development of manufacturing plans, and fabrication of full-scale airframe tooling. Project D313: S-61 rotor research will be completed. A helicopter-configured Rotor Systems Research Aircraft (RSRA) will be used in the four-bladed rotor test program. The Tilt Rotor aircraft will complete documentation testing, making the aircraft available for more extensive Army operational suitability tests and demonstrations to isolate known missions where the tilt rotor concept provides significant advantages over other aircraft configurations. Project D314: Preliminary design of the Integrated Technology Rotor (ITR) will be completed during 3rd Quarter FY 1983. At this time, one or two contractors will be selected to conduct detailed design, fabrication, and flight test hardware including controller, sensors, and prepare for initiation of the High Technology Rotor (HTR). Project D315: Fabrication of flight test hardware including controller, sensors, and optical interconnects will be completed and tested prior to aircraft installation. Flight safety releases will be obtained. First flight will occur 4th Quarter FY 1983.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #DB41 Title: Advanced Structures
Program Element: #6.32.11.A Title: Rotary Wing Controls, Rotors, and Structures
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

A. (U) DETAILED BACKGROUND AND DESCRIPTION: The objective of this project is to demonstrate and establish advanced structures technology for helicopters. This program is designed to demonstrate that composite materials technology can be successfully applied to primary rotorcraft structures to reduce technical risk and to gain significant system improvements including: reduced weight, cost, ballistic damage tolerance; reduced radar cross section; improved crashworthiness; reduced maintenance; and improved survivability while operating in hostile environments. Composite materials require less energy than metals for fabrication, will reduce demand for expensive and precious metals in short supply, and show great promise for reduced life cycle costs. The technology resulting from this program will be applicable to current aircraft (UH-60 Black Hawk, AH-64 Advanced Attack Helicopter) and future Army aircraft systems and ultimately benefit other DOD services and the US helicopter industry as well.

B. (U) RELATED ACTIVITIES: The technology being developed and demonstrated in this program is related to Navy (62241N - Aircraft Technology) and the National Aeronautics and Space Administration (NASA) Research and Technology Objectives Plan (505-42-13). Duplication of effort is avoided by coordination with these agencies on a continuing basis through: joint program reviews, exchange of technical data and reports, The Technical Cooperation Program (TTCP), NASA research and technology committees, North Atlantic Treaty Organization (NATO) Standardization Agreements (STANAGS), and the NATO Advisory Group on Aerospace Research and Development. This technology program is coordinated in the tri-Service Aeronautical Vehicle and Structures Technology Coordinating Papers (TCP). Efforts under this program are related to Exploratory Development being accomplished under Program Element #6.22.09.A, Aeronautical Technology (Tech Area - AH76B). As part of a joint Army-NASA agreement initiated in 1979 the NASA Langley Research Center and the collocated Army Structures Laboratory (Army Aviation Research and Development Command) have structured a comprehensive Advanced Rotorcraft Technology Program to follow and complement the Army's Advanced Composite Airframe Program (ACAP). NASA, in turn, will investigate second-generation concepts for possible civil applications. These two programs are being closely coordinated to avoid duplication and derive maximum advancements in composite technology.

C. (U) WORK PERFORMED BY: This work is performed by the Applied Technology Laboratory at Fort Eustis, Virginia, a part of the US Army Aviation Research and Development Command. For FY 1981 two contractors will be competitively selected from preliminary design concepts developed by five prime helicopter companies including Hughes Helicopters, Sikorsky Aircraft, Boeing Vertol Company, Bell Helicopter Textron, and Kaman Aerospace Corporation. The total anticipated contract dollar value for FY 1982 is $14,000,000.

Project: #DB41 Title: Advanced Structures
Program Element: #6.32.11.A Title: Rotary Wing Controls, Rotors, and Structures
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: The preliminary design of the Army's Advanced Composite Airframe Program (ACAP) was initiated in FY 1979 as the principal effort for project number DB41. Preliminary concept design was solicited from all of the prime helicopter companies. This effort included trade-off investigations and concept selections with emphasis on choosing the best concepts for composite structural joining, fabrication, assembly, and tooling. All primary and secondary airframe structure designs considered maximum benefits from weight, cost, producibility, maintainability, vulnerability, and survivability. The preliminary design investigation was completed in FY 1980, and the weight and cost savings were confirmed to be achievable. The next step was to demonstrate these improvements and to establish confidence in composite materials for primary airframe structures. Phase I (detail design and support testing) and Phase II (full-scale fabrication, ground/flight test) planning was therefore initiated, and proposals for this effort were received for evaluation. Technical personnel were drawn from the Army research community including the Ballistics Research Laboratory (BRL) and the Army Materiel and Mechanics Research Center (AMMRC), and additional personnel from NASA, the Navy, and the Air Force provided additional expertise for the Phase I selection. Input considered from related exploratory/advanced development technology program includes: aeronautical, structures, propulsion, avionics, reliability and maintainability, and safety and survivability.

2. (U) FY 1981 Program: Offerors have submitted proposals for a two-phased Advanced Composite Airframe Program (ACAP) consisting of detailed design, design support testing, full-scale component fabrication, laboratory structural test, and flight demonstration. The completion of the "Four-Step" source selection procedure and contract award of two contracts is scheduled for March 1981 (2d Quarter FY81). Phase I, detailed design and design support testing, effort will be initiated with Phase I period of performance being approximately 24 months. The FY1981 contractual effort will focus primarily on the detail design of the composite airframe structure. Design considerations of structural integrity, manufacturing methods, crashworthiness, ballistic tolerance, and interface with vehicle systems and subsystems (i.e., rotor, engine, flight controls, avionics, etc.) will be the areas of principal consideration.

3. (U) FY 1982 Planned Program: During FY 1982 a refined detailed design effort of Phase I will be completed with critical design reviews (CDR) conducted by Applied Technology Laboratory (ATL) technical personnel. Additionally, design of test specimens (i.e., airframes sections, subcomponents, joints, attachments, etc.) and test fixtures will be initiated. Test specimen and fixtures will be fabricated and laboratory design support tests initiated. The design support tests will be conducted to verify and quantify structures and materials, radar reflectivity, drag/stability, airframe/landing gear drop test capability, and laser and lightning characteristics. Manufacturing methods for full-scale airframe fabrication, along with detailed design and design support test efforts, will also be further assessed and a final selection made.

Project: #DB41 Title: Advanced Structures
Program Element: #6.32.11.A Title: Rotary Wing Controls, Rotors, and Structures
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

4. (U) FY 1983 Planned Program: During the first half of FY 1983, the laboratory design support tests will be completed, and any impact on the detailed design and proposed manufacturing methods will be assessed. An in-process review (IPR) will be conducted to review and evaluate the results of support testing, determine the suitability of preliminary tooling designs, and provide final approval of completed aircraft detailed design. These efforts will complete the contractual requirements of Phase I. On or about April 1983 (3rd quarter FY 1983), the Phase II contractual efforts will be initiated. Detailed tooling designs and manufacturing plans will be developed along with fabrication of full-scale airframe tooling.

5. (U) Program to Completion: Phase II contractual effort will be continued with airframe fabrication, structural test, flight vehicle assembly, and ground and flight test demonstration. These efforts will consist of fabricating three (3) complete airframe assemblies. The manufacturing techniques selected will be assessed with regards to compatibility with the advanced structural configuration, and cost tracking of composite components will be performed to substantiate projected production cost trends. The full-scale airframe components and airframe assemblies will be subjected to laboratory structural tests (i.e., static & dynamic), ballistic tests, and airframe drop tests. Upon successful completion of the laboratory structural tests, a complete flight vehicle will be assembled, ground tested, and flight tested.

6. (U) Major Milestones:

Major Milestones	Current Milestone Dates	Milestone Dates Shown in FY 1981 Submission
Preliminary Design Completion	3Q FY 1980	3Q FY 1980
Phase I Award	2Q FY 1981	4Q FY 1980
Phase I Completion	2Q FY 1983	3Q FY 1982
Phase II Award	3Q FY 1983	3Q FY 1982
Phase II Completion/ ACAP Program Completion	3Q FY 1985	3Q FY 1984

The six-month delay in Phase I Award was due to the additional time required by the Source Selection Advisory Council (SSAC) to review the Request For Quotations (RFQ) and the Source Selection Evaluation Plan (SSEP) and by the competitors to prepare for proposals. Also, additional time was required in the four-step source selection procedure. The effect is a delay of the ACAP Program completion by one year.

Project: #DB41 Title: Advanced Structures
Program Element: #6.32.11.A Title: Rotary Wing Controls, Rotors, and Structures
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	1970	6571	16282	TBD	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	2500	7050	15053	N/A	Continuing	Not Applicable

The amount of funds decreased in FY 1980 was due to reprograming for higher priority Army programs. The decrease in FY 1981 reflects the application of general Congressional reductions and reductions for improved efficiency. The increase in the FY 1982 estimate reflects an FY 1982 amendment program adjustment necessitated by refinement of the Army's advanced structures program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #D315 Title: Advanced Flight Controls
Program Element: #6.32.11.A Title: Rotary Wing Controls, Rotors, and Structures
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

A. (U) DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is to advance flight control technology for Army aircraft through development, verification, and validation of improved flight control concepts. This is necessary to provide improved capability, survivability, reliability, maintainability, and a better crew-aircraft interface, for rotorcraft weapons systems. The program includes the integration of flight control system logic, mechanization, displays, sensors, and control media into the aircraft system. The basic approach uses digital avionics and fiber optics. The principal goal of the program is to permit pilots to perform multifunctional operational missions without being individually saturated by excessive workloads. Critical test missions include tactical flight profiles for nap-of-the-earth/low-level terrain flying during adverse weather and hostile battlefield conditions for both day and night operations.

B. (U) RELATED ACTIVITIES: The technology being developed and demonstrated in this program closely follows related Navy (Program Element #6.22.41.N, Aircraft Technology), Air Force (Program Element #6.22.01.F, Flight Dynamics), and National Aeronautics and Space Administration (NASA) programs (Research and Technology Operations Plan: 505-42-31). Coordination with these agencies and others is accomplished on a continuing basis to include: joint program reviews; exchanges of technical information and reports; execution of joint projects; and program interfaces required as part of the Department of Defense Tri-Service Aeronautical Vehicle Technical Coordinating Paper (TCP). Program duplication of effort is also avoided through technical panel and action group coordination as a part of The Technical Cooperation Program (TTCP), NASA's Research and Technology Committees, North Atlantic Treaty Organization (NATO) Standarization Agreements (STANAG's) and the NATO Advisory Group on Aerospace Research and Development (AGARD). This program is supported, in part, by exploratory development activities under Program Element #6.22.09.A, Aeronautical Technology, as well as to other major Army aircraft systems currently under development (AH-64 Advance Attack Helicopter).

C. (U) WORK PERFORMED BY: This work is performed by the Research and Technology Laboratories, a part of the US Army Aviation Research and Development Command. Laboratories located at Moffett Field, CA, and Fort Eustis, VA, will execute the program. Work in related activities is also performed by the National Aeronautics and Space Administration (NASA) Ames located at Moffett Field, CA. The contracts for FY 1981 will be competitively determined. The total anticipated contract dollar value for FY 1981 is approximately $3,200,000.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

Project: #D315 Title: Advanced Flight Controls
Program Element: #6.32.11.A Title: Rotary Wing Controls, Rotors, and Structures
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

1. (U) FY 1980 and Prior Accomplishments: The Advanced Digital/Optical Control System (ADOCS) Determination and Findings (D&F) was approved 3rd Quarter FY 1979. Major accomplishments in FY 1980 included completion of contracts with Bell Helicopter Textron and Boeing-Vertol for preliminary design of an advanced scout helicopter fly-by-wire (FBW)/fly-by-light flight control system. These efforts validated anticipated payoffs associated with application of ADOCS-related technology to a medium- or small-sized production helicopter. As part of the ADOCS component program, the following awards were made in FY 1980: Control media mechanization (2 contracts) - Boeing Aerospace and Harris Corporation to investigate Electromagnetic Interference-Electromagnetic Pulse (EMI-EMP) lighting, and nuclear effects on fly-by-wire and fiber optic control systems; fiber optic transducers (6 contracts) - Bertea and Teledyne Corporations to develop electrically passive optical pressure transducers; Sperry and Boeing Aerospace Companies to develop electrically passive critical linear position transducers; and TRW and Hamilton Standard Corporations to develop electrically passive optical rotary position transducers. Two contracts were awarded (Bertea and Sperry) to develop an optical servovalve and nonconventional electric power supply for an actuator requiring no externally supplied electrical power. A Request for Proposal (RFP) was released for the investigation of an advanced controller/Advanced Flight Control System (AFCS). This will be a single contract (due to be awarded 2nd Quarter FY 1981) to develop advanced control laws and an improved cockpit controller. In preparation for an FY 1981 Request for Proposal (RFP) release, discussions were held with major helicopter producers relative to content and structure of the Advanced Digital/Optical Control System (ADOCS) flight demonstration program in order to assist the government in generating the Request for Proposal (RFP). Coordination with the Navy, Air Force, and NASA has also been established and their technical assistance received in preparation of contractual statements of work and evaluation of proposals.

2. (U) FY 1981 Program: The two control media mechanization programs initiated in FY 1980 will be completed in FY 1981 providing data on optimum control media paths along with information on additional testing necessary to assure successful utilization in a control system. The six digital optical transducer programs initiated in FY 1980 will have completed the preliminary and detail design phases and will have initiated fabrication. Design data obtained under previous contracts will be available for the Advanced Digital/Optical Control System (ADOCS) flight demonstration contractor for preliminary system design. The optical servovalve contract awarded in last quarter FY 1980 will be through the preliminary and detail design phases and ready to initiate fabrication. The Advanced Controller Advanced Flight Control System (AFCS) contract award is planned for first quarter FY 1981 with a 24-month period of performance. During this period, initial literature review analyses and simulations will be completed. Two advanced rotor actuation concept contracts will be awarded in first quarter FY 1981 with a period of performance of 15 months. All technical work under these contracts will be completed in FY 1981 and will include preliminary designs of small- and medium-size helicopter rotor actuation concepts. The Advanced Digital/Optical Control System (ADOCS) flight demonstration Request for Proposal (RFP) will be issued early second quarter

Project: #D315 Title: Advanced Flight Controls
Program Element: #6.32.11.A Title: Rotary Wing Controls, Rotors, and Structures
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

with planned award in fourth quarter FY 1981. A 30-month period of performance is planned. Approximately half the preliminary design phase for the digital optical and backup control systems is planned to be completed in FY 1981.

3. (U) FY 1982 Planned Program: The six digital optical transducer contracts and the two optical servovalve contracts will be completed in FY 1982. The resulting design and test data will be used to assist in selection of the technology concepts to be used in the flight demonstration control system. The advanced controllers' Advance Flight Control System Task I post-simulation briefing will provide data to the ADOCS flight demonstration contractor in first quarter FY 1982. Task II completion and post-simulation briefing are planned for last quarter FY 1982. This will supply control/display system information to the flight demonstration contractor. Also during this period, the advanced rotor actuation concepts will be completed with submission of the final reports. The recommendations from these preliminary contracts will be analyzed for potential follow-on laboratory hardware for feasibility demonstrations. The flight demonstration preliminary design will be completed in first quarter FY 1981, the detail design completed second quarter FY 1982, and fabrication approximately half completed by the third quarter FY 1982.

4. (U) FY 1983 Planned Program: Fabrication of flight test hardware, including controllers, sensors, and optical interconnects, will be completed. Integration/testing of all flight hardware will be completed prior to aircraft installation. All flight hardware will be installed in the test aircraft and subjected to extensive ground/tiedown testing prior to actual flight testing. Flight safety approval will be obtained following completion of the ground test program. First flight will occur either at the end of FY 1983 or start of FY 1984. Additional work on advanced optical component concepts will be continued.

5. (U) Program to Completion: A full-up flight demonstration and verification of the advanced digital/optical control system will be demonstrated at the end of FY 1983 or start of FY 1984. The program is a continuing effort.

6. (U) Major Milestones:

Project: #D315 Title: Advanced Flight Controls
Program Element: #6.32.11.A Title: Rotary Wing Controls, Rotors, and Structures
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

Major Milestones	Current Milestones Dates	Milestone Dates Shown in FY 1981 Submission
Contract Program Initiation	3Q FY 1980	Not Shown
Flight Demonstration Program Initiation	4Q FY 1981	Not Shown
First Flight	4Q FY 1983	Not Shown
Final Report (ADOCS)	4Q FY 1984	Not Shown

7. (U) Resources ($ in Thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	2396	4941	9478	10562	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	2114	5296	9143	Not Shown	Continuing	Not Applicable

The adjustment in FY 1980 reflects an acceleration of the component program. The FY 1981 decrease reflects a general Congressional reduction. The FY 1982 increase is the result of readjustment of the Advance Digital/Optical Control System (ADOCS) Program Profile.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.32.16.A Title: Synthetic Flight Simulators
DOD Mission Area: #552 - Environment & Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	2099	6366	7773	5764	Continuing	Not Applicable
DB34	Rotorcraft Systems Integration Simulator (RSIS)	1200	5316	2623	2828	Continuing	Not Applicable
DB39	Flight Simulator Components	899	1050	5150	2936	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED:

The Army, the other Services, and other Federal Agencies need a rotocraft system simulator to reduce systems development cost by providing the means to examine new technolgy developments, rotorcraft systems integration problems, and man-machine interface problems early in the development cycle. There is also a need for the Army and the other Services to use simulations to reduce costs in development of advanced flight simulation components and systems for incorporation in future flight training systems. This program provides for the development of a versatile, high-fidelity, ground-based helicopter simulator to support Army aviation system development and pilot training. Simulation uses include support of conceptual design trade-offs, prototype development, flight tests, product improvement evaluations and analysis of aircraft accidents and investigations for accident prevention (DB34), and development of advanced flight simulation components and systems for incorporation into future flight training systems (DB39).

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Continue the contract development of the Advanced Cab and Visual System (ACAVS). Complete motion generator system development. Continue planning related to simulator operational uses (DB34). Continue advanced development and demonstrate a dual channel cathode ray tube visual display system capable of high-resolution simulation out to the maximum effective ranges of aerial weapons (DB39).

Program Element: #6.32.16.A Title: Synthetic Flight Simulators
DOD Mission Area: #552 - Environ & Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST ($ in thousands):

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	2099	6366	7773	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	1200	6883	11598	Continuing	Not Applicable

The increase in FY 1980 was a result of reprograming action in DB39 to develop and demonstrate the feasibility of single channel laser scan visual technology. The FY81 decrease reflects the application of general Congressional reductions. The FY 1982 decrease was a result of deferring the Aviation Training Research Simulator (DB35) and reducing the scope of advanced visual engineering tasks in the Flight Simulator Components project (DB39) due to funding requirements of higher priority Army and OSD programs.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.32.16.A Title: Synthetic Flight Simulators
DOD Mission Area: #552 - Environ & Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Rotorcraft Systems Integration Simulator (RSIS): Numerous studies, including those by the Army Scientific Advisory Panel (ASAP) Ad Hoc Working Group on Research Facility Requirements for Nap-of-the-Earth (NOE) Day/Night Visual Flight Studies, recommended that the Army, which is the lead Service for helicopter R&D, place increased emphasis on research and development in helicopter flying qualities using ground-based simulation. The Rotorcraft Systems Integration Simulator (RSIS) expands the capabilities of the National Aeronautics and Space Administration (NASA) Vertical Motion Simulator, under a joint Army-NASA agreement to minimize costs and obtain technical expertise in the development of this aeronautical engineering research facility. The Army Scientific Advisory Panel (ASAP) also recommended a modest increase in utilization flexibility of an existing training simulator for training-related research. An Aviator Training Research Simulator (ATRS) Letter of Agreement (LOA) is being staffed between TRADOC and DARCOM to define requirements for a research simulator configured specifically for the study of aviation training problems. An outline concept has been developed which envisions an austere design beginning with an existing Synthetic Flight Training System (SFTS) device. The Flight Simulator Component (FSC) program provides for the development and demonstration of advanced flight simulation techniques and components for incorporation into the design of future simulators or the improvement in training capabilities of current simulators. Full consideration is being given to the accomplishment of the program through cooperative development with Navy and Air Force laboratories. This Effort includes the development of visual simulation components designed to provide full mission training capability for NOE flight, navigation, gunnery, and survivability in a combat environment. Current program includes preliminary design studies for the development of wide-angle, high-resolution, high pictorial detail visual simulation techniques that provide large frontal and downward angle viewing for NOE flight. Efforts related to training in gunnery skills include the development of innovative techniques for multiviewpoint image generation and display for effectively simulating extended range target and sensor images. Technologies include computer image generation (CIG) edge management techniques for full mission simulation.

G. (U) RELATED ACTIVITIES: Program Element 6.42.17.A, Synthetic Flight Training Systems, and 6.22.09.A, Aeronautical Technology. This research and development effort is unique to Army requirements of simulating Nap-of-the-Earth (NOE) helicopter flight visual simulation displays. Coordinated use of Air Force and National Aeronautics and Space Administration (NASA) facilities is being accomplished to minimize program costs. The Research and Engineering Division, Project Manager for Training Devices, Naval Training Equipment Center is tasked with the responsibility to monitor all related research and development to preclude duplication of effort.

H. (U) WORK PERFORMED BY: The Project Manager, Training Devices, Orlando, FL; Naval Training Equipment Center, Orlando, FL; US Army Research and Technology Laboratories, Ames Research Center, Moffett Field, CA; American Airlines Simulator Engineering, American Airlines Plaza, Fort Worth, TX. Total program control is exercised by the Army Materiel Development and Readiness Command.

Program Element: #6.32.16.A Title: Synthetic Flight Simulators
DOD Mission Area: #552 - Environ & Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Rotorcraft Systems Integration Simulator: Completed preliminary design studies for modifying National Aeronautics and Space Administration (NASA) Vertical Motion System. Installation of a CDC 7600 general-purpose digital computer which will satisfy the computational requirements of the Rotorcraft Systems Integration Simulator (RSIS). Contracts awarded for modifying the NASA Vertical Motion Simulator (VMS) motion system and conceptual design studies for the interchangeable cab, cab development station, and the advanced visual system. Flight Simulator Components: one of the two alternative approaches for wide-angle, high-resolution visual display for Nap-of-the-Earth (NOE) flight application was successfully demonstrated with a monochromatic display. The design and fabrication of the 360° annular display system was essentially completed with demonstration of the technical feasibility of the annular camera probe lens scheduled for 1981. Completed preliminary design studies for a laser scanner visual system that provides for a high-resolution, high-detail visual display. Initiated a cooperative advanced development effort for a dual-channel CRT display system for simulation of targets and weapon effects out to the maximum range of relevant aerial weapon systems.

2. (U) FY 1981 Program: Rotorcraft Systems Integration Simulator (RSIS): Complete required fabrication for modification of the NASA Vertical Motion Simulator motion system, the RSIS motion generator. Develop specifications for the Advanced Cab, Cab Development Station and Advanced Visual System. Flight Simulator Components: Initiate design studies for the development and demonstration of a dual-channel visual simulation system for portraying target scenes at ranges out to five kilometers. Initiate cooperative design studies with the Air Force and Navy of a multiple-viewpoint visual display system for simultaneous display of targets, sensors, and a frontal visual scene in a wide-angle background scene. Continue preliminary design effort for development of computer image generation (CIG) edge management techniques for visual simulation of extended gaming areas.

3. (U) FY 1982 Planned Program: Rotorcraft Systems Integration Simulator (RSIS): Complete the motion generator system development. Flight Simulator Components: Complete fabrication of the dual-channel visual display system and install on the Naval Training and Equipment Center Visual Technology Research Simulator for evaluation. Continue the fabrication of the multiple-viewpoint visual display for gunnery and sensor simulation.

4. (U) FY 1983 Planned Program: Rotorcraft Systems Integration Simulator: Continue the contract development of the Advanced Cab and Visual System (ACAVS), and initiate integration of the ACAVS to the motion base. Begin initial RSIS system checkout and verification. Aviator Training Research Simulator: Procure computer and integrate with an existing simulator cockpit and motion platform. Flight Simulator Components: Continue development of wide-angle, multiple-viewpoint visual components as a joint program with the Naval Training Equipment Center's Visual Training Research Simulator. Initiate component development for selected part task trainers designed for specific training tasks in target acquisition, gunnery, and navigation.

Program Element: #6.32.16.A Title: Synthetic Flight Simulators
DOD Mission Area: #552 - Environ & Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #DB34 Title: Rotorcraft Systems Integration Simulator (RSIS)
Program Element: #6.32.16.A Title: Synthetic Flight Simulators
DOD Mission Area: #552 - Environment & Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Demonstration

A. (U) DETAILED BACKGROUND AND DESCRIPTION: The Army, the other Services, and other Federal Agencies (e.g., the National Aeronautics and Space Administration, Federal Aviation Administration, and the National Transportation Safety Board) need a rotorcraft systems simulator in order to reduce the cost of developing new technology, examining advanced technology systems and components, and examining systems and man-machine interfaces early in the development cycle. In addition, a systems and component simulation capability is needed which will permit analysis of aircraft accident cases for use in accident prevention programs. The Army, as the lead Service for helicopter research and development, is participating in a joint program with the National Aeronautics and Space Administration (NASA) in developing a highly versatile, high-fidelity, ground-based, rotorcraft simulator to support ongoing and future helicopter development efforts. The investigation of conceptual designs to include preliminary and detailed designs trade-off, mission capabilities, support of flight test planning, and man-machine/workload evaluations is an essential and analytical tool for Army Aviation development. This simulation capability will provide the first real opportunity to accommodate nap-of-the-earth experiments through simulation. In addition, the simulation will provide a much needed capability to analyze specific accident cases for aiding in accident prevention.

B. (U) RELATED ACTIVITIES: This program supports the Army's Aeronautical Technical program (PE 6.22.09.A). The technology being developed in this program also supports programs related to the Navy (PE 6.22.41.N, Aircraft Technology) and the Air Force (PE 6.22.01.F, Flight Dynamics). This Army rotorcraft simulator utilizes the National Aeronautics and Space Administration Vertical Motion Simulator at the NASA Ames Research Center as the basic motion platform. Duplication of effort is avoided by coordination with these agencies on a continuing basis through joint program reviews, exchange of technical data and reports, The Technical Cooperation Program (TTCP), NASA research and technology committees, and the North Atlantic Treaty Organization (NATO) Advisory Group on Aerospace Research and Development (AGARD).

C. (U) WORK PERFORMED BY: This work is managed at the Aeromechanics Laboratory (NASA-Ames), Moffett Field, California, by the Research Technology Laboratory of the US Army Aviation Research and Development Command. Contractors are being competitively selected for the interchangeable rotorcraft cab, the Cab Development Station, and the Advanced Visual System.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: In-house study conducted in early 1975 documented the need for aircraft systems flight simulation in offering an advanced capability, multipurpose, high-confidence simulator. Feasibility studies for modifying the NASA Vertical Motion Simulator (VMS) and acquisition of a computer system to satisfy the Rotorcraft Systems

Project: #DB34 Title: Rotorcraft Systems Integration Simulator (RSIS)
Program Element: #6.32.16.A Title: Synthetic Flight Simulators
DOD Mission Area: #552 - Environment & Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Demonstration

Integration Simulator computational requirements were accomplished in FY78. In FY79 contract preparation efforts were undertaken to define scope of work for the motion system modification. A Statement of Work and a competitive Request for Proposal (RFP) were prepared for a conceptual study of the design approach for an interchangeable rotorcraft cab, a cab development station and an advanced visual system. These are the major components of the Rotorcraft Systems Integration Simulator and are collectively referred to as the Advanced Cab and Visual System (ACAVS). The contract for the Rotorcraft Simulator motion generator hardware, including system fabrication, delivery, installation, and checkout was awarded in FY80. Conceptual studies to support the ACAVS development were initiated in FY80.

2. (U) FY 1981 Program: Continue in-house project support. Continue to support contract for motion generator hardware. Complete conceptal studies and contract planning phase for the Advanced Cab and Visual System (ACAVS). Receive competitive proposals, evaluate, and award the contract for ACAVS.

3. (U) FY 1982 Planned Program: Motion generator system development completed. Continue the contract development of the ACAVS. Establish planning for simulation operational uses exploring simulation capabilities/limitations.

4. (U) FY 1983 Planned Program: Initiate the integration of the ACAVS to the motion system. Begin initial Rotorcraft Systems Integration Simulator checkout and verify accuracy of the simulation facility.

5. (U) Program to Completion: Verify total RSIS accuracy and begin operational scheduling in FY84. Beyond FY 1984, continue support of the Army's share of the Vertical Motion Simulator (VMS) operation to include refinements/improvements in simulation efficiency.

6. (U) Major Milestones:

Major Milestones	Current Milestone Dates	Milestone Dates Shown in FY 1981 Submission
Contract Award - Motion System	1QFY1980	1QFY1980
Contract Award - ACAVS	TBD	3QFY1980
Motion System Operational	1QFY1983	4QFY1982
ACAVS Operational	TBD	4QFY1983
Motion/Cab/Visual		

Project: #DB34 Title: Rotorcraft Systems Integration Simulator (RSIS)
Program Element: #6.32.16.A Title: Synthetic Flight Simulators
DOD Mission Area: #552 - Environment & Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Demonstration

System Operational	TBD	4QFY1984
Full Up Simulation Capability	TBD	1QFY1985

Current milestone dates for ACAVS contract award, ACAVS operational, system operational, and full-up simulation capability cannot be determined due to FY82 funding reduction, which left inadequate funds for ACAVS contract award. New milestone dates will be determined when project funds are made available. Change in milestone date to have the Motion System operational was due to a six-month contract delay.

7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	1200	5316	2623	2828	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	1200	5772	4468	-	Continuing	Not Applicable

Decrease in FY81 funding reflects application of inflation adjustments and general Congressional reductions. Decrease in FY82 funding is due to higher priority Army programs and OSD reductions. Increased FY83 estimate results from reductions in FY81 funding.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.32.18.A
Title: Airdrop Equipment and Techniques
DOD Mission Area: #553 - Engineering Technology (ATD)
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	685	1269	2752	4709	Continuing	Not Applicable
D266	Airdrop Equipment & Techniques	685	1269	2752	4709	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program supports advanced development of airdrop equipment and techniques for new and improved airdrop operational capabilities. The airdrop projects provide systems which are designed to reduce airdrop aircraft vulnerability to enemy air defense, to improve operational capability of airborne assault, to include Rapid Deployment Operations, and to provide an essential airdrop resupply capability of both conventional and airborne forces for all Services. Efforts are focused on new airdrop equipment and techniques which are transitioned from Program Element 6.22.10.A, Airdrop Technology, for demonstration of technical, operational, and economic feasibility prior to final development and fielding of airdrop equipment. Thus, this program element provides a vital link between research and engineering of airdrop equipment and techniques.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Continue advanced development work of: Ultra-High Level Container System, Airdrop Controlled Exit System, Drop Zone Assembly Aids (Non-Visual), Bundle Airdrop System (C-141Aircraft), and Drop Zone Assembly Aids (Visual). Initiate advanced development of Personnel Offset Airdrop System, Heavy Drop Rigging System, Cargo Offset Airdrop System, and High-Level Platform Airdrop System.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

Program Element: #6.32.18.A
DOD Mission Area: #553 - Engineering Technology (ATD)

Title: Airdrop Equipment and Techniques
Budget Activity: #2 - Advanced Technology Development

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	685	1269	2752	Continuing	Not applicable
Funds (as shown in FY 1981 submission)	1250	2057	2646	Continuing	Not Applicable

The decrease of $565 thousand in FY 1980 reflects the reprograming of funds to other program elements because anticipated requirements documents for three new programs were not received in time to execute work. The $788 thousand decrease in FY 1981 reflects the application of general Congressional reductions. The initiation of a high-priority task (Drop Zone Assembly Aids--Non-Visual) in 1982 is reflected in the $106 thousand increase for this FY.

E. (U) OTHER APPROPRIATION FUNDS: ($ in thousands) Not applicable.

Program Element: #6.32.18.A Title: Airdrop Equipment and Techniques
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Through Fiscal Year 1983, there are twelve major tasks programed under this program element. The tasks are the advanced development of: (1) Drop Zone Assembly Aids Systems (Visual and Non-Visual) to permit rapid location and identification of airdropped materiel and rapid assembly of airborne units; (2) Airdrop Controlled Exit System to solve the problem of excessive drop-zone dispersion for heavy drop platform loads; (3) Ultra High Level Container Airdrop System to provide the capability to airdrop supplies from an altitude of 7600 meters with an accuracy of 200 meters; (4) Bundle Airdrop System (C-141) to permit the airdrop of supplies and personnel from an aircraft during a single pass over the drop zone; (5) Personnel Offset/Precision Airdrop System to provide a capability to airdrop personnel accurately from high altitudes and large offsets from the target area; (6) Heavy Drop Rigging System to enhance rigging and derigging of platform loads; (7) Cargo Offset Airdrop System to provide a capability for accurate airdrop of supplies through use of guidance and control; (8) High-Level Platform System to allow airdrop of platform loads from an altitude of 7600 meters; (9) High-Speed Airdrop System to extend the airdrop airspeed capability to at least 250 knots; (10) Soft Landing Airdrop System to substantially reduce the need to protect airdrop materiel from ground impacts and to provide a roll-on/roll-off capability; (11) Free-Drop Supply Airdrop System to reduce costs and increase accuracy of the airdrop of nonfragile supply items; and (12) Two-Staged Personnel Parachute System to provide a capability to airdrop personnel and accompanying bundles at low altitudes and high speeds.

G. (U) RELATED ACTIVITIES: Program Element 6.22.10.A, Airdrop Technology; Program Element 6.42.18.A, Airdrop Equipment Development; Joint Air Movements Board; Joint Technical Coordinating Group/Airdrop; Mutual Weapons Data Exchange Agreements with France, Germany, and Korea; North Atlantic Treaty Organization Air Transport Working Party; United States/German Non-Major Items Meetings; and Air Standardization Coordinating Group, Working Party 44; and Standardization Agreements. International and interservice agreements and boards are used to exchange information on gains in airdrop technology, to avoid duplication of effort through joint and combined efforts, and to promote and attain the objectives of US Rationalization, Standardization, and Interoperability (RSI) policies and programs.

H. (U) WORK PERFORMED BY: Arthur D. Little, Inc., Cambridge, MA; Pioneer Parachute Co., Manchester, CT; Para-Flite, Inc., Penorsauken, NJ; Irvin Industries Canada Ltd., Fort Erie, Ontario; Stencil Aero Engineering, Inc., Asheville, NC; Army Electronic Warfare Laboratory, Ft. Monmouth, NJ; Naval Ordnance Station, Indian Head, MD; AAI Corporation, Baltimore, MD; US Yuma Proving Ground, Yuma, AZ; and US Army Natick Research and Development Command, Natick, MA.

I. PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Transitioned to engineering development the CTU/2A High-Speed Container

Program Element: #6.32.18.A Title: Airdrop Equipment and Techniques
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

Airdrop System and the High Altitude Airdrop Resupply System. Completed engineering design tests of the Airdrop Controlled Exit System prototype and procured development test quantities; completed fabrication of the flight test vehicles and aeroshells for the Ultra High Level Container Airdrop System prototype. With Army user and Air Force participation, developed several potential advanced concepts for Bundle Airdrop Systems (C-141 Aircraft). Initiated design of the pyrotechnic cutter for the Two-Staged Personnel Parachute System and initiated design tests of the System.

2. (U) FY 1981 Program: Award contract for candidate level I off-the-shelf Drop Zone Assembly Aids System (Visual) and conduct advanced development tests. Initiate advanced development of electromagnetic level I Drop Zone Assembly Aids System (Non-Visual). Initiate development tests of Airdrop Controlled Exit System for C-130 and C-141 aircraft. Complete in-house design and fabrication of interim parachute recovery system for the Ultra High Level Container Airdrop System and initiate design flight tests of the prototype. Continue development testing of the Two-Staged Personnel Parachute System.

3. (U) FY 1982 Planned Program: Complete advanced development tests of level I visual Drop Zone Assembly Aids System and initiate development of level II system. Continue development of electromagnetic level I Drop Zone Assembly Aids System and test prototype system. Complete development tests of Airdrop Controlled Exit System. Finalize design and fabricate parachute recovery system for the Ultra High Level Container Airdrop System and initiate study of fabrication techniques and materials for the aeroshell. Initiate advanced development of the C-141 Aircraft Bundle Airdrop System; the Heavy Drop Rigging System and award contract for initial prototype hardware; and Cargo Offset Airdrop System (2000-lb). Establish design parameters for personnel-mounted navigation system for Personnel Offset/Precision Airdrop System. Complete optimization studies of the High Level Platform Airdrop System and initiate design of the prototype. Complete development testing of the Two-Staged Personnel Parachute System and transition to engineering development.

4. (U) FY 1983 Planned Program: Transition to engineering development: level I Drop Zone Assembly Aids System (Visual); Airdrop Controlled Exit System; C-141 Aircraft Bundle Airdrop System; and Personnel Offset/Precision Airdrop System. Initiate advanced development of: High-Speed Airdrop System; Softlanding Airdrop System; and Free-Drop Supply Airdrop System. Continue advanced development of: level II Drop Zone Assembly Aids System (Visual) and level I nonvisual System; Ultra High Level Container Airdrop System; Bundle Airdrop System (C-141 Aircraft) Heavy Drop Rigging System; Cargo Offset Airdrop System (2000-lb.); and High-Level Platform Airdrop System.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.32.21.A Title: Nap-of-the-Earth Avionics and Navigation Equipment
DOD Mission Area: #551 - Electronic & Physical Science (ATD) Budget Activity: #2-Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	492	1594	6292	11570	Continuing	Not Applicable
DB96	Aircraft Navigation & Control Equipment	300	140	3944	3881	Continuing	Not Applicable
D312	Nap-of-the-Earth Essential Equipment	192	1454	2348	7689	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: DB96 supports the Joint Tactical Microwave Landing System (JTMLS), a tactical derivative of the worldwide civil Microwave Landing System now being developed by the Federal Aviation Agency (FAA). The JTMLS, unlike the civil version, will be a lightweight, man-portable, rapidly employable system. It will be used at tactical landing areas to provide all-weather aviation support to the Army, day or night. The JTMLS is necessary because current tactical equipment for take-offs or landings under adverse weather is limited to a Precision Approach Radar (PAR) or a Non Directional Beacon (NDB), both of which can be easily located, targeted, or jammed by enemy electronic warfare. In addition, PAR's can handle only limited traffic and NDB's cannot be used in really bad weather with low ceilings. The JTMLS will also allow joint operations between US services and NATO combat forces and will replace tactical PAR's and fixed base Instrument Landing System (ILS) equipment now in use. D312 supports development of new equipment to allow effective helicopter operations at those nap-of-the-earth altitudes required to avoid sophisticated enemy surveillance and air defense systems. Emphasis is on a multifunction laser sensor to give warning of wires and obstacles as well as providing input for an automatic hover system plus advanced communications to allow non-line-of-sight transmission and digital burst transmission so that target information from a scout helicopter can be instantly converted into firing information by an attack helicopter. These developments answer problems currently limiting low-level operations.

C. (U) BASIS FOR 1982 RDTE REQUEST: The FY 1982 request supports management of the triservice Joint Tactical Microwave Landing System (JTMLS) program during the period that Advanced Development hardware is scheduled for delivery and initial testing. In addition, the target handoff system will be tested with the Systems Testbed for Avionics Research (STAR) aircraft and the wire and wire-like detection system will have a contract for flight-testable hardware awarded.

Program Element: #6.32.21.A Title: Nap-of-the-Earth Avionics and Navigation Equipment

DOD Mission Area: #551 - Electronic & Physical Science (ATD) Budget Activity: #2-Advanced Technology Development

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	To Completion	Additional	Total Estimated Cost
RDTE						
Funds (current requirements)	492	1594	6292	Continuing	Not Applicable	
Funds (as shown in FY 1981 submission)	1195	1727	8621	Continuing	Not Applicable	

FY 1980 decrease due to internal Army reprograming to support higher priority items which resulted in one-year delay to the airborne target handoff digital communication system. Decrease of FY 1981 funds is attributable to the application of general Congressional reductions. FY 1982 decrease due to internal Army support of higher priority items which resulted in one-year delay in beginning the wire and wire-like obstacle detection system. NOTE: DB96 and D312 were previously reported as part of program element #6.32.07A, Aircraft Avionics Equipment, but will be described from now on under Program Element #6.32.21.A.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.32.21.A Title: Nap-of-the-Earth Avionics and Navigation Equipment
DOD Mission Area: #551 - Electronic & Physical Science (ATD) Budget Activity: #2-Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Project DB96: The Federal Aviation Administration (FAA) manages and funds the National Microwave Landing System (NMLS) development. However, in accordance with mutual agreements between the FAA and Department of Defense (DOD), funds ($6.5 million) and management responsibilities were transferred to DOD for the development of the first military system, the Joint Tactical Microwave Landing System (JTMLS). The House Appropriations Committee supported the DOD/FAA agreement to transfer the funds for the JTMLS development from the FAA to DOD. Program management responsibilities for the military systems are now assigned to DOD who designated the Army as lead service for the JTMLS development. Although civil MLS equipment has been developed for test and evaluation, equipment to satisfy military requirements has not been developed. For the military, there are several key technical issues affecting the acceptance and ultimate design which have not been totally resolved. They are: adequacy of the proposed precision L-Band Distance Measuring Equipment (DME); feasibility of operation in a tactical environment; performance of reduced-size ground antennas; and adequacy of collocated azimuth/elevation ground unit operation. The Advanced Development phase will concentrate on these critical issues. Project D312: This project was initiated to fund subsystems needed for nap-of-the-earth helicopter operations. Efforts center on a digital automatic target handoff system to allow a scout helicopter to pass target information rapidly to waiting attack helicopters without giving itself away to enemy detectors. An additional effort to develop a laser warning device to alert aircrews to nearly invisible wires or wire-like obstacles is also needed to enhance low-level helicopter survivability. This effort will begin as soon as funds are available.

G. (U) RELATED ACTIVITIES: In order to avoid unnecessary duplication of effort, related programs of the Air Force, Navy, Federal Aviation Agency and other organizations are monitored by the Army through committees and working groups. Cost reduction is pursued through joint developments and hardware standardization. This program element is related to Program Elements #6.22.02.A, Aircraft Avionics Technology, and #6.42.01.A, Aircraft Avionics. The Joint Tactical Microwave Landing System (JTMLS) program will capitalize upon the collective background and technology base already established through ongoing development of the Federal Aviation Administration's (FAA) civil Microwave Landing System. The FAA program has proceeded through the technique analysis/contract definition and feasibility demonstration phases with prototype development and evaluation.

H. (U) WORK PERFORMED BY: Avionics Research and Development Activity (Project #D312), Fort Monmouth, NJ. Contractors include American Electronic Laboratory, Colmar, PA; Bell Northern Research Corp., Ottawa, IA; E. Systems, Greenville, TX; Sikorsky, Stratford, CT; Raycomm, Freehold, NJ; United Technologies Research Center, E. Hartford, CT; Analytical Science Corp., Reading, PA; ANACAPA Sciences, Santa Barbara, CA. Project Manager, Navigation and Control (Project #DB96), Fort Monmouth, NJ. Contractor, Bendix (Communication Division), Baltimore, MD.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Participated in the National Microwave Landing System (NMLS) program in the areas of program planning, preparation for the International Civil Aeronautics Organization (ICAO) Divisional meeting in

Program Element: #6.32.21.A Title: Nap-of-the-Earth Avionics and Navigation Equipment

DOD Mission Area: #551 - Electronic & Physical Science (ATD) Budget Activity: #2-Advanced Technology Development

April, 1978, proposal evaluations, triservice testing of civil avionics, and preparing specifications for military Advanced Development equipment. Established Lead Service Program Office with supporting rationale and documentation. Conducted a cost/performance trade-off study for tactical and military landing systems. Procurement data package for the Joint Tactical Microwave Landing System (JTMLS) Advanced Development Program was completed which resulted in a request for proposals. A triservice team was established to evaluate bidders' proposals. Evaluation of proposals was completed April 1980, with contract awarded 30 May 1980. Conducted nap-of-the- earth (NOE) communication test/evaluation program for a system that operates effectively during NOE flight in an electronic counter-countermeasure (ECCM) environment. Evaluated conventional flight director systems. Accomplished computer modeling of aircraft vulnerability, survivability, performance, and avionics reliability. Completed the contract for a Design Approach to a Laser Wire Detection System for a candidate Wire and Wire-Like Object Detection System. Completed investigation of state-of-the-art low-airspeed sensing system. Demonstrated single frequency transmission system. Developed and installed integrated target location and navigation system for Optic IV OH-6A helicopter which provides evaluation of automatic target location, offset navigation update, and night hover capability. Conducted steady state hover tests of night navigation and pilotage system. Awarded contract for feasibility models of airborne data transfer system. Completed concept formulation package for NOE communications system.

2. (U) FY 1981 Program: A Federal Aviation Administration (FAA)-funded contract was awarded on 30 May 1980 by the Army for the design and fabrication of Advanced Development models of the Joint Tactical Microwave Landing System (JTMLS). This contractual effort is being managed by the JTMLS Lead Service Program Office, Project Manager, Navigation and Control Systems (PM NAVCON). The JTMLS Lead Service Program Office will also continue to coordinate with the FAA and other Department of Defense (DOD) elements on specifications and standards relative to the JTMLS and National Microwave Landing System (NMLS) Program, prepare the Coordinated Test Program (CTP) and coordinate with other services. Phase I of the multifunction CO2 Laser nap-of-the-earth (NOE) Sensor System will undergo flight evaluation in the System Testbed for Avionics Research (STAR). Continue developing improvements in aircraft speech communications in the NOE/Electronic Warfare environment. Results of the design approach for a Laser Wire Detection System will be used in conjunction with Wire Obstacle Warning System (WOWS) and Laser Obstacle Terrain Avoidance Warning System (LOTAWS) test data to determine specifications for a Wire and Wire-Like Object Detection System for which a Letter of Agreement (LOA) is anticipated in FY81. Continue contractual effort on a target handoff system. Complete fabrication, and bench test two (2) Airborne Data Transfer Systems.

3. (U) FY 1982 Planned Program: The Joint Tactical Microwave Landing System (JTMLS) Lead Service Program Office will continue to manage the JTMLS Advanced Development contractual effort and will continue to coordinate with the Federal Aviation Administration (FAA), NATO and other Department of Defense (DOD) elements on specifications and standards relative to the JTMLS and National Microwave Landing System (NMLS) programs. Plan and initiate Tri-Service testing of JTMLS equipment followed by consolidation, analysis and reduction of test data. Initiate procurement data package for follow-on Engineering Development. In the night nap-of-the earth (NOE) environment, pilots will be required to perform difficult missions with sophisticated equipment. To do this, pilots must have an integrated cockpit and avionics system. The next step

in the development of such an avionics system with integrated sensors, processors, controls and displays, and target location and handoff capability will be the installation of the ADAS (Army Digital Avionics System) in the Systems Testbed for Avionics Research (STAR) Aircraft using a standard Digital Data Bus Controller. This system will result in increased survivability, reduced pilot workload, and improved mission performance for NOE operations. Development and operational testing will be done on the target handoff system. Flight testing will begin on the Phase I multifunction CO2 NOE sensor in STAR.

4. (U) FY 1983 Planned Program: Complete Tri-Service testing of the Joint Tactical Microwave Landing System (JTMLS) equipment. Plan and conduct validation In-Process Review (IPR). Initiate plans for follow-on Engineering Development (ED) program, and award contracts for design, fabrication and testing of ED equipment. Promising configurations resulting from exploratory development tasks will be flight tested as appropriate. Testing will be completed on the target handoff system, and a contract awarded for low-rate initial production units. A contract will be awarded for a fully developed wire and wire-like object detection system with a new sensor capability to allow aircraft to fly NOE avoiding wire-like objects. Engineering efforts will be initiated to formulate an advanced state-of-the-art aircraft communications package featuring digital communication techniques for both voice and data transfer and data bus compatibility.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: # 6.33.06.A
DOD Mission Area: #553 - Engineering Technology (ATD)

Title: Terminally Guided Projectiles
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	2970	10774	0	0	0	17402
D236	Terminal Guidance System	2970	8588	0	0	0	15216
D174	8" Guided Projectile		2186	0	0	0	2186

B. (U) BRIEF DESCRIPTION OF PROJECT: The program provided for the development of a passive radio frequency (RF) seeker for application to an 8-inch projectile airframe. The integration of this airframe with the United States Marine Corps (USMC) development effort of an 8-inch semiactive laser (SAL) seeker was also included. The RF projectile was to be used to acquire and home on battlefield RF emitters such as air defense radars and countermortar/counterartillery radars. The USMC SAL projectile was to defeat armor and other hard point targets.

C. (U) EXPLANATION OF CANCELLATION OR DEFERRAL: This program was terminated in response to OSD guidance to identify marginal programs in FY82. Evaluation of this program by the Army revealed that its low relative priority, its projected cost and a preliminary assessment of its cost effectiveness made it a marginal program at this time. The FY81 program will be terminated in an expeditious manner, and the technology developed will be documented so as to remain available for any future fire-and-forget development.

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FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.33.13.A
Title: Missile/Rocket Components
DOD Mission Area: #553 - Engineering Technology (ATD)
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	2029	6419	317	530	Continuing	Not Applicable
D087	Missile/Rocket Components	0	0	317	530	Continuing	Not Applicable
D121	Guidance Control System	0	6419	0	0	Continuing	Not Applicable
D691	Advanced Munitions	2029	0	0	0	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: To survive and win against a potential enemy that must be assumed to possess weapons generally as effective as our own will require a balanced mix of complementary weapons that enable commanders to respond to the dynamics of the future battlefield, neutralize the impact of numerical superiority, and complicate the problem of the attacker in the development and execution of his offensive strategy. This program provides the Army nonsystems advanced development, feasibility demonstration, and research related to technological advancements in missile and rocket system components. This program is needed to permit the rapid movement of technology from exploratory development to systems development or immediate integration into an already fielded system. These development efforts are in response to user established requirements identified in the form of science and technology (S&T) objectives. These S&T objectives are addressed through brassboard hardware development, testing, demonstration, and evaluation. This program addresses all science and technology objectives for missile- and rocket-related functions but primarily in the mission areas of air defense, fire support, and close combat. This effort provides the technological advances to maintain qualitative superiority in Army missile and rocket systems.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: To initiate the technology insertion program to capitalize on the maturity of microelectronic circuit developments as applied to missiles/rockets and to accelerate the development of product improvements related to large improvements in reliability, availability, and maintainability as well as cost reduction for air defense missile systems.

Program Element: #6.33.13.A Title: Missile/Rocket Components
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	2029	6419	317	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	0	0	0	Continuing	Not Applicable

This program was not funded for FY81 at the time of the FY81 submission. The current requirements shown for FY 1981 are the result of a Congressional increase for a classified program.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.33.13.A Title: Missile/Rocket Components
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This program is the Army missile and rocket nonsystems advanced development effort to provide for immediate integration into fielded systems as product improvements or rapid movement of domestic and foreign technological innovations and advancements from exploratory development to new systems advanced or engineering development. This effort is primarily in the air defense, fire support, and close combat mission areas. This is a nonsystems advanced development program with primary thrusts in the technical areas of low probability of intercept radar, modular missile testbed, software application, advanced simulation techniques, military operations in urban terrain weapons, digital technology applications, advanced munitions, and air defense microelectronics. This latter application of microelectronics will be the initial year effort. This program is needed to provide the link between technology and applications. This program protects the US technological lead in missiles and rockets and provides the Army a critical capability to: (1) maintain expertise to be a smart buyer and provide the Army the best missile/rocket systems at the least life cycle cost; (2) provide for technological development in areas where there is little or no industry incentive due to lack of commercial applications; (3) provide a quick response in time of crisis; and (4) to preclude technological surprises by potential enemies.

G. (U) RELATED ACTIVITIES: This Program Element is related to efforts conducted in Program Element 6.23.03A, Missile Technology, and Program Element 6.34.52.F, Very High Speed Integrated Circuits. Duplication is avoided by active participation by laboratory personnel in interagency working groups, liaison visits to agencies/activities involved in related efforts, the free exchange of information among agencies, and the structuring of the program toward unique Army needs in tactical missiles.

H. (U) WORK PERFORMED BY: US Army Missile Laboratory, US Missile Command, Redstone Arsenal, AL; Raytheon Comapny, Bedford, MA; Hughes Aircraft Corporation, Fullerton, CA; Sanders Associates, Nashua, NH; and Westinghouse Electric Corporation, Baltimore, MD.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Hemispheric Coverage Antenna (HCA): This effort was initiated in FY 1974 for the design, fabrication, and testing of the antenna. Tests were conducted in FY 1978 to determine performance characteristics. Storage Reliability: This effort was initiated in FY 1974. A computerized storage reliability data bank was established and updated on a continuing basis. Eighteen storage reliability data summary reports and a storage reliability parts count prediction handbook were published and widely distributed with Department of Defense and industry. Published storage failure rate data were utilized to accomplish storage reliability prediction on several systems to date. Tri-Service Active Radio Frequency (RF) Seeker (TRI-FAST): Prior to FY 1976, this was a Navy/Air Force project and was known as the Fast

Program Element: #6.33.13.A Title: Missile/Rocket Components
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

Acquisition, Search and Track (FAST) Program. In June 1976, a joint program under a tri-service memorandum of agreement was established. In FY 1978 five TRI-FAST seekers, including two 8-inch-diameter and three 5-inch diameter, were delivered and government testing completed. This testing included laboratory, fly-over, captive flight and sled tests. Advanced Munitions: This project was established in November 1969. Efforts have included the investigation of dispersal techniques, combined effects, an antimaterial munition, an antiarmor bomblet, a munitions delivery system, and a focused blast warhead. Proven antiarmor lethal mechanisms from Exploratory Development were evaluated, and feasibility for existing and future warhead designs was confirmed. Hardware was fabricated and was tested with favorable results. Design efforts and fabrication research directed toward possibly providing an improved warhead for the TOW antiarmor missile system were performed.

2. (U) FY 1981 Program: Program content is SECRET "Limited Distribution - Special Access Required," precluding further description in this summary. Access to information is controlled by the Deputy Chief of Staff for Research, Development, and Acquisition.

3. (U) FY 1982 Planned Program: Army air defense missile systems will be analyzed to determine technology insertion requirements for microelectronic applications. This investigation will emphasize the potential system improvements to be expected and user requirements so that candidates can be put in a priority order. Plans will be completed for the remaining years of the program using these priorities, with the goal of obtaining a maximum air defense benefit from the limited microelectronics resources.

4. (U) FY 1983 Planned Program: The system studies, performance trade-offs, architectural definition, and preliminary design of the microelectronics processors and controllers needed will be completed. The design will be developed to a level sufficient to specify the microelectronics that will be required for hardware implementation of processing algorithms. Plans will be made to procure the needed microelectronic circuits in coordination with other ongoing Army microelectronic circuit developments.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.36.02.A
Title: Advanced Land Mobility System Concepts
DOD Mission Area: #553 - Engineering Technology (ATD)
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	17915	34428	9421	16614	Continuing	Not Applicable
D118	Combat Vehicle Technology	2550	4196	9421	16614	Continuing	Not Applicable
D188	High Survivability Test Vehicle	15365	30232	0	0	0	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The objective of this Program Element is to demonstrate and evaluate innovative future combat vehicle technology in vehicle testbed hardware to determine initial feasibility and military potential. Prior to FY82 this Program Element also funded the High Survivability Testbed Vehicle - Lightweight (HSTV-L).

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Funds continuation of three ongoing tasks and initiation of a fourth task in FY82: (1) the Loopwheel, which is an innovative development offering an alternative to present-day track and suspension systems; (2) the Elevated Kinetic Energy Weapon, which includes evaluating a vehicle-mounted cannon on elevatable trunnions permitting firing from defilade positions while using natural terrain for protection and concealment; (3) the Tank Testbed which is being used to demonstrate and evaluate advances in tank component technology on a total system performance basis and at the same time examine crew site reduction and target servicing rate; and (4) initiation of an Integrated Countermeasures Testbed which will exploit nonconventional solutions for providing vehicle survivability and improved mission effectiveness against future threats. See paragraph I.3 for more details.

Program Element: #6.36.02.A
DOD Mission Area: #553 - Engineering Technology (ATD)

Title: Advanced Land Mobility System Concepts
Budget Activity: #2 - Advanced Technology Development

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST:

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	17915	34428	9421	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	15916	12370	11733	Continuing	Not Applicable

FY80 increase due to initiation of a 90mm gun/ammunition development in the HSTV-L project.
FY81 increase due to Congressional reduction of inflation allowance and $25 million increase for 90mm gun/ammunition effort.
FY82 decrease due to Army decision to fund near-term readiness needs.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.36.02.A
DOD Mission Area: #553 - Engineering Technology (ATD)

Title: Advanced Land Mobility System Concepts
Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The Army has a continuing need to increase its ground combat vehicle technology base through examination of innovative concepts and unique weapons systems. While theoretical studies provide a great deal of information, it is mandatory that hardware testbed vehicles be fabricated which can be evaluated under actual field conditions. This Program Element encompasses development and evaluation of experimental testbed vehicles to be used in achieving an objective of increasing the combat effectiveness of future combat vehicles while decreasing developmental costs, risk, and time. Continuous upgrading of the technology is essential for the United States to regain and maintain qualitative superiority over combat vehicles fielded by other countries.

G. (U) RELATED ACTIVITIES: Specific programs related to the technical areas of this program element (PE) are: PE 6.11.02.A, Defense Research Sciences; PE 6.21.05.A, Materials; PE 6.26.01.A, Tank Automotive Technology; PE 6.26.03.A, Large Caliber and Nuclear Technology; 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; PE 6.26.08.A, Tank Gun Development and Tank Ammunition; PE 6.36.21.A, Combat Vehicle Propulsion Systems, PE 6.36.31.A, Combat Vehicle Turret and Chassis; and PE 2.37.35.A, Combat Vehicle Improvement Program. Close coordination is maintained with other Services and Governmental agencies to preclude duplication of effort. 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 maintained, and exchange of technical reports through the data exchange agreements is achieved.

H. (U) WORK PERFORMED BY: Primary in-house efforts will be performed by the US Army Tank-Automotive Command, Warren, MI. Other in-house efforts will be performed by the US Army's Armament Research and Development Command, Dover, NJ. Contractors involved are: Pacific Car and Foundry Co., Renton, WA; and Lockheed Missiles and Space Co., Inc., Huntsville, AL.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Completed fabrication and initiated testing of the High Mobility/Agility (HIMAG) test vehicle, High Survivability Testbed Vehicle - Lightweight and initiated a 90mm gun/ammunition program. Completed 3000-pound test rig utilizing the Loopwheel concept and demonstrated obstacle performance and reduction in absorbed power for given speed versus tracked test rig baseline. Elevated Kinetic Energy Weapon design feasibility analysis was completed and hardware design and fabrication was initiated.

2. (U) FY 1981 Program: Work will begin on putting the Loopwheel on an M113 to demonstrate military utility of this new concept. Fabrication of the Elevated KE Weapon will be completed and contractor testing will begin. A Tank Testbed program will be initiated; it will permit on-vehicle testing of component developments prior to inclusion as product improve-

Program Element: #6.36.02.A Title: Advanced Land Mobility System Concepts
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

ments for existing vehicles; FY81 will involve preliminary design and analysis followed by fabrication of the testbed vehicle. The High Survivability Testbed Vehicle-Lightweight program will be concluded.

3. (U) FY 1982 Planned Program: The Loopwheel Program, using an M113, will continue with field testing. Contractor testing of the Elevated Kinetic Energy Weapon will be completed and government testing will begin; this will provide the Army with an answer concerning the feasibility of elevated guns. Final design and fabrication of a Tank Testbed will begin in FY82; advanced componentry will be examined prior to inclusion as a product improvement for existing vehicles; further, the program will examine the feasibility of crew size reduction and increased target servicing rate. An Integrated Countermeasures Testbed will begin development in FY82 with an objective of exploiting nonconventional solutions for increasing survivability, while at the same time improving mission effectiveness against future threats. FY82 will involve preliminary design and mockups; nonconventional solutions could include reactive armor, IR suppression, acoustic sensors and IR missile detectors, among others.

4. (U) FY 1983 Planned Program: Loopwheel field testing will be completed; a decision as to military utility will be made. Government testing of the Elevated Kinetic Energy Weapon will be completed; the program will end. Fabrication of the Tank Testbed will be completed, componentry for testing will be assembled, and testing will begin. Fabrication of the Integrated Countermeasures Testbed will begin. A Future Infantry Fighting Vehicle will begin contractor design and analysis and mockup; this effort will exploit advanced technology in unique infantry fighting vehicle configurations to determine application to combined arms fighting vehicles.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.36.06.A Title: Landmine Warfare/Barrier Development
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	3858	4784	10799	10518	Continuing	Not Applicable
D006	Landmine Warfare Development	2076	1641	1952	6042	Continuing	Not Applicable
D608	Countermine & Barrier Development	1782	3143	8847	4476	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Provides for advanced development of components and concepts applicable to landmine warfare and the family of scatterable mines (FASCAM). Mines continue to provide a formidable obstacle to assist in overcoming the massive tank threat posed by the Warsaw Pact. Mines are required to fortify natural obstacles such as defiles, rivers, and urban areas in order to delay, canalize, and interdict attacking forces and enhance the performance of direct and indirect fire weapons. Component efforts include improved sensors, fuzes, target discrimination logic and anticountermeasure devices to improve the overall effectiveness of mines and make minefields more difficult to traverse. New concepts include controllable minefields to allow for greater battlefield mobility of friendly troops, and an off-route antitank mine for use along highways and roads and in urban terrain. Identified components, when integrated, will provide a system of mines and delivery means meeting Army requirements. Soviet and Warsaw Pact doctrine advocates the large-scale use of landmines in both offensive and defensive operations. In support of this doctrine, the Soviets have developed mechanized devices which rapidly lay minefields having a variety of complex mine fuzes. Mutually supporting countermine devices and techniques are required to meet the threat. This program element also improves the Army countermine capabilities by investigating and exploiting materials, techniques, and equipment evolving from exploratory development. These investigations will ultimately lead to enhanced tactical mobility by neutralizing the barrier potential of enemy minefields. Also, improved field fortifications techniques are being devised and evaluated to improve battlefield survivability of friendly forces by hardening combat positions.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Continue efforts on: improved lethal mechanisms, counter-countermeasure components, increased area mine system components, target signature analysis, controllable minefield components, and analysis of systems effectiveness; an improved fuel-air explosive mine neutralization system, a remote minefield detection system, a

Program Element: #6.36.06.A Title: Landmine Warfare/Barrier Development
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

dedicated counterobstacle vehicle and a cleared lane minefield marking system (CLAMS) as long-range efforts to counter the minefield threat; and development of a family of improved combat shelters.

D. (U) COMPARISON WITH FY81 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	3858	4784	10799	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	5165	5205	9985	Continuing	Not Applicable

The FY80 decrease is the result of reprograming to higher priority Army programs. FY81 decrease reflects the application of general Congressional reductions. The FY82 increase results from changing Army priorities for this program.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.36.06.A Title: Landmine Warfare/Barrier Development
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The family of scatterable mines (FASCAM) is being developed utilizing baseline antitank and antipersonnel mines which can be emplaced by multiple delivery means. This objective is accomplished through new developments in mine sensing and discriminating logic, lethal mechanisms, fuzing, and improved resistance to enemy countermeasures. Efforts supported by this program are then integrated into ongoing and new mine hardware systems in order to meet the requirements for Army barrier systems. This program supports efforts for new landmine warfare concepts and to demonstrate concept feasibility. The long-range goal of this program is to provide truly controllable barriers, highly lethal to enemy forces, while harmless to friendly troops. Also, this program 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 technology achieved during Exploratory Development, P.E. 6.26.03.A, Large Caliber and Nuclear Technology. Detection thrust has transitioned from the meticulous point-to-point search to methods of detecting minefields from standoff locations. Neutralization has been redirected from a slow defuzing process to one of rapid neutralization by explosives or hardened components. Surface-Launched Unit Fuel Air Explosive (SLUFAE) introduced the first potential for standoff neutralization. Barrier efforts are being directed towards the use of the most advanced technology to deny or reduce enemy mobility on the battlefield with a goal of a tenfold reduction in barrier system logistics. A family of combat shelters is being developed to provide for survival of weapons and personnel during periods of indirect fire. Frame and fabric structures with earth cover are proposed for future development.

G. (U) RELATED ACTIVITIES: Exploratory development for this program is conducted in Program Elements 6.26.03.A, Large Caliber and Nuclear Technology, and 6.27.33.A, Mobility Equipment Technology. Systems advanced development for landmine warfare/barrier systems is performed in Program Element 6.36.19.A, Landmine/Barrier Systems. Engineering development of items and concepts in this program is performed in Program Elements 6.46.12.A, Countermine & Barriers, and 6.46.19.A, Landmine Warfare. Developmental information is coordinated and exchanged between the Services by the Tri-Service Joint Technical Coordination Group for Bombs, Mines, and Clusters to avoid duplication of effort. The Department of Defense Armaments Munitions Requirements and Development Committee monitors the scatterable mine program with a view towards avoiding Service duplication. Countermine efforts are closely coordinated with the Development Project Office for Selected Ammunition, Dover, NJ, the responsible agency for the Army Mine Program.

H. (U) WORK PERFORMED BY: The Development Project Office for Selected Ammunition, US Army Armament Research and Development Command (ARRADCOM), Dover, NJ, is responsible for management of Landmine Warfare systems and components. The US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA, is assigned responsibility for Countermine and Barriers. Contractors include: Raytheon Company, Bedford, MA; Hughes Aircraft, Fullerton, CA; Martin Marietta, Orlando, FL; and Burroughs Corporation, Paoli, PA; IIT Research Institute, Chicago, IL; BMY Corporation, York, PA.

Program Element: #6.36.06.A Title: Landmine Warfare/Barrier Development
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Prior to FY 1975, helicopter-delivered and artillery-delivered antitank and antipersonnel mine systems were validated and moved into engineering development. Comprehensive systems effectiveness studies were conducted. Components for the Ground-Emplaced Mine Scattering System (GEMSS) were successfully developed. Power supply and sensors were developed. In FY 1975, investigations on remote control components for minefield command arm/disarm were initiated. Systems effectiveness studies and component field tests continued. In FY 1976, studies continued on off-route and controllable mine systems. Design work on improved power sources and influence sensors were conducted with excellent results. A prototype command and control module for scatterable mines was developed. During FY 1977, efforts were initiated on a microprocessor for mine sensor logic to assist in target discrimination and to improve lethal probability. Advanced development on the Modular Pack Mine System (MOPMS) was completed. Command and control functions for the employment of scatterable mines were categorized. A long-standoff sensing mechanism was investigated. During FY 1978, efforts continued on a microprocessor for mine sensor logic and on counter-countermeasures for antitank sensors. Work was initiated on improved lethal mechanisms and off-route mine components. During FY80 work on the microprocessor for mine sensor logic was completed. In the area of mine detection, the potential of pulse radar, 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 successfully demonstrated, and a canine mine detection manual was completed. A prototype evaluation of the vehicle-mounted roadmine detector was conducted. In mine neutralization, fuel-air explosives (FAE) were shown to be an effective minefield clearance device. Work was initiated on a portable projected line charge for antipersonnel minefields and hardening of vehicle components to resist mine damage. A variety of shelters from exploratory development, P.E. 6.27.33.A, were demonstrated.

2. (U) FY 1981 Program: Initiate advanced development of an antitank electronic assembly containing a microcomputer and multiple influence sensors. Continue development efforts on improved lethal mechanisms, counter-countermeasure components, increased area mine system components, target signature analysis, controllable minefield components, mine sensor components, analysis of systems effectiveness, improved fuel-air explosives and an improved combat shelter. Continue development on a dedicated counterobstacle vehicle. Initiate development on remote minefield detector and cleared lane marking system.

Program Element: #6.36.06.A Title: Landmine Warfare/Barrier Development
DOD Mission Area: #553 ngineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

3. (U) FY 1982 Planned Program: Complete Advanced Development of the microcomputer multisensor antitank electronics. Initiate development of an influence sensor for an antipersonnel mine. Continue efforts on improved lethal mechanisms, counter-countermeasures components, target signature analysis, controllable minefield components, and analysis of systems effectiveness. Complete component development for increased-area mine and mine sensor components. Continue advanced technology efforts on improved fuel-air explosives. Continue advanced development on a dedicated counterobstable vehicle and a family of improved combat shelters, and remote minefield detecton.

4. (U) FY 1983 Planned Program: Complete advanced development of an antipersonnel influence sensor. Continue efforts on counter-countermeasure components, target signature analysis, systems effectiveness, improved lethal mechanisms, and controllable minefield components. Continue efforts on improved countermine, barrier, and field fortification concepts, techniques, and components. Complete devlopment of improved fuel-air mine neutralization system.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #D608 Title: Countermine & Barrier Development
Program Element: #6.36.06.A Title: Landmine Warfare/Barrier Development
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

A. (U) DETAILED BACKGROUND AND DESCRIPTION: Provides for advanced development of improved countermine and barrier capabilities exploiting materials, techniques, and equipment evolving from exploratory development in 6.26.03.A, Large Caliber and Nuclear Technology, and 6.27.33.A, Mobility Equipment Technology. Threat mine warfare doctrine is well developed for both offensive and defensive operations. In the offense, threat doctrine calls for resolute offensive operations with the intent of driving through defending force formations and penetrating deep into rear areas. Mines will be employed extensively along the attacking force flanks to disrupt or prevent counterattacks. Mines are expected to be laid as economy of force measures to concentrate forces at another location and in rear areas to block lines of communication. In the defense, the threat forces are expected to employ mines extensively in fields or belts in depth to delay, disrupt, and canalize attacking forces into kill zones. Minefields are expected to be encountered throughout the threat defensive zones. To win on the next battlefield, US Army maneuver elements must be capable of maintaining freedom of movement and be able to minimize the effects of mined obstacles to that capability. Mined areas must be detected and then bypassed or neutralized. Current Army systems are handheld and mechanical and incapable of supporting the needs of the maneuver force on the modern battlefield. Emerging systems, notably the Surface-Launched Fuel Air Explosive (SLUFAE) system offer a standoff breaching capability. To insure survivability on the modern battlefield, a mutually supporting family of detection and neutralization systems is required. Minefields will have to be located from standoff distances, and to the extent possible, breaches made without exposing the breaching capability to mine field protective fires. The present project entails tasks designed to provide the Army with a family of mutually supporting countermine devices and techniques including the following items: a countermine capability for the M1 tank that facilitates the attachment of mine rollers and plows; a Cleared Lane Minefield Marking System (CLAMS) that marks a cleared lane so that following vehicles can see the lane in reduced visibility; a Remote Minefield Detection (RMD) capability for rapid and safe detection from airborne platforms; a dedicated counterobstacle vehicle that provides a countermine/counterobstacle and obstacle emplacement capability; and an improved fuel-air explosive technology that will significantly enhance standoff explosive minefield clearance capability. Also under this project, a family of combat shelters is being developed to provide for survival of weapons and personnel during periods of indirect fire.

B. (U) RELATED ACTIVITIES: This project is supported by exploratory development conducted in Program Element 6.26.03.A, Large Caliber and Nuclear Technology, and forms the basis for systems advanced development in Program Element 6.36.19.A, Landmine/Barrier Systems. Engineering development of items and concepts developed in this program is performed under Program Element 6.46.12.A, Countermines and Barriers.

Project: #D608 Title: Countermine & Barrier Development
Program Element: #6.36.06.A Title: Landmine Warfare/Barrier Development
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

C. (U) WORK PERFORMED BY: The US Army Mobility Equipment Research and Development Command, Fort Belvoir, VA, is assigned responsibility for Countermine and Barriers. Contractors include: Martin Marietta, Orlando, FL; IIT Research Institute, Chicago, IL; BMY Corp, York, PA; Israel Military Industries, Israel Aircraft Industries and URDAN Industries of Israel.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY80 and Prior Accomplishments: In mine detection, the potential of pulse radar, X-ray, and gamma ray excitation, passive infrared devices, microwave techniques, and trace gas detection devices was evaluated. The ability of dogs to detect the explosive in landmines and booby traps was successfully demonstrated, and a canine mine detection manual was completed. A prototype evaluation of the Vehicle-Mounted Road Mine Detector (VMRMD) was conducted. In mine neutralization, fuel-air explosives (FAE) were shown to be an effective minefield clearance device. Work was initiated on a portable projected line charge for antipersonnel minefields, and hardening of vehicle components to resist mine damage. A variety of combat shelters from exploratory development, PE 6.27.33.A, were demonstrated.

2. (U) FY 1981 Program: Continue advanced development of improved fuel-air explosives, an improved combat shelter, and the dedicated counterobstacle vehicle and initiate development on a remote minefield detector and cleared lane marking system.

3. (U) FY 1982 Planned Program: Continue advanced development efforts on improved fuel-air explosives, complete fabrication of hardware and conduct concept evaluation proposal (CEP) tests of the counterobstacle vehicle (COV) and transfer to 6.3B effort; complete fabrication of hardware and support CEP tests of the Cleared Lane Marking System (CLAMS). Accelerate work on the remote minefield detection (RMD) program, continue efforts on improved combat shelters, and initiate work on countermine attachments for the M1 tank.

4. (U) FY 1983 Planned Program: Complete 6.3A work in improved fuel-air explosives (FAE) and the cleared lane marking system (CLAMS) and continue efforts on remote minefield detection.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones:

Project: #D608 Title: Countermine & Barrier Development
Program Element: #6.36.06.A Title: Landmine Warfare/Barrier Development
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

	Milestone Event	Current Milestone Dates	Milestone Dates Shown in FY 1981 Submission
Cleared Lane Marking System (CLAMS)	CEP Test	2QFY82	Not Shown

7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	1782	3143	8847	TBD	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	2859	3337	5243	Not Shown	Continuing	Not Applicable
Quantities (current requirements)	Not Applicable					
Quantities (as shown in FY 1981 submission)	Not Applicable					

Changes to the funding profile reflect the following: In FY80, the decrease in actual results from reprograming to higher Army priorities. The reduction in FY81 is attributed to the application of general Congressional reductions. The increase in FY82 is requested to restore the Counterobstacle Vehicle (COV) and Cleared Lane Marking System (CLAMS) to their original schedules, to accelerate work on the Remote Mine Detection (RMD) System, and initiate a countermine attachment program for the M1 tank.

Other Appropriations: Ammunition Procurement, Army - funds and quantities to be determined.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.36.21.A
DOD Mission Area: #553 - Engineering Technology (ATD)

Title: Combat Vehicle Propulsion Systems
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	5810	4599	13186	19514	Continuing	Not Applicable
DG07	Combat Vehicle Engine	4081	59	10296	13915	Continuing	Not Applicable
D395	Combat Vehicle Transmission	1729	4540	2890	5599	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides for advanced technology demonstration of combat vehicle propulsion systems and components. Due to extreme operational requirements, propulsion systems intended for military use must possess high output, low volume and weight, multifuel capability, and efficiency and durability not normally available on the commercial market. Ancillary components, such as air filtration and cooling systems, must also be provided to enable these systems to operate in a unique military environment. Combat vehicle propulsion systems are among the longest leadtime development items associated with ground combat vehicles. This program insures that state-of-the-art propulsion systems unique to military needs are under development in advance of a decision to develop new ground combat vehicle systems. This program also develops key improvements to existing propulsion systems. The Tank-Automotive Command, responsible for this program, maintains continuous dialogue with government agencies and commercial contractors to preclude any duplication of effort.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Funds are requested to continue development of three tasks and initiate two new tasks in the combat vehicle engine project (DG07) and to continue development of two tasks and initiate two new tasks in the combat vehicle transmission project (D395). Engine tasks are the adiabatic engine, turbine air cleaner, AGT 1500 Improvements, an Advanced Main Battle Tank Engine, and examination of engine concepts for alternate fuels. Transmission tasks are the CVX650 transmission, transmission component development, an advanced turbine transmission demonstrator, and the Electric-Hybrid transmission. A more detailed description of the FY82 program can be found in paragraph I.3 and the descriptive summary for project DG07.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

Program Element: #6.36.21.A
DOD Mission Area: #553 - Engineering Technology (ATD)

Title: Combat Vehicle Propulsion Systems
Budget Activity: #2 - Advanced Technology Development

RDTE	FY 1980	FY 1981	FY 1982	Additional To completion	Total Estimated Cost
Funds (current requirements)	5810	4599	13186	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	3811	11547	22700	Continuing	Not Applicable

FY 80 increase due to increased emphasis placed on engine and engine component task.
FY81 decrease due to Congressional reduction applied to Combat Vehicle Engines (DG07).
FY82 decrease due to Army decision to fund near-term readiness needs.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.36.21.A Title: Combat Vehicle Propulsion Systems
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: To be effective, ground combat vehicles must be able to move far and rapidly with a high degree of reliability. The unique operational requirements of combat vehicles most often dictate that propulsion systems and other components be developed under government auspices. To insure that such systems and components are available for integration into present and future ground combat vehicles, power train systems and components are developed within this program. The program's goals are to develop cost-effective systems and components that will: (1) increase fuel tolerance; (2) improve fuel economy; (3) improve horsepower-to-ton ratio; (4) improve compactness; (5) improve reliability, availability, maintainability, and durability; and (6) improve control and driveability.

G. (U) RELATED ACTIVITIES: Program Elements (PE): PE 6.26.01.A, Tank and Automotive Technology; PE 6.36.02.A, Advanced Land Mobility Systems Concepts; PE 6.21.05.A, Materials; PE 6.27.33.A, Mobility Equipment Technology; PE 6.32.01.A, Aircraft Power Plants and Propulsion; PE 6.31.09, Fuels and Lubricants Advanced Development; PE 6.31.02.A, Materials Scale-up; PE 6.36.26A, Advanced Diesel Engine Technology; and PE 2.37.35A, Combat Vehicle Improvement Program. Foreign State-of-the-art trends in military propulsion systems are monitored by the Tank-Automotive Command, and data is exchanged with allied countries via data exchange agreements. Inter/Intra-Service/Department duplication of effort is prevented through active planning and coordination of this program at all levels of organization. Program content is subject to continuous review.

H. (U) WORK PERFORMED BY: United States Army Tank-Automotive Command, Warren, MI, is responsible for the development of this program. Major contractors are: AVCO Lycoming, Stratford, CT; Donaldson Corporation, Minneapolis, MN; Cummins Engine Company, Columbus, IN; Detroit Diesel Allison, Indianapolis, IN.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: A contract was awarded for a 1500 hp advanced diesel program (AVCR-1360) in accordance with guidance provided by Congress. This program provides for engine design improvements including development of variable area turbocharger and the development of a modulated cooling fan system. The adiabatic engine successfully demonstrated that it is the most fuel-efficient engine in the world. The AGT-1500 fuel economy program completed component design and initiated fabrication and testing. A Self-Cleaning Air Filter demonstrated a 500-hour endurance capability. An Advanced Main Battle Tank Engine program was defined. Procurement and fabrication of main transmission components for the CVX650 transmission were begun after successful testing of critical components.

2. (U) FY 1981 Program: The combat vehicle engine project (DG07) is unexecutable due to Congressional action. Efforts begun in FY80 are being stretched out to maintain program continuity and to keep engineer teams intact where possible. The CVX-650 transmission development effort includes completion of fabrication and assembly of two prototype transmissions.

Program Element: #6.36.21.A Title: Combat Vehicle Propulsion Systems
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

3. (U) FY 1982 Planned Program: Plans include continued development of an adiabatic (low heat loss) diesel engine. This engine is being developed from a commercial base and has already demonstrated that it has exceptional fuel efficiency potential. The Self-Cleaning Air Filter will be installed and tested in a testbed. A prototype Pulse Jet Air Cleaner will be designed and fabricated. The AGT-1500 Fuel Economy Program will be completed and dynamometer validation of an improved AGT-1500 will be initiated. The Army will begin preliminary design of an Advanced Main Battle Tank Engine incorporating state-of-the-art advancements not currently in the AGT-1500; this effort could produce an engine ready for integration into the main battle tank in the 1990's. Additionally, the Army will initiate a program to develop (modify) engines with the capability of operation on a wide range of fuels (from gasoline to diesel, including shale- or coal-derived fuels) without requiring physical adjustment in the field or compromising engine performance or life. This effort is in compliance with a Defense Department requirement to conduct an orderly transition from natural to synthetic fuels in the 1985-2010 timeframe. The CVX-650 transmission will be given extensive in-vehicle testing leading to completion of advanced development in FY84. Vehicle evaluation of selected transmission component improvements will be conducted; candidates include improved brakes, extended range torque converters, synthetic fluids, and electronic controls. An Advanced Main Battle Tank transmission for use with an advanced diesel or turbine will begin the design phase in FY82; goals include increased capacity, if needed, smaller size, electronic controls, and improved total propulsion systems improvement through early integration to candidate engine systems. Feasibility of an electric hybrid transmission will be examined; this option is being reviewed in light of current energy considerations and recent advancements in electric propulsion technology. Refer to the descriptive summary for project DG07 for more details.

4. (U) FY 1983 Planned Program: Advanced development of the adiabatic engine with fabrication of prototype engines will continue leading to a demonstration of 750-1000 hp version. Testing of the Self-Cleaning Airfilter will be completed leading to a final design. Work on a ceramic recuperator, more temperature-tolerant turbine blades and improved oil/bearing temperature tolerance for the AGT-1500 will begin. Component development for the Advanced Main Battle Tank Engine will begin. Combustors and injectors for alternate fuel use will be demonstrated. RAM testing and data collection will be done on the CVX-650. Testing of transmission components will continue; design updates will start. Critical components for the Advanced transmission will be fabricated. Concepts for electric hybrid transmissions will be formulated.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #DG07 Title: Combat Vehicle Engines
Program Element: #6.36.21.A Title: Combat Vehicle Propulsion Systems
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

A. (U) DETAILED BACKGROUND AND DESCRIPTION: The objective of this project is to provide engines to meet Army ground combat mobility goals. Problems and needs resulting from the fuel shortage are among the most acute to be attacked. Major objectives include: improved fuel economy and fuel tolerance of future engines, improved survivability through higher horsepower-to-weight ratios resulting in enhanced agility, and reduced weight and volume resulting in lower silhouettes. The approach involves development of advanced technologies in major components; these components are then applied to a total propulsion system to demonstrate performance improvements. Upon successful completion of demonstrator tests, full-scale development is undertaken. The Tank Automotive Command, responsible for this program, maintains continuous dialogue with government agencies and commercial contractors to preclude any duplication of effort.

B. (U) RELATED ACTIVITIES: Program Element (PE): PE 6.26.01.A, Tank and Automotive Technology; PE 6.36.02.A, Advanced Land Mobility Systems Concepts; PE 6.21.05.A, Materials; PE 6.27.33.A, Mobility Equipment Technology; PE 6.32.01.A, Aircraft Power Plants and Propulsion; PE 6.31.09.A, Fuels and Lubricants Advanced Development; PE 6.31.02.A, Materials Scaleup; PE 6.36.26.A, Advanced Diesel Engine Technology; and PE 2.37.35.A, Combat Vehicle Improvement Program. Foreign state-of-the-art trends in military propulsion systems are monitored by the Tank-Automotive Command, and data is exchanged with allied countries via data exchange agreements. Inter/Intra-Service Department duplication of effort is prevented through active planning and coordination of this project at all levels of organization. Project content is subject to continuous review.

C. (U) WORK PERFORMED BY: United States Army Tank-Automotive Command, Warren, MI, is responsible for the development of this program. Major contractors are: AVCO Lycoming, Stratford, CT; Donaldson Corporation, Minneapolis, MN; Cummins Engine Company, Columbus, IN.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: The adiabatic engine demonstrated that it was the most fuel-efficient engine in the world during testing in FY80. This engine uses nonmetallic components, high temperatures, and turbo-compounding, and promises a revolution in internal combustion engine systems. Using a commercial block, the engine demonstrated a 30% improvement in fuel economy over the nonadiabatic version. The Self-Cleaning Air Filter for the AGT-1500 successfully completed a 500-hour durability test. The Fuel Economy version of the AGT-1500 was designed in FY80, and testing of improved components was initiated. An Advanced Main Battle Tank Engine Program was defined to provide a framework for design efforts

Project: #DG07 Title: Combat Vehicle Engines
Program Element: #6.36.21.A Title: Combat Vehicle Propulsion Systems
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

for the follow-on Main Battle Tank Propulsion System of the 1990's; cycle analysis was initiated to verify advanced performance and address current engine configuration options.

2. (U) FY 1981 Program: To meet requirements for a priority program that had not been included in the budget submitted to Congress, this project was essentially unfunded in the FY81 appropriation. Engine-related efforts planned for FY81 have been stretched out from FY80 in order to maintain engineer teams and program continuity. Concurrently the Army is pursuing Congressional approval to shift funds from Project Number D395 (Combat Vehicle Transmission) to this Project. Several high-payoff tasks have been delayed including the Adiabatic Engine which has demonstrated a 30% improvement in diesel fuel economy, therefore demonstrating that it is the most fuel-efficient engine in the world.

3. (U) FY 1982 Planned Program: An uncooled Adiabatic Engine will be demonstrated in a 5-ton truck; this effort will clearly establish the feasibility of the adiabatic concept. Concurrently, the Army will initiate design of an advanced prototype Adiabatic Engine in the 750-1000 hp category. The Adiabatic Engine is a high-payoff technology program. Recognizing the extreme need for continued advancement in air filtration for its high-technology propulsion systems, air cleaner development continues in FY82 with the installation of a Self-Cleaning Air Filter into a testbed and the conduct of extensive testing. The Army will continue to develop improvements for the AGT-1500 turbine engine; objectives include a 10% increase in fuel economy, 2% lower acquisition cost, 2% better RAM-D, and introduction of new materials and manufacturing processes; these improvements will be packaged and targeted for introduction into the XM1 tank when development is completed. Dynamometer testing of improvements will be carried out during FY82. Preliminary design for an Advanced Main Battle Tank engine will begin in FY82; goals include an alternate fuel capability, improved fuel economy, lower procurement cost, integrated air cleaner, minimized cooling system, integrated auxiliary power unit, integrated infrared, noise, and smoke signature suppression, and a central microprocessor for control of functions. This effort will lead to an engine ready for integration into the main battle tank in the 1990's. In compliance with Department of Defense guidance, the Army is moving towards an orderly transition to synthetic fuels in the 1985-2010 timeframe and has accelerated its efforts to develop engines capable of burning a broad range of conventional and synthetic fuels; the undertaking will begin in FY82 with a demonstration of a sensor/compensator capable of detecting fuel density and viscosity variations.

4. (U) FY 1983 Planned Program: The Adiabatic Engine will be built in a 750-1000 hp version. Final design for the Self-Cleaning Air Cleaner will be determined; a Pulse Jet Air Cleaner and an ionization detector will be tested. AGT-1500 improvement will continue development to include a ceramic recuperator, more temperature-tolerant blades and improved oil/bearing temperature tolerance. Component development on the Advanced Main Battle Tank Engine will be initisted. Utilizing results of FY82, the Alternate Fuels effort will demonstrate new combustor and fuel injector technology.

Project: #DG07 Title: Combat Vehicle Engines
Program Element: #6.36.21.A Title: Combat Vehicle Propulsion Systems
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not applicable.

7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	4081	59	10296	13915	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	2511	6222	17510	-	Continuing	Not Applicable

FY80 increase represents an increase in emphasis on engine and engine component development.

FY 81 decrease due to Congressional action.

FY82 decrease due to Army decision to fund near-term readiness needs.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.36.31.A
Title: Combat Vehicle Turret and Chassis
DOD Mission Area: #533 - Engineering Technology (ATD)
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	4024	5018	8014	13442	Continuing	Not Applicable
D014	Combat Vehicle Hull & Turret	2508	3147	4197	8661	Continuing	Not Applicable
D424	Combat Vehicle Track & Suspension	1516	1871	3817	4781	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides for advanced technology demonstration of components associated with ground combat vehicle hull, turret, track, and suspension subsystems; in general, such systems are militarily unique and therefore must be developed through US Army research and development. Common goals of all tasks in this program are increased performance, improved survivability, enhanced reliability, availability, maintainability and durability, and reduced cost. Results of the program will often lead to product improvements to current Army combat vehicles as well as innovations to be incorporated into new vehicle systems as they are being developed.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Provides for funding of eight tasks: Advanced Countermeasures, Advanced Techniques for Electrical Power Systems, Fire Control Integration, Automatic Fire Detection, a 20-40-ton track program, Fluidic Dampers, Independent External Suspension, and Mine Hardened Track for Special Applications. With the exception of Independent External Suspension, all these tasks are funded from previous years. A more detailed description of the FY82 program can be found in paragraph I.3.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	4024	5018	8014	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	3732	5877	13977	Continuing	Not Applicable

Program Element: #6.36.31.A Title: Combat Vehicle Turret and Chassis
DOD Mission Area: #533 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

FY80 increase due to increased emphasis placed on fire control integration.
FY81 decrease due to general reduction for inflation.
FY82 decrease due to Army decision to fund near-term readiness needs.

E. (U) OTHER APPROPRIATION FUNDS: Not applicable.

Program Element: #6.36.31.A Title: Combat Vehicle Turret and Chassis
DOD Mission Area: #533 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This program element contains two projects, D014 Combat Vehicle Hull and Turret, and D424, Combat Vehicle Track and Suspension. Both provide: fully tested and validated components and subsystems for application to combat vehicle; long-lead components available for adaption to new combat vehicle concepts as well as existing vehicles; and component building blocks for increasing performance, survivability, RAM-D, reducing costs, and providing new capabilities to combat vehicles of the future.

G. (U) RELATED ACTIVITIES: Program Elements (PE): PE 6.21.05.A, Materials; PE 6.31.02.A, Materials Scale-up; PE 6.21.20.A, Nuclear Weapons Effects/Fluidics; PE 6.26.01.A, Tank Automotive Technology; PE 6.36.02.A, Advanced Land Mobility Systems Concepts; PE 6.26.17.A, Small Caliber and Fire Control Technology; PE 6.27.02.A, Night Vision Investigations; PE 6.27.16.A, Human Factors in Military Systems; PE 6.26.18.A, Ballistics Technology; and P 2.37.35.A Combat Vehicle Improvement Program. Foreign state-of-the-art trends in military propulsion systems are closely monitored, and technology information is exchanged with allied countries via data exchange agreements. Close coordination and continuous discussion with other Services/Departments preclude duplication of efforts.

H. (U) WORK PERFORMED BY: The Army Tank-Automotive Command, Warren, MI, is responsible for the development and system integration of this program. Major contractors for the program elements include Chrysler, Huntsville Electronics Division, Huntsville, AL; Santa Barbara Research Center, Goleta, CA; Graviner Incorporated, Mountainside, NJ; Standard Products Company, Port Clinton, OH; Goodyear Tire and Rubber Company, St. Mary's OH; Northrup Corporation, Anaheim, CA.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Advanced Countermeasures/Vehicle Integrated Defense System program demonstrated several subsystems. This program will develop active and passive countermeasures to enhance survivability. The Advanced Techniques for Electrical Power System (ATEPS) task established technical requirements for tank development; ATEPS is a multiplexed power distribution and control system to simplify combat vehicle wiring at the same time permitting a diagnostic/prognostic capability and an instantaneous readiness status. A Fire Control Integration program was initiated in FY80; its goal is to combine advanced fire control efforts into integrated packages for demonstration in combat vehicles. The Automatic Fire Detection and Suppression program developed specifications for standardized fire suppression components, procured hardware and began testing. Field testing of three classes of track (15t-18t, 20t-40t, and 45t-65t) was initiated. Brassboard testing of a fluidic damper was conducted; this system has a goal of improving gun platform stability, RAM-D, mobility, and a 50% increase in mean miles between failure.

2. (U) FY 1981 Program: Advanced Countermeasures efforts will include continued testing and development of a threat warning display. ATEPS hardware/software will be installed and tested. Fire Control Integration will include initiation of

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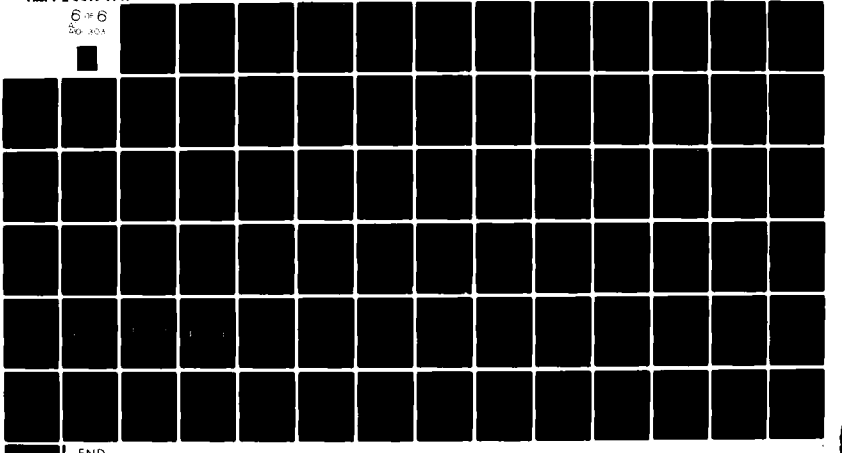

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Program Element: #6.36.31.A Title: Combat Vehicle Turret and Chassis
DOD Mission Area: #533 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

a fire control design for a main battle tank. Testing of Automatic Fire Detection and Suppression will continue. Six sets of 20t-40t track will be fabricated. Fluidic dampers will be fabricated and field tested. Design of a mine-hardened track will begin; this program has a goal of reducing vulnerability of Army tracked vehicles to landmines.

3. (U) FY 1982 Planned Program: The Advanced Countermeasures system will be mounted on a combat vehicle for testing and demonstration; signal suppression materials and hardware will be installed on combat vehicles for evaluation. Fabrication of Advanced Techniques for Electrical Power Systems (ATEPS) prototype hardware for turret use will be completed and will be tested in a vehicle; reliability and cost effectiveness information will be gathered. Integration of the fire control system for an XM1 demonstration will continue. Explosive testing will be conducted with the Automatic Fire Detection and Suppression System. 20t-40t track will be tested to confirm design. Fluidic dampers will be fabricated and tested. An Independent External Suspension System will be transitioned to advanced development in FY82; this effort will provide an improved suspension system for 60t-65t tracked vehicles; efforts will include fabrication of componentry. The Mine-Hardened Track program will fabricate prototypes, conduct laboratory and development tests, and conduct blast and mobility analysis.

4. (U) FY 1983 Planned Program: Testing and refinement of the Advanced Countermeasures system will continue, demonstrating countermeasure combinations that will have significant survivability payoffs. Testing of ATEPS will continue to completion for current design. The fire control system for XM1 technology demonstration will be completed. A future fire control system based on ongoing studies will be initiated. A fast fire extinguisher system and improved optical sensors will be evaluated. Third-generation 20t-40t track will be fabricated based on previous testing. Fluidic damper testing will be completed, and a design for an XM1 compatible damper will be started. Independent External Suspension fabrication will be completed and testing will begin. Based on prior testing, mine-hardened track will be redesigned leading to a decision for its use.

5. (U) Program to Completion: This is a continuing Program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.02.A
Title: Electric Power Sources
DOD Mission Area: #553 - Engineering Technology (ATD)
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	3780	3916	5177	3260	Continuing	Not Applicable
	QUANTITIES						Not Applicable
DG10	Advanced Tactical Power Sources	780	1630	1508	1930	Continuing	Not Applicable
DG11	Advanced Electrical Energy Sources	3000	2286	3669	1330	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: New and developing sophisticated modern weapons, fire control and communications systems depend heavily on the availability of electric power sources tailored to their requirements. The changing world petroleum supply situation, and the increasing cost of petroleum-derived fuels and lubricants also drive the development of newer electric power generation concepts that are capable of higher fuel efficiency and of using alternate fuels. Current engine-driven generators, particularly in the 0.5 to 10 kilowatt (kW) power range, have low fuel efficiency, limited multifuel capability and require excessive maintenance. In addition, existing mobile generators are excessively noisy and provide heat signatures that allow them to be easily detected by enemy surveillance. Present batteries and low-power sources for various battlefield communications and electronics systems have short shelf lives, are undependable, and are temperature sensitive. This program provides for the necessary development of battery power sources designed to satisfy the tactical and logistic requirements for long unactivated shelf life, high energy density, continuous long-life operation and high-performance capabilities. In addition, this program provides the necessary technologies required to develop improved mobile electric power sources with emphasis on greater mobility, higher efficiency, common components, improved reliability, reduced noise and heat signatures, and multifuel and/or non-fossil-fuel capabilities.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Funding is required to continue the development of batteries with higher energy densities and that are suitable for lower temperature and higher gravity force (G) applications. Development of direct cur-

Program Element: #6.37.02.A Title: Electric Power Sources
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 Advanced Technology Development

rent (DC-to-DC) voltage converters, to supply multiple precision power voltages to battle field digital equipment is scheduled to continue. The development of fuel cell components for the family of silent, lightweight, tactical power sources and of ceramics components to increase the efficiency of turbine electrical power generators will continue. In addition, effort will be committed to the development of power conditioning devices to provide the required type and quality of power from various sources.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	3780	3916	5177	Continuing	Not Applicable
Funds (as shown in FY 1980 submission)	5055	4348	8731	Continuing	Not Applicable

DG10 - In FY 1980 the $81 thousand reduction in funding was the result of reprograming to higher priority Army requirements. The decrease of $85 thousand in the FY 1981 funding level reflects the application of general Congressional reductions. The net decrease of $184 thousand in estimated funding in FY 1982 includes a funding increase of $116 thousand resulting from a faster-than-anticipated rate of development of primary batteries for laser designators, and a decrease in funding requirement of $300 thousand due to program realignment, reflecting incremental funding policies.

DG11 - The reduction of $1194 thousand in FY 1980 funding was the result of Army reprograming to higher priority requirements. In FY 1981, the decrease of $347 thousand reflects the application of general Congressional reductions. Of the $3370 thousand reduction in FY 1982 funding, a reduction of $2670 thousand results from a difference in the planning estimate from last year caused by a slower-than-anticipated development of the hydrocarbon fuel processor for the methanol fuel cell. The remaining decrease in funding ($700 thousand) is due to program realignment to reflect incremental funding policies.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.37.02.A
DOD Mission Area: #553 - Engineering Technology (ATD)
Title: Electric Power Sources
Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The objectives of this program are to develop technologies and conduct feasibility demonstrations as prerequisites for Engineering Development (ED) of new and improved tactical military electric power sources. The projects encompass efforts on engine-driven power generation (electromechanical power), fuel cells and batteries (electrochemical power), and other power-related devices and associated technology to improve efficiency, type, and quality of power required to support Army tactical systems. Power requirements range from very low outputs (milliwatts) to moderately high outputs (hundreds of kilowatts). To satisfy low power demands, new types of batteries are being developed which will provide higher energy densities, longer storage life, operate over wider temperature ranges, and are better configured to support system requirements than present equivalent capacity batteries. Higher power needs will be met by the latest state-of-the-art engine-driven generators and fuel cells with emphasis on meeting Army tactical requirements and Department of Defense goals for the standardization of power generation equipment to achieve benefits of component commonality, reduced logistics support requirements, lower life-cycle costs, and improved fuel economy.

G. (U) RELATED ACTIVITIES: In order to preclude a duplication of effort, the Army maintains continuing coordination with the other Services, the Department of Energy; the National Aeronautics and Space Administration, the Department of Health and Human Services, and the Department of Transportation through the Interagency Advanced Power Group and the Department of Defense Project Manager for Mobile Electric Power. The Power Sources Conference sponsored by the US Army Electronics Research and Development Command provides a forum for exchange of information between government, academic, and industrial researchers. Additionally, the Joint Deputies for Laboratories (Panel for Batteries and Fuel Cells) assures coordination between the Services on programs concerning battery and fuel cell systems. Advanced Development items in this program element progress to Engineering Development in Program Element 6.47.14.A, Tactical Electric Power Sources. Related basic research is conducted in Program Element 6.11.02.A, Defense Research Sciences, Project AH47, Electronic Devices Research, and Project AH51, Combat Support. Exploratory Development is conducted in Program Element 6.27.33.A, Mobility Equipment Technology.

H. (U) WORK PERFORMED BY: In-house work 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. The five largest development contracts are with the following firms: Energy Research, Danbury, CT, Air Research Corporation, Phoenix, AZ, Solar Turbine International, San Diego, CA, Gulton Industries, Hawthorne, CA; and Delta Electronics Control Corporation, Irvine, CA. Five additional development contracts with estimated amounts totaling $851 thousand dollars are also in effect.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

Program Element: #6.37.02.A Title: Electric Power Sources
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 Advanced Technology Development

1. (U) FY 1980 and Prior Accomplishments: Technical requirements for the lithium flat cell high-rate battery for expendible jammers were established, and a contract was awarded for its development. Advanced development was completed on the 2.5 kilowatt (kW) DC-to-DC converter/regulator for digital equipment precision power subsystems. Advanced development continued on the 3 and 5 kW methanol fuel cell components and on the improvement of the gas turbine power generation technology.

2. (U) FY 1981 Program: Advanced development of the lithium flat cell battery will continue. Initial designs of second generation lithium cells for laser target designation and night vision devices will be incorporated into battery configurations and evaluated in the laboratory. Advanced development will begin on an end voltage DC-to-DC converter for supplying precision voltages to digital equipment in communications-electronics systems. Development effort on the 3.0 and 5.0 kW methanol fuel cells and on the improvement of gas turbine power generation systems are scheduled to continue. The 15 kW power conditioner will begin advanced development. This unit is the first of a family of power conditions to be developed for frequency and voltage conversions that provide additional operational capabilities such as using foreign power sources for US Army needs.

3. (U) FY 1982 Planned Program: The development of second-generation lithium battery designs, with increased energy density (50% or more) and capable of providing higher power, will continue. Lithium batteries will be acquired for laboratory testing and for testing with laser target designation equipment. The flat cell designs will be tested in a simulated high-gravity force environment. Development of the power converters for supplying precision power will continue. Advanced development of the 15 kW power conditioner and the ceramic components for improving the performance of turbine generators are scheduled to be completed. The 1.5 kW hydrocarbon fuel power unit will begin advanced development. The unit will allow the use of petroleum-derived fuels in addition to the current energy source (methanol) for the fuel cell electric power generating family.

4. (U) FY 1983 Planned Program: Advanced development of the lithium primary battery for high-gravity force (G) applications will be completed. Laboratory testing of the second-generation lithium battery for laser target designators and night vision equipment is scheduled to be completed, and user evaluation of these batteries will be initiated. The 3 and 5 kW methanol fuel cells are scheduled to complete advanced development. Advanced development will continue on the precision power converters for digital equipment and on the power conditioner family.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.10.A Title: Night Vision Advanced Development
DOD Mission Area: #551 - Electronics & Physical Science (ATD) Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	13801	20537	*35715	34908	Continuing	Not Applicable
DK70	Night Vision Advanced Development	9106	13074	*23788	20834	Continuing	Not Applicable
DK86	Night Vision Airborne Systems	2312	3207	4654	6412	Continuing	Not Applicable
DK87	Night Vision Combat Vehicles	2383	4256	7273	7662	Continuing	Not Applicable

* Includes DOD Supplemental/Amended Request of $7.0 million.

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The Army needs an improved capability to fight at night and during periods of limited visibility. The pinpoint accuracy and massive firepower currently available are valueless unless targets can be acquired, identified, and accurately located. The objective of this program continues to be to apply recent advances in technology to reduce the life cycle costs and improve the performance of night sights to provide the Army with the necessary improved night and limited visibility fighting ability. This improved performance will effectively multiply US ground combat power. With this capability, the Army will be able to successfully counter a foe who plans and trains to continue operations during all visibility conditions. The night vision and electro-optics systems developed are used by the individual soldier, missile systems, helicopters, and combat vehicles. While the current common module Forward Looking Infrared (MOD FLIR) systems can and do provide extremely high performance for surveillance, target acquisition, and fire control, the technology places a severe limitation on the size and weight below which manportable thermal sights may not be reduced. Fielding over 20,000 systems with less size, weight, and cost than the current devices will allow the Army to meet and counter the threat. To reduce the time of target acquisition, identification, and engagement, while increasing survivability and the accuracy of fire control for both aircraft and combat vehicles, will require development and integration of new technology thrusts in automation (auto-cue, auto-track, etc.), IR focal planes and lasers. A critical portion of this technology thrust is the implementation of counter-countermeasures to all methods whereby the fire control systems can be

Program Element: #6.37.10.A Title: Night Vision Advanced Development
DOD Mission Area: #551 - Electronics & Physical Science (ATD) Budget Activity: #2 - Advanced Technology Development

rendered ineffective. This program bridges the gap between the efforts of Night Vision Investigation (PE 6.27.09.A) and Night Vision Devices (PE 6.47.10.A).

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Development within thermal technology will concentrate on prototypes of second-generation manportable thermal imaging systems for individual and crew-served weapons with less than one-half the size, weight, and cost of present systems. Advanced far infrared technology will be applied to driver's viewer and commander's viewer. In addition, prototypes of CO2 laser rangefinders and millimeter wave radars will be fabricated and evaluated for combat vehicles. Development of hardening componentry to modify Mercury Cadmium Telluride Common Module FLIR Systems to harden against laser threats will be started.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	13801	20537	*35715	Continuing	Not Applicable
Funds (as shown in FY 1980 submission)	13951	21815	30262	Continuing	Not Applicable

* Includes DOD Supplemental/Amended Request of $7.0 million.

The descrease in FY 1980 ($150) was due to program realignment and higher priority projects. The FY 1981 decrease reflects the application of general Congressional reductions and reductions for efficiencies. Increase in FY 1982 ($5453) provides funds for the modification of Mercury Cadmium Telluride Common Module FLIR Systems to harden against laser threats.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.37.10.A Title: Night Vision Advanced Development
DOD Mission Area: #551 - Electronics & Physical Science (ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Far infrared capability represents a first order improvement over image intensification technologies in that systems made using infrared are light-level independent, exhibit dust, smoke, and fog penetra- tion, and allow for rapid acquisition of targets. The Night Vision & Electro-Optics Laboratory development of Army Forward-Looking Infrared (FLIR) Common Modules has made this technology affordable for the Army; systems for antiarmor and tank applications are now in production. Packaging and integration efforts must still be undertaken to permit infrared capability to be incorporated into combat vehicle driving devices. The application of infrared technology to devices for the individual soldier is not possible with the current technology. Devices of sufficient compactness and lightness are possible only through the use of thermoelectrically cooled 3 to 5 micron second gereration FLIR technology, now in development in the technology base. These devices, thermal weapons sights, include the Infrared Rifle Sight, the Long-Range Weapon Sight for crew-served applications and a surveillance capability for the infantry commander. In addition, the use of this technology will be investigated as an independent sight for the combat vehicle commander. The commander is currently constrained to share a sight with the gunner, thus eliminating the possibility of employing the hunter-killer tactical concept. Under extremely adverse weather conditions, wherever FLIR's are ineffective, it may be possible to secure tactical superiority through the use of millimeter wave radar. A prototype device is being configured for testing to determine the utility of this approach. At the present time, laser rangefinders are adversely affected by adverse atmospheric conditions that are invisible to infrared sights. A CO2 laser range finder will solve this problem. Such a device will be integrated with a tank thermal sight during this period.

G. (U) RELATED ACTIVITIES: The Army's Night Vision Laboratory has been assigned the responsibility for coordination of all night vision technology based programs within the three Services to avoid duplication and to insure that maximum use is made of resources and capabilities within the Department of Defense (DOD) community. Additionally, active international technical interchange is maintained with North Atlantic Treaty Organizations (NATO) through Panel VI (Combat Intelligence) of the NATO Army Armaments Group (NAAG). The Federal Republic of Germany Memorandum of Understanding (MOU) for the sale and coproduction of the DOD Standardized Common Modules is being executed. Germany's plan to use Common Modules on their LEOPARD I & II, MARDER, and LUCHS vehicles is a significant step forward in NATO standardization for Thermal Imaging Systems. Negotiations are in progress within NATO on another Memorandum of Understanding (MOU) for sale and coproduction of common modules with Germany and the Netherlands. Development of an all weather capability for the Army Remotely Piloted Vehicle is funded under program element 6.37.25.DK61, Remotely Piloted Vehicles.

H. (U) WORK PERFORMED BY: Work is performed by the United States Army Night Vision and Electro-Optics Laboratory, Fort Belvoir, VA, with contractor assistance. Representative contractors include: International Telephone and Telegraph Corporation, Fort Wayne, IN; Varian Associates, Palo Alto, CA; Texas Instruments, Inc., Dallas, TX; Aeronutronics Ford Corporation, Newport Beach, CA; Hughes Aircraft, Culver City, CA; Honeywell, Lexington, MA; and Martin Marietta, Orlando, FL.

Program Element: #6.37.10.A Title: Night Vision Advanced Development
DOD Mission Area: #551 - Electronics & Physical Science (ATD) Budget Activity: #2 - Advanced Technology Development

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Tubes for low cost Night Vision Aids were developed and tested, and contracts awarded for fabrication of the aids (goggles) using these tubes. Improvement to the 1st generation of Infrared Common Modules have been completed. These improvements provide increased durability and maintainability. The battery powered cooler for the Night Observation Device, Long Range (NODLR) was developed. A neodymium laser rejection filter for image intensifiers was developed. Advanced development of third generation Pilot's Night Vision Goggles (ANVIS) was completed. A FLIR augmented COBRA TOW Sight (FACTS) was developed, tested, and transferred to AVRADCOM.

2. (U) FY 1981 Program: The Advanced Development of the Low Cost Night Vision Aids is to be completed with transition to Engineering Development. Advanced Development of the Thermal Driver's is to be initiated for application to combat vehicles. Advanced Development of the thermoelectrically cooled Thermal Weapons Sight will start with primary emphasis on the intermediate range for crew-served weapons. A Digital Scan Converter and Head Mounted Displays are to be developed for application to Common Module FLIR Systems. Development of liquid phase epitaxy (LPE) growth Mercury-Cadmium-Telluride Detectors and hardening of first generation thermal sensors will be continued.

3. (U) FY 1982 Planned Program: The Thermal Driver's Viewer will complete Advanced Development and DT/OT will be conducted for validation prior to entering Engineering Development. The Independent Commander's Viewer will continue in Advanced Development as will the Thermal Weapon Sight (TWS). The first units of the TWS will be evaluated for the intermediate range crew-served weapon sight application. Advanced Development will be completed on the CO2 laser rangefinder and it will transition to the PM for product improvement of the MK II XM1. LPE fabrication of detectors will continue and the digital scan converter will be incorporated in a Common Module Test FLIR. Advanced Development will be initiated on an infrared air defense search set and an advanced FLIR for combat vehicle applications. Display and automation component work will continue. Initiate the development of hardening componentry which incorporates curent technology improvements in a form that permits the modification of Mercury Cadmium Telluride Common Module FLIR Systems to harden against laser threats.

4. (U) FY 1983 Planned Program: The Independent Commander's Viewer will transition to the PM for product improvement (XM1) and the TWS will transition to Engineering Development. Automation peripherals for the scan converter will begin advanced development as will the multi-functional laser for combat vehicles. The IR Search Set for air defense will be evaluated prior to transition to PM STINGER. Prototype helmet mounted displays will be integrated into the advanced combat vehicle system and prototype development will conclude on a lightweight airborne FLIR.

Program Element: #6.37.10.A Title: Night Vision Advanced Development
DOD Mission Area: #551 - Electronics & Physical Science (ATD) Budget Activity: #2 - Advanced Technology Development

5. (U) Program to Completion: This is a continuing program.

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FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #DK70 Title: Night Vision Advanced Development
Program Element: #6.37.10.A Title: Night Vision Advanced Development
DOD Mission Area: #551 - Electronics and Physical Science (ATD) Budget Activity: #2 - Advanced Technology Development

A. (U) DETAILED BACKGROUND AND DESCRIPTION: The Army has the need for a cost-effective ability to fight during periods of darkness and limited visibility with a relative combat capability that equals that during daylight. This project applies new techniques, components, and devices to produce significant cost reductions and performance improvements for night vision devices to meet that need. The combat capability is required to counter the threat of a foe that plans to continue combat operations during periods of darkness and limited visibility. The objective of this project is the advanced development of night vision components and devices which have applications independent of specific weapons systems or vehicles. This is the base project for the program element and includes infrared, laser, image intensification and MM wave technologies.

B. (U) RELATED ACTIVITIES: Related Projects are Program Element 6.37.10.A, Project DK86, Night Vision Airborne Systems, and Program Element 6.37.10.A, Project DK87, Night Vision Combat Vehicles. These latter projects were established to increase management visibility of specific applications. The Army's Night Vision and Electro-Optics Laboratory has been assigned the responsibility to coordinate all night vision technology-based programs within the three services to insure maximum use is made of resources and capabilities within the Department of Defense (DOD). Active international technical interchange is maintained within North Atlantic Treaty Organization (NATO) Army Armaments Group. Configuration control is maintained for common modules produced for United States systems as well as those produced under the Memorandum of Understanding with the Federal Republic of Germany.

C. (U) WORK PERFORMED BY: Work is performed by the United States Army Night Vision and Electro-Optics Laboratory, Fort Belvoir, VA, with contractor assistance. Representative contractors include: International Telephone and Telegraph Corporation, Fort Wayne, IN: Varian Associates, Palo Alto, CA; Texas Instruments, Dallas, TX; Hughes Aircraft, Culver City, CA; Martin Marietta, Orlando, FL; and Honeywell, Lexington, MA.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Second Generation Image Intensifier tubes and devices have been developed, tested, and are in production. First Generation Infrared Common Modules have been standardized within the three Services and are in production for such items as the AN/TAS-4, TOW Night Sight, and AN/VSG-2, Tank Thermal Sight, and the Gunner's Primary Sight (GPS) for the XM1. A forward looking infrared (FLIR)-Augmented COBRA TOW Sight (FACTS) was developed, tested, and transitioned to the COBRA PM for engineering development. High sensitivity third-generation Image Intensification Tubes have been

Project: #DK70 Title: Night Vision Advanced Development
Program Element: #6.37.10.A Title: Night Vision Advanced Development
DOD Mission Area: #551 - Electronics and Physical Science (ATD) Budget Activity: #2 - Advanced Technology Development

fabricated and given limited field testing. Low-cost Night Vision Aid Tubes have been fabricated. Advanced development of an Aviators Night Vision Imaging System (ANVIS) was completed and transitioned into egineering development. The performance qualification of first-generation infrared common module competitive infrared common modules was initiated. A neodymium base rejection filter for image intensifiers was demonstrated. A battery-powered closed cycle cooler for manportable thermal sights was developed to replace the current compressed-gas-powered cooler and a thermoelectric cooler for lightweight sights has been initiated.

2. (U) FY 1981 Program: Advanced development will begin on the second-generation 3-5 micron thermalelectrically cooled systems to provide thermal imaging systems for the individual soldier and lightweight weapon applications. A digital scan converter is in development for the common module FLIR. Common module detectors will be fabricated from a new process called liquid phase epitaxy to increase yield and decrease cost of this component. Development will continue on second generation focal planes, their hardening and system analysis for advanced systems.

3. (U) FY 1982 Planned Program: Test will be initiated for the early models of the Thermal Weapons Sights (TWS). Detectors fabricated from liquid phase epitaxy (LPE) process will be evaluated for production transition decision. Helmet-Mounted Display will be fabricated for application to aircraft and combat vehicles. Advanced Development for an infrared (IR) air search system will be initiated and tests will be initiated on the digital scan converter. Second-generation focal planes will be integrated into existing first-generation systems. Initiate the development of hardening componentry which incorporates current technology improvements in a form that permits the modification of Mercury Cadmium Telluride Common Module FLIR Systems to harden against laser threats.

4. (U) FY 1983 Planned Program: Thermal Weapon Sights will complete Advanced Development and transition to Engineering Development. Advanced Development will be completed on the IR search set. The Helmet-Mounted Display will be completed and tested prior to integration into advanced systems. Detector fabrication, using liquid phase epitaxy, will continue with emphasis on second-generation focal planes. Advanced Development will be initiated on automation modules for add-on to existing forward-looking infrared (FLIR) systems.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not Applicable.

Project: #DK70 Title: Night Vision Advanced Development
Program Element: #6.37.10.A Title: Night Vision Advanced Development
DOD Mission Area: #551 - Electronics and Physical Science (ATD) Budget Activity: #2 - Advanced Technology Development

7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	9106	13074	*23788	20834	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	8660	13733	18505		Continuing	Not Applicable

* Includes DOD Supplemental/Amended Request of $7.0 million.

Increase in FY 1980 ($446) was to cover cost growths incurred through general price increases. The FY 1981 decrease reflects the application of general Congressional reductions and reductions for improved efficiencies. Increase in FY 1982 ($5283) provides funds for the modification of Mercury Cadmium Telluride Common Module Systems to harden against laser threats.

FY 1981 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #DK87 Title: Night Vision Combat Vehicles
Program Element: #6.37.10.A Title: Night Vision Advanced Development
DOD Mission Area: #551 - Electronics & Physical Science (ATD) Budget Activity: #2 - Advanced Technology Development

A. (U) DETAILED BACKGROUND AND DESCRIPTION: The Army has a need for a cost-effective means to fight during periods of darkness and limited visibility with a relative combat capability that equals that during daylight. Far infrared capability represents a first order improvement over image intensification technologies in that systems made using infrared are light-level independent, exhibit dust, smoke, and fog penetration, and allow for rapid acquisition of target. This project encompasses efforts in the areas of Forward-looking Infrared (FLIR) common modules, millimeter wave radar, and laser rangefinding. The use of FLIR technology will be investigated as an independent sight for the combat vehicle commander. The commander is currently constrained to share a sight with the gunner, thus eliminating the possibility of employing the hunter-killer tactical concept. Under extremely adverse weather conditions, wherever FLIR's are ineffective, it may be possible to secure tactical superiority through the use of millimeter wave radar. A prototype device is being configured for testing to determine the utility of this approach. At the present time, laser rangefinders are adversely affected by adverse atomspheric conditions that are invisible to infrared sights. A CO2 laser rangefinder will solve this problem. Such a device will be integrated with a tank thermal sight during this period.

B. (U) RELATED ACTIVITIES: Related projects are Program Element 6.37.10A Project DK86, Night Vision Airborne Systems, and Project DK70, Night Vision Advanced Development. While DK70 concentrates on development of night vision components and devices which have applications independent of specific weapons systems or vehicles, DK86 gives management visibility to night vision applications to airborne systems. The Army's Night Vision and Electro-Optics Laboratory has been assigned the responsibility to coordinate all night vision technology-based programs within the three services to insure maximum use is made of resources and capabilities within the Department of Defense (DOD). Active international technical interchange is maintained within North Atlantic Treaty Organization (NATO) Army Armaments Group. Configuration control is maintained for common modules produced for United States Systems as well as those produced under the Memorandum of Understanding with the Federal Republic of Germany.

C. (U) WORK PERFORMED BY: Work is performed by the United States Army Night Vision and Electro-Optics Laboratory, Fort Belvoir, VA, with contractor assistance. Representative contractors include: Martin Marietta Aerospace, Orlando, FL; Hughes Aircraft, Culver City, CA; Magnavox, Mahwah, NJ, Texas Instruments, Dallas, TX; Honeywell, Lexington, MA; and Rockwell International, Anaheim, CA.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

Project: #DK87 Title: Night Vision Combat Vehicles
Program Element: #6.37.10.A Title: Night Vision Advanced Development
DOD Mission Area: #551 - Electronics & Physical Science (ATD) Budget Activity: #2 - Advanced Technology Development

1. (U) FY 1980 and Prior Accomplishments: Advanced Development of the Thermal Driver's Viewer was initiated in FY80. Advanced Development of the CO2 laser rangefinder was started in FY80.

2. (U) FY 1981 Program: Advanced Development for the Thermal Driver's Viewer will be continued. Development of a prototype system for the tank commander will be initiated. Prototype development of millimeter wave radar systems will demonstrate integration with tank Forward Looking Infrared Sights. Advanced Development of the CO2 laser rangefinder for combat vehicles will be continued.

3. (U) FY 1982 Planned Program: Millimeter wave radar for combat vehicles will be evaluated and a determination made as to how to proceed with a tank all-weather system. Advanced Development for the Thermal Driver's Viewer will be completed. Advanced Development of the Independent (Tank) Commander's Viewer will be continued. Advanced Development of the CO2 laser rangefinder will be completed and transitioned to Program Manager XM1. Initiate Design/Development of Autocuer/Tracker for XM1 subsystems.

4. (U) FY 1983 Planned Program: Advanced Development of the Independent (Tank) Commander's Viewer will be completed and transitioned to Program Manager XM1. Initiate integration of Autocuer/Tracker for XM1 subsystems.

5. (U) Program to Completion: This is a continuing program.

6. (U) Major Milestones: Not Applicable.

7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	2383	4256	7273	7662	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	3015	4618	7185		Continuing	Not Applicable

Decrease in FY 1980 ($632) was due to reprograming in favor of other high-priority projects. The decrease in FY 1981 reflects the application of general Congressional reductions. Increase in FY 1982 ($98) is due to inflation.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.25.A Title: Remotely Piloted Vehicle (RPV's)/Drones
DOD Mission Area: #551 - Electronic & Physical Science (ATD) Budget Activity: #2 - Advanced Tech Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT QUANTITIES	3329	4905	4943	7333	Continuing	Not Applicable
DK61	Remotely Piloted Vehicles/ Drones	3329	4905	4943	7333	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides an Advanced Development base for improvements to the Remotely Piloted Vehicle (RPV) System being developed under Program Element (PE) 6.47.30.A and for the development of additional RPV mission capabilities. RPV's are required to extend the eyes of the Brigade and Division commanders to the range of their artillery, increase the effectiveness of their direct support firepower, and provide laser designation for laser-guided weapons. Sophisticated enemy air defense systems preclude the use of manned aircraft performing such penetration missions. Projected improvements to the RPV system include night/adverse weather sensors utilizing Forward Looking Infrared (FLIR) and millimeter radar technology, improved command control techniques such as multiple air vehicle control from a single ground station and extended range of operation, survivability simulations and studies, eye-safe laser and air traffic control/identification friend or foe. Additional penetration missions identified in the ROC for the Remotely Piloted Vehicle include electronic warfare, meteorological sensor, communication relay platform, radiac survey, and decoy operations.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: RPV sensor developments will continue with heavy emphasis on developing a night/adverse weather sensor capability for mini-RPV applications. The survivability enhancement program will address survivability for multicontrol and extended range missions. The United Kingdom (UK) Remotely Piloted Vehicle Study will continue as an effort to take advantage of mutual exchange of data in propulsion, command and control, sensor and survivability techniques through the US/UK Memorandum of Understanding. Rationalization, Standardization, and Interoperability (RSI) interface with other countries, particularly Germany, is planned. Development of Wideband Adaptive Ground Antenna System (WAGAS) for multiple control and extended range will continue. Continued flight testing of equipment resulting from RPV supporting technology programs will be conducted in manned aircraft in order to reduce technological and schedule risks in ongoing RPV programs.

Program Element: #6.37.25.A Title: Remotely Piloted Vehicle (RPV's)/Drones
DOD Mission Area: #551 - Electronic & Physical Science (ATD) Budget Activity: #2 - Advanced Tech Development

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	3329	4905	4943	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	3329	5266	5744	Continuing	Not Applicable

FY 1981 funding was decreased by DARCOM to provide additional funds for the 6.4 Modular Integrated Communication and Navigation System (MICNS) effort and other higher priority projects. The FY 1982 decrease was due to reprograming of funds to higher priority Army projects.

E. (U) OTHER APPROPRIATION FUNDS: ($ in thousands). Not Applicable.

Program Element: #6.37.25.A Title: Remotely Piloted Vehicle (RPV's)/Drones
DOD Mission Area: #551 - Electronic & Physical Science (ATD) Budget Activity: #2 - Advanced Tech Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The objective of the Army RPV program is to field a series of lightweight, small-sized RPV's that operate in a tactical environment to accomplish a broad range of mission capabilities. Initial efforts are oriented on the early fielding of an RPV with daylight television and laser designator/rangefinder to meet the need for target acquisition, adjustment of artillery fire, laser target designation and reconnaissance beyond the forward edge of the battle area (FEBA) and past the range of ground observers. Follow-on efforts are oriented at providing this system with improved night/adverse weather sensors and improved command and control capabilities that permit multiple air vehicle operations from a single ground control station as well as operations at greater ranges. In a parallel effort, the development of other mission capabilities for mini-RPV's is being pursued to provide a broad range of capabilities for use beyond the FEBA. Commonality of components within the Army programs and with other service programs is being pursued. The major activities to date have been the Aquila System Technology Demonstrator Program, which completed testing in FY78, and its associated supporting technology programs, and the initiation of full-scale engineering development (FSED).

G. (U) RELATED ACTIVITIES: Within the Army, Exploratory Development of RPV technology is conducted under Program Element (PE) 6.27.32.A, RPV Supporting Technology. Full-scale engineering development (FSED) of the first-generation RPV is conducted under PE 6.47.30.A, Remotely Piloted Vehicles. This program element (6.37.25.A) provides an Advanced Development base for transitioning Supporting Technology programs into Engineering Development. Air Force RPV programs consisting of PE 6.37.39.F, Advanced RPV's, and PE 6.47.46.F, Expendable Drones, are being monitored to preclude duplication of effort and commonality of design where possible. The Army, Air Force, and the Navy RPV Program Managers and Marine Corps liaison officer meet to preclude duplication of efforts between the services. Interoperability is being pursued through a Memorandum of Understanding with the United Kingdom (UK). There is no duplication of effort in mini-RPV's within the Services.

H. (U) WORK PERFORMED BY: US Army Aviation Research and Development Command, St Louis, MO; Combat Surveillance & Target Acquisition Laboratory, US Army Electronics Research and Development Command, Fort Monmouth, NJ; Research and Technology Laboratories, Aero Mechanics Lab, Moffett Field, CA; Applied Technology Lab, Fort Eustis, VA; and the US Army Night Vision and Electro-Optics Laboratory, Fort Belvoir, VA. Contractors actively participating in the RPV development are Lockheed Missiles and Space Company, Inc., Sunnyvale, CA; Honeywell, Lexington, MA; Harris Corporation, Melbourne, FL; and Norden Systems, Norwalk, CT.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: In FY 1973 and FY 1974, the Remotely Piloted Aerial Observer/Designator System (RPAODS) program yielded parametric data in such areas as detectability, survivability, target search and acquisition, and target tracking. In FY76, a demonstration was conducted using the Aeronutronics Ford (formerly Philco Ford) PRAIRIE II

Program Element: #6.37.25.A Title: Remotely Piloted Vehicle (RPV's)/Drones
DOD Mission Area: #551 - Electronic & Physical Science (ATD) Budget Activity: #2 - Advanced Tech Development

RPV to laser designate a tank target for a laser-seeking Cannon-Launched Guided Projectile (COPPERHEAD). A direct hit was scored. Based on general requirements derived from the Remotely Piloted Aerial Observer/Designator System (RPAODS) program, the Aquila System Technology Demonstration Program was established in FY75. Contractor flight testing of Aquila was initiated in mid-FY 1976. Aquila flew 218 flights and successfully demonstrated automatic launch, flight, and navigation; semiautomatic net recovery in an unimproved site; target detection, recognition, and laser rangefinding/designation; artillery adjustment and handoff of control from one Ground Control Station to another. A second RPV laser designation for the COPPERHEAD precision-guided munition was successfully performed in FY78. Formal user testing was conducted in simulated field conditions. User and developer testing was concluded in FY78. Information acquired from this program was used in the development of the system Required Operational Capability. The RPV was approved to enter Full-Scale Engineering Development (FSED) by Headquarters, Department of the Army (HQDA) in late FY78 and has been transitioned to Program Element (PE) 6.47.30.A, Remotely Piloted Vehicles. An antijam data link program was initiated in FY76 to provide an improved command and control capability. The resulting hardware consisted of two airborne data terminals integrated in Aquila RPV's and one ground station. Flight testing was successfully concluded in FY78. The resulting system provided the baseline for the data link that is being developed for use on the FSED RPV under PE 6.47.30.A. Survivability/vulnerability studies, testing and simulations were conducted in FY78. These included live firing ballistic weapon tests as well as infrared (IR) and radar tracking tests and simulations. Work is continuing in this area. Additional efforts included night sensor Forward Looking Infrared (FLIR) tests on manned aircraft; flight testing of tunable and barrage jammers; parachute recovery tests and engine and propeller test and evaluation. Contracts were issued for two FLIR sensors of Mini-RPV size and weight. Development of a night sensor (FLIR) was initiated. The sensor is effective in degraded visibility conditions during daylight hours. The sensor includes a FLIR imagery sensor, laser rangefinder/designator, autotracker, and associated electronics. The entire sensor package has suitable form factors, including weight, for a mini-RPV payload. Survivability initiatives include IR tracking susceptibility tests using a instrumented STINGER seeker head and air-to-air detection tests. The United Kingdom (UK) vertical take-off and landing RPV program was monitored up to its cancellation. Monitoring of the subsequent RPV study effort continued under the purview of the US/UK Memorandum of Understanding (MOU) on RPV interoperability.

2. (U) FY 1981 Program: Advanced development of the FLIR night sensor will continue. A comprehensive test program to demonstrate FLIR image quality will be conducted. This testing program will include extensive bench testing, as well as integration into a manned aircraft for flight testing. The flight testing will evaluate the effectiveness of the FLIR to perform its mission in a variety of atmospheric conditions. The sensor will be evaluated under both nighttime and daytime conditions. Contracts will be awarded to investigate advanced technology antenna techniques for a Wideband Adaptive Ground Antenna System (WAGAS). This effort is the first step toward fulfilling multicontrol and extended range growth requirements for the RPV System. The second phase of this effort will yield a proposed design for a demonstration model of the WAGAS. The MOU with the United Kingdom was extended for two years to continue the data exchange.

Program Element: #6.37.25.A Title: Remotely Piloted Vehicle (RPV's)/Drones
DOD Mission Area: #551 - Electronic & Physical Science (ATD) Budget Activity: #2 - Advanced Tech Development

3. (U) FY 1982 Planned Program: Evaluation of results of advanced development night sensor (FLIR) will be completed. Phase II of the Wideband Adaptive Ground Antenna System (WAGAS) will be initiated. This effort will include wideband, multiple control antenna hardware and algorithm development, fabrication of a demonstration model, and integration with components of the Modular Integrated Communications and Navigation System (MICNS) RPV data link. The WAGAS concept also applies to the extended range development program. Effort will begin to adapt the eye-safe laser hardware to be compatible with the RPV mission payload to provide a training configuration that would ease range safety requirements. RSI activity will continue under the UK Memorandum of Understanding (MOU) and interface activity with other friendly foreign countries. A level of survivability analysis will be maintained to address multicontrol and future mission RPV scenarios.

4. (U) FY 1983 Planned Program: The FLIR program will transition to Full-Scale Engineering Development under PE 6.47.30.A. The multiple control and extended range development program continues from FY82 including evaluation of Wideband Adaptive Ground Antenna System (WAGAS) interfaced with the MICNS RPV data link. Initiatives with the UK and other countries included in RSI programs will continue. The millimeter wave radar development will advance from PE 6.27.32.A with emphasis on designing this adverse weather sensor subsystem to meet the size and weight constraints of an RPV payload. Eye-safe laser/mission-payload compatibility effort will continue. A program to investigate a suitable Air Traffic Control/Identification Friend or Foe equipment for the RPV will be initiated. Survivability studies as applicable to new RPV missions will continue.

5. (U) Program to Completion: Work on extended range and multiple control mission payloads begin. This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.31.A
DOD Mission Area: #552-Environmental and Life Sciences (ATD)

Title: Manpower and Personnel
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	3085	3065	4675	6360	Continuing	Not Applicable
A792	Manpower and Personnel	3085	3065	4675	6360	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: One of the Army's most critical missions is to man the force. To accomplish this, adequate numbers of capable individuals must be attracted into the officer and enlisted ranks and their abilities used appropriately. Effective manning of the force becomes difficult as the number of available military-age youth declines while new military systems and equipment continue to require increasing numbers of highly trained soldiers. As a result, there is a critical need to improve utilization of soldiers by more effective personnel management at the unit level, and determine the impact of the manpower demand of new systems upon the available manpower pool. The proposed research is designed to: validate Army enlistment criteria and the new Armed Services Vocational Aptitude Battery (ASVAB) based on field performance; develop procedures to increase recruiter productivity; develop techniques for more valid selection and placement of officer trainees; develop procedures that would increase enlisted and officer retention; develop procedures for maintaining and increasing organizational cohesion; and develop better ways of matching available personnel to new systems in a cost-effective manner.

C. (U) BASIS FOR FY 1982 RDTE REQUEST:

1. (U) The requested increase will be used to further concentrate and focus research efforts supporting the Army's highest priority manpower problems, recruiting and retention. This research is required to improve recruiting assessment center techniques for selecting effective recruiters; to identify ways to broaden the population base for Army recruiting; to assure that manpower and personnel resource planning is included very early in design of new weapons and materiel systems; determine which factors enhance cohesion in military units; to develop personnel management methods to reduce attrition of first-tour soldiers; to evaluate tools and techniques to increase the personnel effectiveness of organizations; to develop techniques for managing turbulence, rotation and cross-training of crews to maintain unit effectiveness; and to determine the impact of selected personnel management variables on individual readiness.

Program Element: #6.37.31.A Title: Manpower and Personnel
DOD Mission Area: #552 - Environmental and Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

2. (U) The Army has a continuing requirement to man and maintain the force. This research effort reflects the need to develop and maintain effective selection techniques such as the ASVAB; to increase recruiter productivity in a changing cultural environment; to develop more valid selection and placement techniques for officer trainees; to match new systems personnel requirements to the available personnel pool, and to maintain (and increase) organizational cohesion.

D. (U) COMPARISON WITH FY 1981 REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (Current Requirements)	3085	3065	4675	Continuing	Not Applicable
Funds (as shown in FY 1981)	3121	3230	3738	Continuing	Not Applicable

Decrease in FY81 is attributable to the application of general Congressional reductions. The change indicated in FY82 reflects a recognition by the Army of the requirement to achieve a significant improvement in recruiting and manpower management to meet force objectives.

E. (U) OTHER APPROPRIATION FUNDS:. Not Applicable.

Program Element: #6.37.31.A Title: Manpower and Personnel
DOD Mission Area: #552 - Environmental and Life Sciences(ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: Manpower and personnel research has the following objectives: identify ways to broaden the available manpower pool for Army recruiting; improve recruiting practices; determine factors which will attract new enlistees; improve methods for assessing and rewarding soldier performance; reduce attrition of trained personnel; enhance non-material reward for Army service; ensure that the personnel available can be used effectively within the organizational structure and materiel and weapons systems envisioned for the future Army; develop ways of determining the personnel impact of new system development and relate the personnel requirements of new systems to the available supply of trained manpower. Research has been initiated to identify successful recruiters through use of assessment-center techniques. Research to determine what motivates young people to join the Army and Research Forces and what contributes to their retention. Research on reenlistment for both Active and Reserve Component forces will relate characteristics of successful reenlistees to Army reenlistment policies. Other research concentrates on unit personnel management techniques to increase unit effectiveness. Work continues on methods to evaluate crew requirements of new weapons systems during operational tests and to relate these requirements to aptitude distributions of the population. Work on effectiveness of organizations will explore non-survey methods for diagnosis of organizational problem areas identify techniques for dealing with them. A program to determine the impact of new system acquisitions upon the affordability of personnel, both in terms of the potential manpower pool and impact on current Army force structure is well underway.

G. (U) RELATED ACTIVITIES: Through the Department of Defense, this work is coordinated with Naval Personnel Support Technology, P.E. 6.27.63.N; Navy Manpower Control System Development, 6.37.07.N; Air Force Personnel Utilization Technology, 6.27.03.F. The related Army Program Element is Manpower, Personnel and Training, 6.27.22.A. Interservice coordination is effected through tri-service Technical Advisory Groups (TAG) in such areas as education and training, manpower, personnel, and organizational effectiveness. The purpose of the TAG is to coordinate Service developments and eliminate undesirable overlap and duplication of effort. Cooperative research efforts with the Navy and Air Force are being conducted in areas of selection and the ASVAB.

H. (U) WORK PERFORMED BY: Contractors include: Systems Development Corp., Santa Monica, CA; Personnel Decision Research Institute, Minneapolis, MN; American Institutes for Research, Arlington, VA; McBer and Co., Boston, MA; Human Sciences Research, Inc., McLean, VA; and, Richardson, Bellows, and Henry, Washington, DC. More than three-fourths of the funds expended for contracts are for competitive procurements. In-house research is performed by the US Army Research Institute for the Behavioral and Social Sciences, Alexandria, VA, and its field units at Ft Bliss, TX; Ft Rucker, AL; Ft Benjamin Harrison, IN; and USAREUR.

Program Element: #6.37.31.A Title: Manpower and Personnel
DOD Mission Area: #522 - Environmental and Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Past efforts have produced: the Military Applicant Profile (MAP) test to screen out poor candidates for enlistment which has resulted in a 24 percent increase in retention of lower mental category personnel accepted for enlistment; Armed Services Vocational Aptitude Battery (ASVAB) tests for the Joint US Army Recruiting Command/US Army Recruiting Program; guidelines for managing tank crew turbulence which have contributed to improved tank crew performance; improved reserve Officer Training Corps (ROTC) scholarships selection system; and an improved management and leadership training package for ROTC; revised ROTC Cadet Evaluation and Officer Selection batteries which result in high correlations between predictions of officer performance and actual data. A plan for validation of new Armed Services Vocational Aptitude Battery (ASVAB) (#8, 9, and 10) has been completed. The field test of a performance-based officer selection/evaluation system is in its final stages of data collection and analyses. The basic cohort file of attrition variables data for FY 76-79 has been completed and will be used to help identify possible causes of attrition. A survey instrument for assessing the aviation warrant officer retention problem is completed. A preliminary test of the Navy "Hardman" model for assessing Army manpower, personnel and training requirements will be used to help improve Army new weapon system personnel procedures. The evaluation of platoon-sized unit replacement program to increase unit cohesiveness is under way. Criteria for early identification of leadership development needs have been developed. An assessment of the relationship of quality-of-life to personnel readiness and retention is being completed. A revised Flight Aptitude Selection Test (FAST) to improve the success rate of Army aviators; Evaluation of the Army's current organizational effectiveness (OE) program has been used to increase the program's efficiency.

2. (U) FY 1981 Program: Collect data for validation of Army enlistment standards and new Armed Services Vocational Aptitude Battery (ASVAB). Test and validate of the paper and pencil portion of the officer selection battery. Develop preliminary specifications of procedures for reducing female attrition based upon previous research in this area. Assess negative effects of relocation on personnel performance and determine methods for their control will be determined. Development of a questionnaire for determining factors related to officer retention will be completed. Initiate a program for identification of demographic, attitudinal and other factors that are predictive of aviation warrant officer attrition. The complete Navy "hardman" model for assessing Army manpower, personnel and training requirements will be evaluated for application to several selected new weapons systems. The delineation of criteria for manpower and personnel evaluation of competing weapon systems concepts will be tested. Planning will be completed for application of socio-technical systems techniques to improve acceptance of new methods of manufacture in a selected Army depot. The evaluation of a company-level unit replacement program to increase unit cohesion is underway and will be closely followed to determine factors in unit performance. An improved method to assign aviator trainees to advanced undergraduate training in the initial entry rotary wing (IERW) program to reduce attrition costs is being validated. Determination of the minimum personnel and training requirements for the Army acquisition process (support of ASARC) has begun. These requirements will be related to the adequacy of manpower and personnel planning and projections associated with acquisition of emerging weapons and

Program Element: #6.37.31.A Title: Manpower and Personnel
DOD Mission Area: #522 - Environmental and Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

support systems. Evaluate the non-commissioned officer organizational effectiveness program. Initiate research on the impact of quality-of-life factors on individual and unit readiness and evaluate the impact of alienation among soldiers. Continue the evaluation of the Army personnel management system at Division and lower unit levels.

3. (U) FY 1982 Planned Program: Continue to develop a personnel requirements estimation process for new Army systems. Develop guidelines and models for determining need for new manpower as well as current personnel availability for new system acquisition. Develop prediction models for personnel requirements and assignment during system acquisition. Develop a new set of predictors for each Military/Occupational Specialty (MOS) and career management field, which are performance based and job related. Develop assignment algorithms to assist recruiters in optimally matching manpower needs with individual aptitudes/desires. Develop prototype officer assessment program training modules as well as a preliminary validation of performance-based officer assessment program. A comparative assessment of military commitment of soldiers stationed in CONUS and USAREUR will be conducted to determine if the location has any significant effect on unit effectiveness. An evaluation of the application of socio-technical systems technology to Depot Systems Command (DESCOM) depots will be made and possible applications to other locales evaluated. Assess results of company-level unit replacement programs to increase unit cohesion. Continue development of improved personnel management techniques for unit commanders.

4. (U) FY 1983 Planned Program: Research will continue to develop prediction models for personnel requirements and assignment for system acquisition; methods for a recruiter reward system, validation of performance-based and job-related predictors for the ASVAB and for Army assignment. Validation of officer selection battery will be concluded. Continue testing of experimental procedures for enhancing ROTC cadet and officer retention. Specification of generalized socio-technical system procedures to a number of Army organizational types will be done based upon DESCOM try-outs. Continue follow-up of unit replacement system innovations to assess maintenance of unit cohesion. Improved methods of unit personnel management will be expanded to a variety of Army units.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.32.A
Title: Combat Medical Materiel
DOD Mission Area: #522 - Environmental and Life Sciences (ED)
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	111	132	191	225	Continuing	Not Applicable
A836	Combat Medical Materiel	111	132	191	225	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program element is the basis for advanced development of field medical materiel to allow the medical system to match the mobile combat forces it supports and to effectively handle a large number and variety of combat injuries.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: These funds will be directed to the development and fielding of priority items required by the field medical system to provide the advanced technical equipment necessary for localization, stabilization, treatment and evacuation of combat casualties.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

RDTE	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
Funds (current requirements)	111	132	191	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	111	141	182	Continuing	Not Applicable

The reduction in FY 1981 funds results from a decrement by the House Appropriations Committee.

E. (U) OTHER APPROPRIATION FUNDS: ($ in Thousands): Not Applicable.

Program Element: #6.37.32.A Title: Combat Medical Materiel
DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: 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 program is an aggressive research effort to develop new and improved medical field equipment in areas such as diagnostic and special purpose equipment; treatment and evacuation equipment, and medical support in chemical defense. Special emphasis is placed on simplicity for use by non-professionals, mobility to minimize burdens on the combat logistical system and utility under a variety of environmental conditions.

G. (U) RELATED ACTIVITIES: The program contains items and systems that have progressed to advanced development from related exploratory development Program Element 6.27.72.A, Combat Casualty Treatment Technology. Related engineering development Program Element is 6.47.17.A, General Combat Support, Project D832, Combat Medical Materiel. Army development is closely coordinated with Air Force and Navy medical materiel development programs via formal symposiums and informal contact to insure that there is no duplication.

H. (U) WORK PERFORMED BY: All in-house work is performed by the US Army Medical Bioengineering Research and Development Laboratory, Fort Detrick, Frederick, MD. No contract work is programmed for this area.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Three backpack pesticide dispersal units were evaluated in operational testing. The laboratory evaluation and field testing of controlled-release environmentally degradable pesticide formulations was completed marking the end of operational testing/developmental testing I. The requirement was developed for a field clinical laboratory system and the tests required at each level of field care were partially determined. The product improvement analysis was begun on the surgical field sink unit to determine the level and cost of improvement needed. Short and long spine boards for transportation of neck and back injuries were selected for procurement.

2. (U) FY 1981 Program: Design and testing of vibration proof containers for sensitive medical equipment is in process and design and testing of new field sterilizer units will be completed.

Program Element: #6.37.32.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Combat Medical Materiel
Budget Activity: #2 - Advanced Technology Development

3. (U) FY 1982 Planned Program: Development of prototypes of modular components for the field clinical laboratory system will be initiated. Development of new low capacity and high capacity field x-ray units and a new all environment field refrigerator for storing biologicals is planned. Total personnel utilized: 2 professional and 2 support.

4. (U) FY 1983 Planned Program: Development of a field laboratory system will be completed. The study on the tactical ambulance, vibration protective containers, cold weather patient transportation bag, and x-ray units should be completed. Other field medical materiel will undergo product improvement or new development as required.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.34.A
DOD Mission Area: #553 - Engineering Technology (ATD)

Title: Combat Engineering Systems
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	0	0	269	258	Continuing	Not Applicable
DT08	Military Construction and Engineering	0	0	269	258	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides for the validation and technology transfer, in a prototype environment, of concepts and techniques developed in exploratory development programs to provide weapon effects information and combat engineering support on the battlefield. One of the mission area shortfalls is the impact of debris clouds created by exploding ordinance on electro-optical sensor systems used for target acquisition and weapon system guidance. Work in this program will address the characterization and measurement of the debris cloud environment.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: The funds requested in FY 1982 are required to demonstrate and verify the obscuration effect of debris clouds on electro-optical sensor systems. The results expected will be an optimization of effectiveness of our current electro-optical sensor systems and information on which to base designs of new systems to overcome battlefield obscuration.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	Additional To Completion	Total Estimated Costs
RDTE					
Funds (Current requirements)	0	0	269	Continuing	Not Applicable
Funds (as shown on FY 81 submission)	0	232	261	Continuing	Not Applicable

Program Element: #6.37.34.A Title: Combat Engineering Systems
DOD Mission Area: #553 - Engineering Technology (ATD) Budget Activity: #2 - Advanced Technology Development

DTOS - The FY 1981 funding request was deleted from the FY 1981 budget by Congressional action. The project for 232 thousand originally requested in FY 1981 is estimated to cost 269 thousand in FY 1982. The original work estimated to cost 261 thousand requested in FY 1982 has been deferred.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The visibility of the mid and high intensity battlefields will be obscured by smoke, debris, fog, snow and dust propelled into the air by nature, combat operations and explosives to the extent that the electro-optical sensors of modern weapons will be affected. This program element is to apply the technological solutions developed in exploratory development to the electro-optical sensors of weapons systems to minimize the degradation of the sensors and allow the weapons system to function efficiently on the dirty battlefield. The aim of the program element is to rapidly transfer to the field those systems, products and techniques that will improve the survivability and operational capability of both men and material in a mid to high intensity conflict.

G. (U) RELATED ACTIVITIES: This program element will apply the exploratory development performed under Program Element 6.27.19.A, Title: Mobility & Weapons Effects Technology, Project AT40. This work is coordinated with the activities of the other services in the Tri-Service Plan for Atmospheric Transmission R&D. The lead laboratory for the Army Program is the Atmospheric Sciences Laboratory. The Naval Research Laboratory is lead laboratory for the Navy and the Air Force lead laboratory is the Air Force Geophysics Laboratory.

H. (U) WORK PERFORMED BY: The US Army Waterways Experiment Station, Vicksburg, MS, is to perform 75% of the work in-house. The balance is split evenly between the Atmospheric Science Laboratory, White Sands Missile Range, NM, and Teledyne-Brown, Huntsville, AL.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 Prior Accomplishment: This program element was not funded in FY 1980 and FY 1981.

2. (U) FY 1981 Program: This program element was not funded in FY 1981.

3. (U) FY 1982 Planned Program: Analytical methods for identification and quantification of clouds of debris which are thrown into the air during combat operations will be developed. The electro-optical sensor equipment supporting combat operation on the realistic battlefield will be evaluated and optimized. The methods used to define battlefield obscuration will be demonstrated and field tested in this program. The impact of the dirty battlefield on the electro-optical sensor systems in weapons systems will be quantified and validated.

4. (U) FY 1983 Planned Program. Follow on development of the work completed in the FY 1982 program will continue. The effectiveness and cost comparison of hardening and passive counter surveillance procedures for protection of fixed installation facilities will be demonstrated. The cost in dollars and time to implement each procedure will be evaluated with troop exercises and simulated combat sorties to determine the most economical and effective mix of techniques to employ.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.39.A Title: Human Factors in Training and Operational Effectiveness
DOD Mission Area: #522 - Environmental and Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	1909	2372	3165	3777	Continuing	Not Applicable
AH79	Human Factors in Training and Operational Effectiveness	1909	2372	3165	3777	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Force modernization will be one of the Army's critical missions over the next decade. The Army has over 200 new systems including 40 major systems programmed for acquisition in the next 10 years. The soldier is an integral part of these weapon systems and must be designed into the system early in development. Rapidly changing technology and doctrine require new tools and methods to ensure that systems are designed for soldier capabilities. Techniques to test the real world effectiveness of systems must be validated and tailored to the specific operational use for which they are intended. Shortcomings in the man-machine match will require the additional development of human performance aids so that the system can achieve full performance capacity. The program will develop those human factors capabilities associated with the development and operational employment of Army weapons systems. This includes a human factors evaluation of the system during the acquisition process and operational tests at maneuver areas, training areas, firing ranges in the continental United States (CONUS) and overseas, as well as evaluation and diagnosis to overcome human factors shortcomings in Army equipment/system maintenance and repair.

C. (U) BASIS FOR FY 1982 RDTE REQUEST:

1. (U) Human factors evaluations must occur during operational tests of new systems to assure that both soldier and system requirements have been met. Results of the evaluations then will be analyzed to compare human factors in actual performance with skill and training predictions. Operational data will be obtained from major armor, infantry, artillery and air defense systems. Results will be used by TRADOC system managers and DARCOM project managers to establish operating and maintenance procedures, define duties of individual crew members, and assess workload as a basis for determining numbers and skill levels of personnel needed for specific new weapon systems. Guidelines are furnished for human factors evaluation of weapons and equipment during operational testing. Demonstrated improvements in field operation procedures and techniques are incorporated into training and doctrinal material.

Program Element: #6.37.39.A Title: Human Factors in Train ing and Operational Effectiveness
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2. (U) There was no research projected for FY 1981 that was cancelled or deferred in this program.

3. (U) New Systems continue to be developed and fielded and related new tactical application techniques must be determined. The most effective use of soldiers in the total system will continue to be a major part of system fielding and application.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in Thousands):

RDTE	FY 1980	FY 1981	FY 1982	Additional to Completion	Total Estimated Cost
Funds (current requirements)	1909	2372	3165	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	1909	2547	3268	Continuing	Not Applicable

This was a new program element in FY 1980. The change in FY 1981 represents a decrease due to inflation. The FY 1982 change represents minor reprogramming actions.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.37.39.A Title: Human Factors in Training and Operational Effectiveness
DOD Mission Area: #522 - Environmental and Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The development and fielding of new weapon systems imposes a critical need to evaluate these systems to determine if soldier abilities and acquired skills are sufficient for effective tactical employment of the systems. This program covers research to match system demands with manpower and personnel capabilities. Major efforts focus on armor, air defense, artillery, infantry and automated or semi-automated command control and intelligence systems; improved procedures for operating and maintaining rotary wing aircraft; human factors operational test and evaluation for major weapons systems to identify improvements needed in operating procedures, doctrine and manning levels; and the development of techno[illegible] to predict training requirements early in the development of new systems. The objectives are to: Determine human factors requirements associated with the operational employment of major weapons systems; determine human factors requirements associated with design and operational employment of command, control, and intelligence systems, and other automated systems; conduct human factors evaluations of systems during development and operational tests at maneuver areas, training areas and firing ranges in CONUS and overseas; provide solutions to human factors problems identified in the maintenance and repair of Army equipment and systems; and develop and evaluate methods for maintaining individual aviator proficiency in tactical units.

G. (U) RELATED ACTIVITIES: Coordination and dissemination/transfer of research is through participation in the Tactical Operations Systems Test Integration Working Group and the Panel for Helicopter Human Resources Research, through annual DOD budget and apportionment review and through membership in tri-service committees such as the Human Factors Engineering Technical Advisory Group, the Human Factors Test and Evaluation Subgroup, and the DOD/NASA Simulation Working Group. Additional Coordination is obtained through participation in the NATO Working Group on Fidelity Requirements of Flight Simulation and the Technical Cooperation Program Panel on Human Factors in Command and Control Systems. In addition, direct coordination is effected with pertinent service elements, such as the Air Force Human Resources Laboratory (AFHRL), Naval Personnel Research and Development Center (NPRDC), Army Project Manager for Training Devices (PM TRADE), Army Human Engineering Laboratory (HEL) and the Naval Training Equipment Center (NTEC) to cover related research in visual displays, training simulation, human factors in operational testing, aviation crew performance, and instructional technology. Data exchange among Army Research Institute, related Army agencies and other services is used to eliminate unnecessary duplication of research.

H. (U) WORK PERFORMED BY: Contractors include: Manned Systems Sciences, Los Angeles, CA; Human Resources Research Organization, Killeen, TX; System Development Corporation, Leavenworth, KS; Vector Research, Ann Arbor, MI; Canyon Research, Inc., West Lake CA. In-house work is performed by the US Army Research Institute for the Behavioral and Social Sciences, Alexandria, VA and its field units distributed at major installations, including Ft. Bliss, TX; Ft. Hood, TX; Ft. Knox, KY; Ft. Leavenworth, KS; Ft. Rucker, AL; and Ft. Sill, OK.

Program Element: #6.37.39.A Title: Human Factors in Training and Operational Effectiveness
DOD Mission Area: #522 - Environmental and Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Past efforts have produced: An analytic model for evaluating routing and processing of information in command control and intelligence systems which provides new design criteria for systems in development; preliminary procedures for controlling information in future command control and intelligence systems; initial development of new procedures for collection planning, and intelligence analysis functions undergoing field evaluation at the 18th Airborne Corp; completed questionnaires for human factors analysis of four developmental battlefield automated systems for use during operational test; recommendations for optimum format for portraying terrain relief; new maps recommendations for color coding of computer displays which reduce human error by 30%. A handbook for human resources test and evaluation system (HRTES) was prepared and is now undergoing field test. The human factors test and analysis of the Multiple Integrated Laser Engagement System (MILES) was completed and the results used in product improvement of the new training system. Human factors and training analysis consultation was provided for design of an automated tactical data system test bed. A field test of the new individual ready reserve (IRR) aviator training program was conducted which will allow IRR training and performance to be more effective upon active duty.

2. (U) FY 1981 Program: Continue to develop procedures for operating and maintaining armor, artillery, air defense and automated communications systems. Provide guidelines to Combined Arms Combat Development Agency (CACDA) and related program managers on information management techniques for future command and control systems. Develop preliminary recommendations for improved analytic procedures in automated intelligence systems. Develop a provisional set of human factors design guidelines for battlefield automated systems. Develop recommendations for preferred military symbols for computer display. Conduct a field evaluation of the handbook for human resources test and evaluation system (HRTES). Document human factors aspects of minimum equipment levels for training (MELT) test. Evaluate prototype individual ready reserve (IRR) training program for aviators. Field validate nap-of-the-earth aviator lexicon to be used in communication and control procedures.

3. (U) FY 1982 Planned Program: Continue to develop operating procedures for tactical intelligence analysis and management of intelligence collection systems. Conduct research on operation and maintenance of combat aviation systems. Conduct human factors analysis during operational test and evaluations on selected battlefield systems. Conduct the preliminary evaluation of information management procedures during field tests of tactical command, control and intelligence systems for tactical operations and control. Participate in the field evaluation of analytic procedures in automated intelligence systems. Develop standard design criteria for assessing soldier interface in battlefield automated systems. Complete research on a catalogue of recommended standard tactical symbols for computer displays. Implement the handbook for human resources test and evaluation system (HRTES). Conduct the human factors analysis of XM-1 unit-conduct-of-fire trainer. Perform an evaluation of aircrew training manual (ATM) requirements. Develop and evaluate methods, materials and devices to maintain aviator flight proficiency and combat skill in units. Evaluate aviator performance in Advanced Attack Helicopter training.

Program Element: #6.37.39.A
DOD Mission Area: #522 - Environmental and Life Sciences (ATD)

Title: Human Factors in Training and Operational Effectiveness
Budget Activity: #2 - Advanced Technology Development

4. (U) FY 1983 Planned Program: Continue research on techniques for information management in battlefield automated systems. Field test design handbook and criteria for assessing the soldier interface in battlefield automated systems. Conduct a comprehensive evaluation of aircrew tactical training manuals. Continue research on information management techniques for battlefield automated systems. Document and implement procedures for computerized support for intelligence collection planning and analysis. Conduct field validation tests of human factors guidelines for battlefield automated systems. Try out new techniques for simplifying soldier tasks in automated weapon systems. Evaluate the impact of human issues on Army combat and force structure models.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.42.A
DOD Mission Area: #551 - Electronics & Physical Sciences (ATD)

Title: Advanced Electron Devices
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	2065	0	2278	4397	Continuing	Not Applicable
DF32	Advanced Electron Devices	2065	0	2278	4397	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEEDS: This advanced development program in electronic devices, component assemblies, and subsystems will resolve critical major defects common to several high-priority Army systems such as XM1 Tank, Standoff Target Acquisition System, Remotely Piloted Vehicles, Signals Intelligence Systems, and radars and will provide new "technology insertion"/preplanned product improvements into a substantial number of systems currently under development or in initial production in order to assure qualitative superiority to Soviet systems in the field. The highest priority research and exploratory development devices for which feasibility has been successfully demonstrated on 6.1 and 6.2 programs will be completed and demonstrated to meet specific user needs in accordance with established system schedules. This program will permit the latest performance or cost improvements (major technology advances) to be incorporated into ongoing systems developments so that technolgically obsolete systems will not be fielded. Completion of these devices will provide enhanced combat performance, improved reliability levels, and cost effectiveness. Such new components will be completely developed and tested so that program managers can use them with acceptable risk rather than rely on 5-15-year-old technology. To obtain a committment from system managers, it is vital that demonstrations of advanced devices and subsystems as called for in 6.3A funding be carried out.

C. (U) BASIS FOR FY 1982 REQUEST: The Army needs a substantially better capability to fight a land war under the limited visibility conditions of a contemporary battlefield. Accordingly, one of our highest priority exploratory development programs has been the development of millimeter wave devices to provide the capability to detect and recognize battlefield targets through smoke, dust, and adverse climatic conditions. Specifically, millimeter wave circuits that will now be completed are receiver devices operating at 94 and 140 GHz for the STARTLE Antitank Warfare System, and for terminally guided submunitions. The Program does not duplicate other millimeter wave efforts, but in fact provides the mechanism for getting devices

Program Element: #6.37.42.A
DOD Mission Area: #551 - Electronics & Physical Sciences (ATD)

Title: Advanced Electron Devices
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from completed 6.2 efforts into ongoing system development programs. In addition, compatible solid state transmitter modules (Indium Phosphide Gunn Diodes) operating at the same frequencies (94 and 140 GHz) will be demonstrated for the Receiver/Transmitter Radar System for the XM1 Tank and for Remotely Piloted Vehicles (RPV) to provide realtime intelligence and surveillance of the battlefield. Higher power electron tube transmitters are essential for ground data links to communicate with RPV's. In the microelectronics area, the design, fabrication, and final evaluation of advanced microelectronic circuits, modules, and subsystems will be completed for insertion into the advanced QUICKLOOK and GUARDRAIL Electronic Warfare systems, and Electronic Warfare Intelligence Systems. In addition, microelectronic design and prototype samples of slow frequency-hopping synthesizers will be evaluated for use in secure Standoff Target Acquisitions System and Remotely Piloted Vehicle data links. A high-resolution, reliable, lightweight display will be completed and technology demonstrated for TRAILBLAZER, TACJAM, and QUICKFIX Electronic Warfare Systems to replace present unreliable, heavy, and "power-hungry" displays. The first prototype of a highly reliable Traveling Wave Tube (TWT) will be retrofitted into the AN/TPQ-36 Radar to provide a significant improvement in the mean time between failure of these systems. Improved frequency-stable surface wave oscillators (403 MHz/1680 MHz) will be tested and delivered to the contractor for the Field Artillery Meteorological Atmospheric System (FAMAS) to permit radiosonde operation in the dense frequency interference environment in Germany. The Very High Speed Integrated Circuit (VHSIC) program has not progressed to the point where advanced VHSIC devices could be used on microelectronics programs planned herein; however, any improved microfabrication techniques emanating from VHSIC Phase 3 contracts currently in progress will be utilized to fabricate improved microelectronic Large and Very Large Scale Integrated circuits required under this program element.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	2065	0	2278	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	1999	2875	4971	Continuing	Not applicable

Funding differences between Congressional Descriptive Summaries submitted last year (1981) and this year are as follows:

1. (U) FY 1980 - There was an actual expenditure of $2,065 (+66K) over the estimated amount ($1,999K); this increase was effected by a below threshold reprograming action.

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2. (U) FY 1981 - Congress zeroed out the planned funding but subsequently allowed the Army to reprogram residual FY79/80 funds to continue to provide the electronic devices support critical to high-priority Army systems.

3. (U) FY 1982 - Reduction due to reprograming to higher priority Army programs.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.37.42.A
DOD Mission Area: #551 - Electronics & Physical Sciences (ATD)

Title: Advanced Electron Devices
Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The objective is to complete the development of electronic devices, assemblies, and subsystems for application and technology insertion in military systems. Proven (feasible) devices are scheduled into specific system applications. The approach will include the development of sufficient number of devices/modules to determine reliability, performance, and reproducibility with major emphasis on greater commonality of application of such devices and lower life cycle costs. This program is critical to the planned improvement in fielded Electronic Warfare (EW), Radar, and Communications Systems.

G. (U) 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).

H. (U) WORK PERFORMED BY: The Electronics Technology and Devices Laboratory, ERADCOM, Fort Monmouth, NJ. This Laboratory is scheduled to use no more than 20% of the program funds in-house. The principal contractors are: Sanders Associates, Merrimack, NJ; Varian Associates, Palo Alto, CA; Hughes Aircraft, Fullerton and Torrance, CA; United Technology Research Center, Hartford, CT; TRW, Redondo Beach, CA; Litton, San Carlos, CA; Bendix Corp., Towson, MD; Texas Instruments, Dallas, TX; Norden Systems, Norwalk, CT; and RCA, Camden, NJ.

I. (U) PROGRAM ACCOMPLISHMENTS:

1. (U) FY 1980 and Prior Accomplishments: The development of Travelling Wave Tubes (TWT) for Artillery Locating Radar AN/TPQ-37 is in final stages of completion; improved tube life of 3 to 5 times is indicated in preliminary evaluation. A microprocess control has been completed and evaluated in an AN/TPQ-37 testbed transmitter; fault isolation has been demonstrated as well as RF drive and cathode current control of the final amplifier. A similar TWT improvement was started for the Mortar Locating Radar AN/TPQ-36 to raise the operating life from 1,000 hours to 5,000 hours. A "brassboard" model of a sapphire faceplate high-contrast Cathode Ray Tube (CRT) has been delivered and is presently undergoing test for use in the AN/APR-39 (Radar Warning Receiver). Additional models will be delivered and incorporated in the AN/APR-39 display modules being developed and built by Norden for delivery to Electronic Warfare Laboratory Systems Contractor (LORAL). Diodes operating at 94 GHz have produced over 15 watts of peak power (100 ns pulses). These millimeter wave sources are required in radar transmitters for the XM1 tank to provide the capability to see through smoke and fog on the battlefield. A significant improvement in the stability of oscillators using surface acoustic wave technology has been demonstrated; this development will meet the stringent frequency bandwidth requirements imposed by the Federal Republic of Germany on Army meteorological radiosondes (FAMAS System). An improved one-cubic-inch, temperature-controlled tactical miniature crystal oscillator, having

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an order of magnitude improvement in size, power consumption and warmup time, has been developed to provide precision timekeeping capability for secure, jamproof operation required by a wide range of system developers, including Single Channel Ground and Airborne Radio, Global Positioning System, and Joint Tactical Information Distribution System.

2. (U) FY 1981 Program: Congressional action on the FY81 Defense Budget resulted in the deletion of FY81 funds from this program element. At the request of the Army, the Chairman of the Research and Development Subcommittee of the House Armed Services Committee, in a letter dated 26 Sep 80 to the Assistant Secretary of the Army for Research Development and Acquisition advised that he interposed no objection to the Army reprograming FY79 or 80 funds to enhance high-priority Army operational systems. The Senate Armed Services Committee and both Appropriations Committees were advised of the Army's plans to use prior year funds on this program element. At this time, the exact amount of Army funds to be reprogramed has not been determined. If and when funds are reprogramed, the following ongoing tasks will be completed: (1) Advanced TWT to improve transmitter reliability of AN/TPQ-36 Mortar Locating Radar--5,000-hour tube life compared to present 500 hours; (2) High-contrast, color, direct sunlight-illegible display to replace existing sunlight-unlegible display in the AN/TPQ-39 Radar Warning Receiver; (3) Modulator for CO2 Laser Rangefinder for XM1 tank--present modulators are too large/unreliable for use; (4) Two of five low-cost Large Scale Integrated Signal Processing Modules for a new class of Electronic Warfare equipment (MASS); (5) Low-cost Quartz Resonators for Secure Communications and Position Location Equipment; (6) Millimeter Wave Solid State Components (93 GHz) for Antitank Radars and for Secure Communications Equipment.

3. (U) FY 1982 Planned Program: Urgently needed is a low-cost capability to detect and recognize battlefield targets through smoke, adverse weather, and camouflage at line-of-sight distances of up to 5 km. Equipment operating at millimeter wave frequencies (60, 94, 120 and 220 GHz) have the ability to penetrate smoke and fog with the added potential for significant cost reductions. Reliable, low-cost solid state oscillators for MMWave transmitters operating at 94 GHz will be completed and tested for use in the XM1 tank radar; a 60 GHz version will be demonstrated for use in a secure antijam radio. A compact, nanosecond pulser for the laser rangefinder going into the XM1 tank will also be completed. Improved frequency stable surface acoustic wave oscillators (403 MHz, 1680 MHz) will be tested and delivered to FAMAS contractor as replacement models to resolve radiosonde frequency interference problems in Germany. The remaining Large and Very Large Scale Integrated Circuit Modules (3 each) for Advanced QUICKLOOK and GUARDRAIL Electronic Warfare and Intelligence Systems will be designed, fabricated, and tested for insertion into the systems. The initial design and prototype models of slow frequency-hopping synthesizer to improve the security of the Standoff Target Acquisition System and Remotely Piloted Vehicle data links will be completed. A program will be started to incorporate the transparent flat-panel sunlight-legible display (11" x 15") with map overlay capability into a suitcase-sized remote terminal to enable the tactical commander to receive map format intelligence in near-realtime, and for other uses in SOTAS and netted radars. A reliable, higher output infrared source will be initiated to protect Army aircraft against heat-seeking missiles (AN/ALQ-44), and an affordable full I/J band electronic jammer amplifier is required to protect Army aircraft against enemy air defense radars.

Program Element: #6.37.42:A
Title: Advanced Electron Devices
DOD Mission Area: #551 - Electronics & Physical Sciences (ATD)
Budget Activity: #2 - Advanced Technology Development

4. (U) FY 1983 Planned Program: Implement a new concept of conformal "all electronic" scanning antenna which can be applied to surface of tanks (XM1) to reduce silhouette; also applicable to surface of terminal homing shells and missiles to eliminate mechanical gimbals. Ruggedized millimeter wave (94 MHz) Integrated Circuit Receiver and Transmitter Modules will be delivered for evaluation in terminally guided munitions and for other military applications; i.e., Remotely Piloted Vehicles, and missiles. Fabrication of fast frequency-hopping synthesizer will be initiated to provide antijam capability to the Standoff Target Acquisition System ground and airborne data links; lightweight (1.5 lb), wide-bandwidth, 10-watt Travelling Wave Tube package will be delivered to Standoff Target Acquisition System data link contractor. Fabrication of transparent flat-panel sunlight-legible display with map overlay lay capability as part of a suitcase-sized remote terminal to allow tactical commanders to receive map format intelligence in near-realtime, and for use in SOTAS and netted radar applications will be completed. Low-cost secondary emitter transmitter for AN/TPQ-37 and PATRIOT Missile system will be initiated; development of 8-14 micron infrared source to protect Army aircraft (AN/ALQ-144) against enemy air defense weapons will be completed, and the final version of the I/J band jammer package to protect Army aircraft against air defense radars delivered.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.43.A Title: Education and Training
DOD Mission Area: #552 - Environmental and Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	5388	7973	9499	9748	Continuing	Not Applicable
A794	Education and Training	5388	7973	9499	9748	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Changes in military doctrine (e.g. Division 86) and the continuing introduction of new sophisticated systems have changed many of the skills and abilities required of soldiers at a time when the aptitude of incoming personnel is decreasing. This has lead to serious difficulties for Army training centers and unit commanders in providing and managing effective training programs. This technological base research supports Army-wide requirements for developing training techniques that realistically address combat readiness requirements. Research results are used by the Army's Training and Doctrine Command (TRADOC) for developing basic, advanced and refresher training programs in combat and technical skills for use in schools and operational units. Results also are used to assist the unit commander in determining training needs and training loads and in assessing individual, crew/team and unit proficiency.

C. (U) BASIS FOR FY 1982 RDTE REQUEST:

1. (U) This broadly-based program will provide improved combat, combat support and combat service support training through research that systematically explores the relationships among individual skills, team performance requirements and unit readiness demands, and assists in the development of methods for improving crew/team and unit training. The program seeks to develop and test training methods to prepare low aptitude (CAT IV)personnel in the basic skills necessary for Army jobs. A special emphasis of this program will be the development and validation of training techniques and training programs that can be exported from Army schools to units in the field. This program will also develop and evaluate procedures for maximizing skill retention in combat and maintenance skills. Team training procedures will also be a focus of this program. Unit training programs, some employing MILES engagement simulation, will be developed, with emphasis on air-ground engagement simulation and on training at the National Training Center, Fort Irwin, CA.

Program Element: #6.37.43.A Title: Education and Training
DOD Mission Area: #552 - Environmental and Life Sciences(ATD) Budget Activity: #2 - Advanced Technology Development

2. (U) This continuing program represents a comprehensive research effort to develop a new generation of instructional technologies to meet current training challenges -- basic skills training for low aptitude personnel, improved methods for training combat arms teams and crews, and improved training exercises for combat units. This research endeavor will insure proper application of modern electronic technologies for more cost-effective training and improved combat readiness.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Costs
RDTE					
Funds (Current Requirements)	5388	7973	9499	Continuing	Not Applicable
Funds (as shown in FY 1981	7105	8388	9079	Continuing	Not Applicable

Decrease in FY81 is attributable to the application of general Congressional reductions. Changes in FY 1982 reflect higher civilian pay costs. FY 1980 funds reprogramed to higher priority requirements.

E. (U) OTHER APPROPRIATE FUNDS: Not Applicable.

Program Element: #6.37.43.A Title: Education and Training
DOD Mission Area: #552 - Environmental and Life Sciences(ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This research will identify instructional principles that provide direction and guidance to TRADOC training developers for the development of improved training methods and materials that assist Army commanders in achieving their training objectives. The research focuses upon: (1) training for individual job performance, (2) basic skills training, (3) innovative, cost-effective instructional technology, (4) procedures for evaluating the training effectiveness of new training methods, 5) techniques for more reliable measurement of individual and unit proficiency and (6) procedures for managing training in units. This research will result in new, more cost-effective training technology to enhance the performance and combat readiness of individuals and units. Individual and unit training must be relevant, efficient and economical to insure that combat readiness is achieved within fiscal and other resource constraints. To achieve this, training research and development must be expanded to permit the development of realistic training environments that approximate the requirements of combat. This research will lead to prototype training/evaluation techniques that include: methods and materials to decentralize training, tools to enable NCOs, junior officers and unit commanders to be effective trainers and training managers, on-the-job refresher training and cross-training programs to enhance crew combat skills, improved evaluation measures for individuals and units, and techniqes for increasing the retention of critical military skills.

G. (U) RELATED ACTIVITIES: This program is coordinated with Air Force Program Element 6.37.51.F, (Training and Education Innovations), with Navy Program Element 6.37.20.N, (Education and Training) and DARCOM (PM-TRADE) Project Element 6.37.38.A, (Non-Systems Training Device Development). Its products are coordinated with US Army Training and Doctrine Command (TRADOC) and operational troop commands. Interservice coordination is effected through Tri-Service developmental efforts, as well as tri-service Technical Advisory Groups (TAG) in educational technology and training simulation; the objective of the TAGs is to exchange results and to eliminate duplication of effort by the military services in this area.

H. (U) WORK PERFORMED BY: Contractors include: Perceptronics, Inc., Woodland Hills, CA; Applied Science Associates, Valencia, PA; Applied Psychological Services, Inc., Wayne, PA; Litton Mellonics, Columbus, GA; McFann-Grey Associates, Monterey, CA. In-house work is performed by the US Army Research Institute for the Behavioral and Social Sciences, Alexandria, VA, and its field units distributed at major installations, including Ft Benning, GA; Ft Bliss, TX; Ft Hood, TX; Ft Knox, KY; Ft Leavenworth, KS; Ft Ord, CA; Ft Rucker, AL and USAREUR.

Program Element: #6.37.43.A Title: Education and Training
DOD Mission Area: #552 - Environmental and Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS.

1. (U) FY 1980 and Prior Accomplishments. Designed and developed prototype training progams for gunnery/ maintenance tasks in armor systems. Completed training effectiveness analysis for AN/TSQ-73 "Missile Minder" air defense system training program that reduced training time by one-quarter. Developed and assisted in Army-wide implementation of self-paced instruction program for nap-of-the-earth helicopter navigation, reducing pilot errors by 33%. Conducted detailed task analysis of job requirements for the XM1 tank commander. Field tested a "sight picture" training handbook for tank gunners which resulted in a 22% increase in performance. Developed and tested a new basic rifle marksmanship training program. Validated a training developer decision aid to assist in the development of more effective school/unit training programs. Developed and tested a combat vehicle identification training program for Army-wide use. Validated a refresher and transition training program for Army reserve tank crews that reduced required training time. Developed software for an adaptive computerized training system (ACTS) for maintenance training. Developed and tested improved job aids for the Analyze, Design and Develop phases of the Instructional System Development (ISD) model used by the three services to guide training developments. Field tested an Automated Instructional Management Systems (AIMS). Served as the Army test agency for Operational Test (III) of the Multiple Integrated Laser Engagement System (MILES) that provides realistic combat training and will be used at the Army's National Training Center. Developed and tested a performance-based aviator applicant selection system (PASS). Validated procedures for "local" (i.e., unit) scoring of Skill Qualification Tests to permit more immediate feedback on individual proficiency.

2. (U) FY 1981 Program: Implementation of an assignment algorithm for attack helicopter pilot training. Development of advanced school and unit rifle marksmanship program of instruction. Development of an augmented training developer decision aid package. Development of a helicopter pilot range estimation and target identification training program. Validation of an expanded combat vehicle identification training program. Development of standardized tank gunnery crew drills for the XM1. Development of a comprehensive tank platoon training program. Testing of procedures for assessing organizational maintenance training requirements. Development of "exportable" (i.e., unit oriented) combat aviator training modules for night terrain flight, nap-of-earth (NOE) communications, and permission planning. Evaluation of TRADOC's preliminary Basic Skills Education Program (BSEP). Feasibility of testing of BSEP information centers (intended to provide guidance on how to improve soldier skills). Validation of the adaptive computer training system (ACTS). Development of computerized job aids for last two phases of the joint-service ISD model. Evaluation of the Automated Instructional Management (AIMS). Development of MILES Air/Ground Engagement Simulation (MILES AGES) exercise control system. Conduct evaluation of strategies for integrating individual and collective training in units. Field testing of aviator performance measurement and grading system (PGMS). Evaluation of prototype SQT training evaluation feedback system for riflemen. Complete development of flight training program management model. Development of measurement techniques for assessing armor crew performance. Development of guidelines for tank platoon "Battlerun" evaluation. Development of prototype XM1 tank platoon test and evaluation package.

Program Element: #6.37.43.A
DOD Mission Area: #552 - Environmental and Life Sciences (ATD)
Title: Education and Training
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3. (U) FY 1982 Planned Program. Cross validation of Aeroscout selection and training algorithm. Development of an improved machinegun crew training program. Continue development of the training developer decision aids to assist in development of improved training for combat MOS. Continue development of advanced combat vehicle identification training program for use with night vision devices. Development of a moving tank gunnery training program. Development of XM1 tank gunnery sustainment training program. Development and evaluation of MOS oriented baseline skills training program for lower aptitude enlisted personnel. Effectiveness evaluation of BSEP information centers. Testing of portable Adaptive Computerized Training System (ACTS). Evaluation of 19 computerized job aids for tri-service ISD Model. Development of methods for enhancing computer-based Instruction (CBI) system effectiveness. Refinement of the MILES AGES control system. Preliminary cost/benefit analysis of alternative strategies for integrating individual and collective training. Effectiveness evaluation of the performance-based aviator applicant selection system (PASS) in training situations. Testing of improved battalion-level after action review procedures for the National Training Center (NTC). Evaluation of prototype SQT training evaluation feedback packages for selected MOS. Development of improved maintenance training programs for units.

4. FY 1983 Planned Program: Field implementation of the attack helicopter selection and training algorithm. Implementation of XM1 tank commander selection test. Implementation of integrated individual/crew/platoon XM1 tank training program. Development of a sustainment training program for the cavalry fighting vehicle (CFV). Development of design guidelines for next-generation computer-based instruction (CBI) systems. Testing of procedures for helicopter initial entry training (IET) on simulators with visual simulation systems. Development of guidelines for generalized use of SQT feedback packages for training evaluation. Field testing of a training program for M60 machinegun/Viper target tracking and engagement. Initial development of an improved mortar training program. Evaluation of life coping skills program for BSEP. Implementation of BSEP information centers. Evaluation of portable Adaptive Computerized Training System (ACTS). Testing of improved indirect fire simulation procedures. Development of maintenance training programs for use in schools and for self-instruction.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.44.A Title: Training Simulation
DOD Mission Area: #552 - Environmental and Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	2746	1413	2243	2822	Contining	Not Applicable
A795	Training Simulation	2746	1413	2243	2322	Contining	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: The growing cost of operational equipment, the high cost of ammunition, the increasing cost of fuel, the lack of suitable training sites, and the complexity of modern weapon system are placing increasing emphasis on the development and use of simulators and training devices. This research program will provide guidance to Army training developers for the design of simulators and training devices that meet required training objectives cost-effectively. This research will establish proven principles for the design of simulation and training devices, methods for evaluating their training methods, and training programs that make optimum use of their capabilities.

C. (U) BASIS FOR FY 1982 REQUEST: Simulation methods have proven cost-effective in improving both individual and unit training. There is a continuing need to extend their use to training for new system training and for "non-system" training requirements (e.g., tactical training exercises). Research is required to determine how simulators and training devices should be used as partial substitutes for training on operational weapon systems (as has been done for aviator training) and for partial substitution for live artillery rounds. The need exists for more reliable procedures for estimating the training affectiveness of simulators and training devices during the design state. There is also a requirement to develop procedures that will permit potential users to specify their simulator and training device requirements in sufficient detail that designers can develop devices that meet required training objectives. The Army aviation community requires additional research to determine the extent to which initial entry pilots may be trained on flight simulators and to determine requirements for part-task trainers for continuation training in units. Research will be initiated to determine where and how modern electronic technology may be most cost-effectively employed for team and unit tactical training; improved battle simulation (i.e., war gaming) and alternative engagement simulation training techniques should be the result. Research will be initiated on the Aviation Training Research Simulator (ATRS) that will lead to the future development of improved flight simulators.

Program Element: #6.37.44.A Title: Training Simulation
DOD Mission Area: #552 - Environmental and Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (Current Requirements)	2746	1413	2243	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	983	1517	2353	Continuing	Not Applicable

Decrease in FY 81 is attributable to the application of general Congressional reductions.
The increase in FY 80 reflects increased emphasis on the development of improved and more cost effective Army training.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.37.44.A Title: Training Simulation
DOD Mission Area: #552 - Environmental and Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The objective of this research is to provide guidance that can be used to develop improved, more cost-effective simulators and training devices. This research emphasizes development of alternatives to the use of high cost operational systems and extremely expensive artillery rounds for acquiring and maintaining the complex skills required of a combat ready force. This research will include the development of more precise procedures for specifying simulator and training device requirements and for estimating their effectiveness during design stages. This research will also address issues related to the development of improved simulators and training devices for the training and retention of: complex maintenance skills, helicopter pilot skills, XM1 tank crew skills, and leader tactical skills. Also to be explored are techniques for the use of simulators and training devices to assess individual and crew/team performance.

G. (U) RELATED ACTIVITIES: Within the Army this research is coordinated with Army Training & Doctrine Command (TRADOC) Systems Manager for the National Training Center; TRADOC Combined Arms Training Development Agency; Director of the Training Development, US Armor School; TRADOC Training Support Center; Project Manager - Training Devices (PM TRADE); TRADOC Systems Manager for XM1 Tank; the Army Aviation Center and School; Tri-Service/NASA Helicopter Research Coordination Panel; Army Materiel Development & Readiness Command (DARCOM); US Army Air Defense School; US Army Communicative Technology Office; and the 7th Army Training Command USAREUR. This program is also coordinated with Air Force Program Element 6.37.38.A (Non-Systems Training Device Development). In addition, direction coordination is effected with pertinent service elements, such as the Air Force Human Resources Laboratory (AFHRL), Navy Personnel Research and Development Center (NPRDC), Army Human Engineering Laboratory (HEL) and the Naval Training Equipment Center (NTEC) to cover related research. Data exchange among Army Research Institute, related Army agencies and other services is used to eliminate duplication of research.

H. (U) WORK PERFORMED BY: Contractors include: Human Sciences Research, McLean, VA; Perceptronics, Woodland, CA; American Institute for Research, Washington, DC; McDonnell Douglas Corporation, St. Louis, MO; Applied Sciences Associates, Huntsville, AL; Applied Psychological Services, Wayne, PA. In-house work is performed by the US Army Research Institute for the Behavioral and Social Sciences, Alexandria, VA, and its field units distributed at major installations, including Ft Bliss, TX; Ft Hood, TX; Ft Leavenworth, KS; Ft Ord, CA and Ft Rucker, Al.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: A draft training circular entitled "How to Prepare and Conduct a Multiple Integrated Laser Engagement System (MILES) Exercise" (that included a MILES-based ARTEP for squad through company sized units) was prepared and fielded. Training feedback procedures for a computer-assisted map maneuver system (CAMMS) battle simulation were

Program Element: #6.37.44.A Title: Training Simulation
DOD Mission Area: #552 - Environmental and Life Sciences (ATD) Budget Activity: #2 - Advanced Technology Development

developed. Procedures for integrating engagement simulation (MILES) with battle simulation (CAMMS) were tested during MILES OT - III, enabling battalion command groups to participate in engagement simulation exercises. A revised model for selecting alternative training device designs has been evaluated. A handbook on how to determine training device requirements was completed. An evaluation of the training effectiveness of XM1 training simulators was conducted for PMTRADE. Specifications for a simulation facility for forward air defense systems were prepared.

2. (U) FY 1981 Program: An analysis of alternative procedures for empirically determining training device effectiveness during the design phase will be prepared for the TRADOC. Development of a test plan for evaluating alternative Army Maintenance Training and Evaluation Simulator System (AMTESS) designs. Specification of the role of battlefield visualization graphics system (BVGS) in land navigation/tactical planning simulator development. Development of test plans for evaluation of Infantry Fighting Vehicle (IFV) and Cavalry Fighting Vehicle (CFV) unit-conduct-of-fire trainers. Specification of requirements for thermal imagery target detection training devices. Identification of critical visual requirements for XM1 driver simulator. Extension of transfer-of-training research methodology to additional flight simulator systems. Development of a battle simulation training management planning aid. Analysis of US Army Europe (USAREUR) simulator programs and facilities for XM1 tank gunnery training.

3. (U) FY 1982 Planned Program: Preliminary specification of guidelines for development of innovative simulators and training devices for combat unit tactical leader training. Evaluation of alternative procedures for estimating training device design effectiveness during design. Validation of a battle simulation training management planning aid. Development of guidelines for the design of IFV and CFV unit-conductof-fire trainers. Evaluation of XM1 tank visual simulation subsystems. Evaluation of methods for increasing training transfer for XM1 tank training devices. Specifications of requirements for a general-purpose maintenance simulator. Evaluation of techniques for training initial-entry helicopter pilots in pre/post solo maneuvers using flight simulators. Development of an instructor pilot guide for the AH-1 and UH-60 rotary wing aircraft. Initiation of research on the partial substitution of simulators for operational weapon systems and for live artillery rounds to prepare combat ready units.

4. (U) FY 1983 Planned Program: Research on the cost-effective application of videodisc and voice technologies for the design of improved simulators and training devices for tactical training in units. Continuation of research on the substitution of simulators/training devices for training on operational equipment and for gunnery training. Development of guidebook for planning and conducting training device effectiveness evaluations. Development of controller training package and diagnostic feedback procedures for battalion/brigade battle simulation (ARTBASS). Research on substituting time on flight simulators for aircraft time. Development of guidelines for improved maintenance simulator and job aids.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.47.A
Title: Soldier Support/Survivability
DOD Mission Area: #552 - Environment and Life Sciences (ATD)
Budget Activity: #2 Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	2129	3276	3181	3307	Continuing	Not Applicable
D610	Food Advance Development	545	1069	1399	1703	Continuing	Not Applicable
D669	Clothing and Equipment	1584	2207	1782	1604	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: There is a continuing need for modernization of the way the Army satisfies the basic needs of the individual soldier on the modern battlefield. Taking advantage of new materiels and techniques developed by industry and in-house government research, this program is designed to conduct advanced development on items of individual clothing and equipment which substantially increase soldier protection from both environmental extremes and increasingly lethal battlefield hazards. It also includes Advanced Development of individual and group feeding systems for the three Services. New items of clothing, individual equipment, and field service support equipment will improve the effectiveness and survivability of the individual soldier through: better cold and hot weather protective clothing; individual equipment for noise attenuation; and protection against nuclear flash, chemical and biological agents; increased protection from visual and electronic detection; and improved personal hygiene. New food systems and components will ensure a responsive food system anywhere in the worldwide military mission areas many of which are outside the sphere of the Continental United States (CONUS) commercial food distribution system. Overall emphasis in food development is to reduce the number of combat food service personnel, minimize food procurement cost, and reduce overall food logistic support requirements.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Items listed in this program are essential for improving the combat effectiveness of the soldier, assuring compatibility of soldier's clothing and equipment with new weapons systems, and increasing his survivability and effectiveness on the battlefield. Prototype items and concepts will be developed and tested to generate preliminary data relative to producibility, cost, and capability of prototypes to meet a defined operational need. The program allows for generation of projected life cycle cost and evaluation by developer and user prior to the decision to enter full-scale development. The food research requirements provide for Advanced Development of items of food and equipment for the Army, Navy, Air Force, Marine Corps, and Defense Logistics Agency, and constitute a part of the Department of Defense (DOD) Food Research, Development, Testing, and Engineering (RDT&Eng) Program managed by the Army as the Executive Agent.

Program Element: #6.37.47.A
Title: Soldier Support/Survivability
DOD Mission Area: #552 - Environment and Life Sciences (ATD)
Budget Activity: #2 Advanced Technology Development

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

RDTE	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
Funds (current requirements)	2129	3276	3181	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	2915	3462	3676	Continuing	Not Applicable

D610 - There was no change in FY 1980 funds. The funding decrease of $63 thousand in FY 1981 reflects the application of general Congressional reductions. The FY 1982 increase of $42 thousand is due to the application of higher fuel, inflation and civilian pay pricing indices than were applied last year.

D669 - In FY 1980 $786 thousand was reprogramed to higher priority Army requirements because of the lack of an approved requirements document for armored crew microclimate cooling system. The funding decrease of $123 thousand in FY 1981 reflects the application of general Congressional reductions. The decrease in FY 1982 of $537 thousand is caused by the slippage of the initiation of work on the microclimate cooling system by one year.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.37.47.A
Title: Soldier Support/Survivability
DOD Mission Area: #552 - Environment and Life Sciences (ATD)
Budget Activity: #2 Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This program element contains two soldier support-oriented projects which include food, clothing, and related personal and protective equipment for the individual soldier. A major effort will be the continuation of development of a ballistic/noise attenuation helmet to protect combat vehicle crewmen and artillerymen. Department of Defense (DOD) assigned the Army overall responsibility, to include funding, for the DOD Food Research, Development, Testing and Engineering program. This includes efforts to respond to DOD and other Services' requirements relative to their specific operational needs for food and food service equipment, as well as to address jointly those needs which are common to two or more Services. Allocation of funds to the various food program efforts is based on priorities assigned by a Joint Formulation Board comprised of representatives from all military Services and the Defense Logistics Agency.

G. RELATED ACTIVITIES: Each of the military Services performs work to develop its Service-peculiar items of clothing and individual equipment. To prevent duplication of effort, close coordination is maintained through joint working groups, Joint Service agreements and circulation of requirement documents. Many of the items developed under this program are now used by other Services. Work in clothing and individual equipment is also performed in Program Element (PE) 6.27.23.A, Clothing, Equipment, and Shelter Technology, Project AH98, Clothing and Equipment Technology; and in PE 6.47.13.A, Combat Feeding, Clothing and Equipment, Project DL40, Clothing and Equipment. Food research is a coordinated Joint Services effort and related work is conducted in PE 6.27.24.A, Food Technology; and PE 6.47.13.A, Combat Feeding, Clothing and Equipment, Project D548, Military Subsistence Systems. Basic research in support of both the food and clothing programs is done in PE 6.11.02.A, Defense Research Sciences, Project AH52, Research in Support Equipment of Individual Soldier.

H. (U) WORK PERFORMED BY: In-house work in this program is performed by the US Army Natick Research and Development Laboratories, Natick, MA; US Army Human Engineering Laboratory, Aberdeen Proving Ground, MD; US Army Research Institute of Environmental Medicine, Natick, MA; US Army Aeromedical Research Laboratory, Fort Rucker, AL; US Army Electronics Research and Development Command, Fort Monmouth, NJ; and US Department of Agriculture Stored Products and Insects Research and Development Laboratory, Savannah, GA.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: New helmets and body armor for ground troops with greatly improved protection were developed in this program and are now being fielded. Two prototype concepts of the Combat Vehicle Crewman/Artilleryman's helmet have been procured and are undergoing human factors evaluation. This helmet will provide greatly increased ballistic and noise protection for personnel using the Army's newer weapon systems. Work was initiated on the aircrew cold weather clothing system which is to provide increased environmental protection with lighter weight and eliminate incompatibilities between current clothing and aircraft controls. In the food systems area a prototype automated field bakery system has been procured and is ready for operational and developmental testing. A lightweight and compact assault

ration has been developed for testing by the Marine Corps. This ration uses new freeze dehydration and compression techniques which drastically reduce space and weight requirements for food in prepositioned or floating supplies for rapidly deploying forces. The effect of rising meat procurement costs for defense troop feeding has been retarded by employment of meat products developed in this program. An industry-developed hydroponic unit which produces fresh salad vegetables under controlled environmental conditions was procured for testing by the Navy in areas where normal resupply of fresh vegetables is impracticable.

2. (U) FY 1981 Programs: Continue Advanced Development (AD) effort on Combat Vehicle Crewmen (CVC) Artillery helmet. Continue effort on the aircrew cold weather clothing system. Initiate effort on microclimate cooling system to solve heat stress problem of armored vehicle crews operating in hot climates. Complete AD of automated bakery system for Army and of helicopter enclosure. Continue evaluation of Navy hydroponics unit for production of fresh vegetables in remote locations. Initiate field evaluation of special military subsistence items for which there are no commercial equivalents for all Services use. Initiate advanced development on USMC and Air Force field feeding systems to overcome deficiencies in current field feeding equipment.

3. (U) FY 1982 Planned Program: Complete (AD) on microclimate armored vehicle crew cooling system. Continue effort on the aircrew cold weather system. Initiate AD for: heated handwear to provide crews high-tactility gloves capable of use at temperatures below 0°F; cold weather clothing system for ground troops to achieve a 30% weight reduction and reduce the bulk and number of items; advanced Combat Vehicle Crewman (CVC) clothing system which will integrate chemical protection into a reusable, flame/protective uniform; microclimate cooling for the dismounted soldier to provide the mechanized infantryman with an auxiliary cooling capability and relieve the heat stress problem when operating with chemical clothing in hot climates; chemical biological protective gloves to provide a high degree of tactility for crewmen operating in a chemical environment. Continue AD of field food service equipment to replace obsolescent Army, Air Force, and Marine Corps equipment with particular emphasis on food service systems which complement and support the highly mobile weapon systems being introduced into the combat forces. Continue evaluation of the Navy's hydroponic unit. Initiate AD on Army field feeding system equipment for 1990's. Continue Marine Corps assault pack.

4. (U) FY 1983 Planned Program: Complete AD on the Marine assault pack. Complete AD on the aircrew cold weather clothing system. Continue AD on: heated handwear; cold weather clothing and equipment system for ground troops lightweight CB gloves; microclimate cooling for the dismounted soldier. Initiate AD of equipment in support of the USAF forward base food service system. Continue AD of Army field feeding equipment for 1990's. Provide support for Army hospital food service system implementation. Initiate advanced development of new field laundry/bath system to reduce weight, save fuel and water, and to provide capability to decontaminate personnel and clothing. Complete evaluation of the Navy hydroponics unit.

Program Element: #6.37.47.A
Title: Soldier Support/Survivability
DOD Mission Area: #552 - Environment and Life Sciences (ATD)
Budget Activity: #2 Advanced Technology Development

5. (U) Program to Completion: This is a continuous program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.48.A
Title: Advanced Development of Automatic Test Equipment and Systems
DOD Mission Area: #551 - Mobility and Logistics Technology Demonstrations
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT QUANTITIES	1400	8480	14631	9665	Continuing	Not Applicable
AJ29	Automatic Test Support Systems (ATSS)	1400	7835	12456	7024	Continuing	Not Applicable
D244	ATSS Language Util & Stand	0	645	2175	2641	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This Program Element (PE) leads directly to production and fielding of test equipment by transferring today's automatic test equipment technology to hardware to overcome logistics problems in the field caused by the complex electronic and optical systems which are an inherent part of the advanced technology systems being fielded by the Army. Maintenance of these systems now requires highly trained repairmen, excessively large Automatic Test Equipment (ATE), or interim small-scale special purpose ATE. The objective of this PE is to achieve a substantial improvement in maintenance support by fielding the fewest variations of type classified STANDARD test equipment possible. Complementary ATE systems will be fielded to enable relatively low-skilled electronics technicians to troubleshoot and repair highly sophisticated electronic and optical systems. The Direct Support Automatic Test System (DS ATSS) will be shelter mounted and consist of a Base Station Test Facility (BSTF) and an Electro-Optical Test Station (EOTS). A contract test set (CTS) will allow direct support maintenance on the forward battle area. A DS ATSS will allow direct support diagnosis on electronic and electro-optical assemblies removed at the organizational level from such systems as the Advanced Attack Helicopter and the XM1 Tank. The work under this PE is consistent with the efforts to reduce ATE proliferation being sponsored by the Joint Logistics Commanders (JLC). Both the large and the small ATE's are required to reduce incorrect diagnosis and unnecessary repairs; reduce diagnostic time; reduce the variety of manual test equipment in the field; and reduce provisioning requirements and need for skilled personnel. These efforts support the Army requirements for ATE at division level and below. This PE includes vital complementary software efforts related to standard programing languages and software maintenance facilities to allow the maximum possible applications of expensive software development. The Army was requested by House of Representatives Report #96-916 that, prior to any final decision or action taken relative to consolidation or creation of a Single Manager, Test,

Program Element: #6.37.48.A
DOD Mission Area: #551 - Mobility and Logistics Technology Demonstrations

Title: Advanced Development of Automatic Test Equipment and Systems
Budget Activity: #2 - Advanced Technology Development

Measurement and Diagnostic Equipment (TMDE) function, or any realignment or moves on this topic, the House Armed Services Committee be notified of the plan and provided justification. On 7 January 1981 a letter was forwarded to the Honorable Melvin Price stating that the Commander, Communications and Electronics Materiel Readiness Command (CERCOM), was designated the Single Manager of TMDE. This decision will allow the Army to achieve the goals of standardization, economy, and productivity, and provide program managers and development commands technical support to insure that system diagnostic requirements are addressed early in the program cycle. The establishment of the Single Manager for TMDE is the result of continuous management reviews and evaluation processes. An important element of this review was the "Heiser Study" completed in the fall of 1979. This study together with other quantitative reviews made by US Army Materiel Development and Readiness Command (DARCOM) resulted in the decision to locate the Single Manager for TMDE at Ft Monmouth, NJ.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Continue the development started in FY 1981 of a shelter-mounted Directed Support Automatic Test Support System (DS ATSS) consisting of the base station test facility (BSTF) and contact test set (CTS). Production of the DS ATSS and the CTS is scheduled for FY84, and the first test sets will deploy to Europe. The request for proposal will be issued to develop the electro-optical test station portion of DS ATSS.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	1400	8480	14631	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	1400	9121	11756	Continuing	Not Applicable

The increase in FY82 reflects adjustments due to inflation. The decrease in FY81 is attributable to the application of general Congressional reductions.

E. (U) OTHER APPROPRIATION FUNDS: ($ in thousands): Not Applicable.

Program Element: #6.37.48.A
DOD Mission Area: #551 - Mobility and Logistics Technology Demonstrations

Title: Advanced Development of Automatic Test Equipment and Systems
Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: These efforts support the Army requirements for Automatic Test Equipment (ATE) at division level and below. The first automatic test set was the simplified Test Equipment - Internal Combustion Engines (STE-ICE) which provided the motorpool engine repairman with ATE. This test set, fielded in FY 1979, is being expanded to cover the entire vehicular electrical systems on the XM1 tank and Fighting Vehicle System. This Simplified Test Equipment-Expandable (STE-X) is being partially funded by the vehicle development managers. The STE-X program transistions to Program Element 64746A this year. Defective electrical/electrical assemblies such as as receivers, transmitters, missile guidance systems, optics, fire control subassemblies, etc., when detected by STE-X or by other test equipment, are removed and sent to the rear for repair. This rear echelon maintenance facility, direct support, will be provided with the Modular Direct Support Automatic Test Support System (DS ATSS). The shelter-mounted DS ATSS will be specially configured for each commodity class. For example, the missile DS ATSS will include appropriate optical diagnostic/alignment capabilities. Subassemblies and printed circuit boards (PCB) that are identified as faulty by the DS ATSS are sent to the General Support (GS) where larger ATE Automatic Test Equipment Missile Support (ATEMS) and/or the AN/USM-410 have the powerful diagnostic capability required to identify defective piece parts (e.g., semiconductor devices) that need to be replaced so that the subassembly/PCB can be returned to stock. This PE funds development and fielding efforts for DS ATSS, the direct support transportable contact test set and the electro-optical test station. The objective of this PE is to provide the Army with standardized ATE at the direct support level.

G. (U) RELATED ACTIVITIES: Program Element 6.47.46.A, Automatic Test Support Systems, accomplishes the engineering development work.

H. (U) WORK PERFORMED BY: In-house work is performed by the US Army Communications Research and Development Command, FT. Monmouth, NJ; US Army Tank Automative Research and Development Command, Warren, MI; and US Army Missile Command, Huntsville, AL. Contractors are: RCA Corporation, Burlington, MA; University of Pennsylvania, Philadelphia, PA, Ultrasystems, Irvine, CA. The contract for DS ATSS will be awarded in 2d Quarter FY 1981.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Provided intensive and continual technical support to Army Program Managers (PM's) in the integration of ATE into their systems. Continued contractual effort to reduce test software development costs and to determine the methods of implementing a Department of Defense Standard Automatic Test Equipment language. Completed the definition of a Direct Support Automatic Test Support System (DS ATSS) and released the RFP for DS ATSS development. Begin the source selection process for DS ATSS. Continued contractual effort to reduce test software development costs and to determine

Program Element: #6.37.48.A
DOD Mission Area: #551 - Mobility and Logistics Technology Demonstrations

Title: Advanced Development of Automatic Test Equipment and Systems
Budget Activity: #2 - Advanced Technology Development

methods of implementing DOD directives on standardization of ATE software languages. Continued to monitor DOD-wide ATE development efforts.

2. (U) FY 1981 Program: Award the Advanced Development contract for the Direct Support Automatic Test Support Systems (DS ATSS). System software and prototype test program sets (TPS) will be developed. The TPS are the software sets designed to allow diagnosis of specific repairable items. Begin development of electro-optical test set (EOTS) specifications. Continue Joint Logistics Commanders (JLC) tasking on Automatic Testing assigned areas. Completed the development contract for the general purpose vehicular ATE, STE-X.

3. (U) FY 1982 Planned Program: Continue development of hardware design and prototype fabrication DS ATSS. System software and prototype test program sets will be developed. Complete development of specifications for the electro-optical test station and incorporate it into the DS ATSS contract. Begin planning with program managers for use of DS ATSS with their systems. Continue work leading to establishment of full-transportability of ATE software and efficiency of test program set generation and continue JLC taskings in areas of ATE standards and tools.

4. (U) FY 1983 Planned Program: Complete engineering development of DS ATSS. Conduct developmental and operational testing of DS ATSS with the objective of making a production decision during FY 84. Complete initial fielding plan for DS ATSS and continue ATE requirements update on the development status of new Army systems. Continue development of the electro-optical test station.

5. (U) Program to Completion: DS ATSS will transition into production capitalizing on advancements made by industry with microprocessing, configuration, and sizing of test equipment. This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Project: #AJ29
Program Element: #6.37.48.A
Title: Automatic Test Support Systems (ATSS)
Title: Advanced Development of Automatic Test Equipment and Systems
DOD Mission Area: #551 - Mobility and Logistics Technology Demonstrations
Budget Activity: #2 - Advanced Technology Development

A. (U) DETAILED BACKGROUND AND DESCRIPTION: This effort supports the Army requirements for Automatic Test Equipment (ATE) at Division level and below. A need exists within the Army to develop a modular, mobile direct support automatic test equipment system which will allow forward area testing and either repair on site or evacuation to the more capable large-scale General Support ATE now being procured and fielded. Without the direct support ATE capability, the operational readiness of prime weapons systems such as Advanced Attack Helicopter (AAH), TOW Fighting Vehicle Systems, Single Channel Ground and Airborne Radio System (SINCGARS) will be significantly degraded. The alternative is to let each prime system develop its own unique test equipment resulting in greater costs, proliferation of different test sets, and unacceptable level on nonoperational weapons systems. Organizational-level ATE, the Simplified Test Equipment - Internal Combustion Engines (STE-ICE), was fielded in FY 1979 to units in Europe. Further application of this diagnostic capability Simplified Test Equipment-Expandable (STE-X) is being developed so that all on-board electronic systems will be tested, with the final result that the Army will have one organizational test set to fault-isolate combat vehicles.

B. (U) RELATED ACTIVITIES: Program Element 6.47.46 (Automatic Test Support Systems) accomplishes the engineering development work.

C. (U) WORK PERFORMED BY: In-house work is performed by the Command, Fort Monmouth, NJ; contractual efforts are provided by Emerson Electric, St. Louis, MO; RCA Corporation, Burlington, MA; University of Pennsylvania, Philadelphia, PA; Ultrasystems, Irvine, CA. One contract is to be awarded in FY 1981 via competitive bid.

D. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS: Completed Operational Test (OT 1) of concept of applying Automatic Test Equipment (ATE) at the General Support Field Maintenance Level. Required Operational Capability (ROC) was initiated, and the need for a Direct Support Automatic Test System (DS ATSS) was validated. The request for proposal for the Advanced Development contract for DS ATSS was released in FY 1980. Award contract for general purpose Vehicular Automatic Test Equipment STE-X. In FY 1981, award contract for hardware design and prototype fabrication of DS ATSS. The STE-X tester will transition into engineering development. The electro-optical test station (EOTS) requirements will be incorporated into the DS ATSS contract in FY 1982. DS ATSS will go into production in FY 1984.

1. (U) FY 1980 and Prior Accomplishments: Determined the technical capabilities of industry in ATE and finalized the DS ATSS requirement for the Army. Developed DS ATSS design specifications and released request for proposal. Initiated source selection in FY80. Mission Element Need Statement (MENS) was prepared for the DS ATSS development. Completed preparations and studies leading to advanced development of Simplified Test Equipment-Expandable (STE-X).

Project: #AJ29 Title: Automatic Test Support Systems (ATSS)
Program Element: #6.37.48.A Title: Advanced Development of Automatic Test Equipment and Systems
DOD Mission Area: #551 - Mobility and Logistics Technology Demonstrations Budget Activity: #2 - Advanced Technology Development

2. (U) FY 1981 Program: Award Advanced Development contract for the DS ATSS. Prepare specifications for the electro-optical test station (EOTS). Award the development contract for the general purpose vehicular ATE, STE-X.

3. (U) FY 1982 Planned Program: Continue DS ATSS contract and release request for proposal for EOTS development. Complete development contract for general purpose STE-X. Begin intensive coordination with program managers to insure maximum possible design aimed at use of DS ATSS for system maintenance.

4. (U) FY 1983 Planned Program: Complete advanced development of DS ATSS base station test facility and contact test sets. Continue development of EOTS. Initiate DS ATSS fielding plans and provide system specifications to program managers. Begin production planning for DS ATSS.

5. (U) Program to Completion: The DS ATSS will transition into production capitalizing on advancements made by industry with microprocessing configuration, sizing of test equipment, and test support philosophy. This is a continuing program.

6. (U) Major Milestones: Not Applicable.

7. (U) Resources ($ in thousands):

	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
RDTE						
Funds (current requirements)	1400	7835	12456	7024	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	1400	8428	9797	Not shown	Continuing	Not Applicable
Quantities (current requirements)	Not Applicable.					
Quantities (as shown in FY 1983 submission)	Not Applicable					

The FY81 decrease is attributable to application of general Congressional reductions.
The FY82 increase reflects adjustments due to inflation.

Project: #AJ29
Program Element: #6.37.48.A

DOD Mission Area: #551 - Mobility and Logistics Technology Demonstrations

Other Appropriations: Not Applicable.

Title: Automatic Test Support Systems (ATSS)
Title: Advanced Development of Automatic Test Equipment and Systems
Budget Activity: #2 - Advanced Technology Development

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.49.A Title: Technical Vulnerability Reduction
DOD Mission Area: #551 - Electronics and Physical Science Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Costs
	TOTAL FOR PROGRAM ELEMENT	2850	5968	12938	To Be Determined (TBD)	TBD	TBD
D462	Technical Vulnerability Reduction	2850	5968	12935	To Be Determined	TBD	TBD

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program established a US Army Development and Readiness Command (DARCOM) focal point to insure that Counter-Countermeasures (CCM) are addressed during the development of Army systems against the known or projected hostile threats. Through performance of detailed technical analyses, evaluations and studies, coordination and integration of various Department of Defense efforts, and presentation of findings to top-level management, this program ensures that countermeasures (CM) threats/CCM alternatives are addressed early and throughout the life cycle of Army materiel systems. The program also enhances the operational user and development community's awareness of the CM threat and the necessity for early pursuit of appropriate CCM technology.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: Assessments of countermeasure effectiveness against major systems will be run using the CM/CCM facilities to provide input to the cost and operational effectiveness analysis (COEA). It is planned to analyze communication jamming, in a realistic environment, including terrain and ECM, for various HELLFIRE operational modes, including laser nonautonomous and fire and forget seeker modes, with use of airborne and/or ground observers for target acquisition and designation (in the case of laser weapons). Analysis of the effect of countermeasures and mutual interference on the SINCGARS, PLRS, and JTIDS communication and data links. Continue analysis of effect of CM on time lines of intelligence, surveillance and target acquiition (ISTA) and air defense system (ADS) assets. Perform independent assessment of proposed PATRIOT product improvements (PIP) in an ECM (including CHAFF) environment. Continue evaluation of possible CM and CCM to fire-and-forget munitions, such as STAFF, SADARM, ASSAULT BREAKER, and the Corps Support Weapon System. Support studies of hardened radar system for use in battlefield surveillance, air defense, and fire control. Hardening concepts include quiet,

Program Element: #6.37.49.A Title: Technical Vulnerability Reduction
DOD Mission Area: #551 - Electronics and Physical Science Budget Activity: #2 - Advanced Technology Development

multistatic and Coherent Imaging radar systems. Support Division Air Defense (DIVAD), Data Link Vulnerability (DVAL), and Program Manager Training Devices (PM TRADE) in insuring that CM/CCM considerations are included in design. Investigate susceptibility of All Source Analysis System (ASAS) to jamming and deception. Direct and execute the US Army Electro-Optical CM/CCM Plan to counter/harden against foreign threat. Support other technology advanced development (AD) and engineering development (ED) efforts as requested by higher authority.

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	2850	5968	12938	To Be Determined (TBD)	TBD
Funds (as shown in FY 1981 submission)	2600	2109	3065	TBD	TBD

Increase in FY80 due to minor internal budget adjustments. Increase in FY81 and FY82 funding through the FY81 Supplemental and FY82 Amendment is required to fund the US Army Electro-Optical Countermeasure/Counter-Countermeasure (CM/CCM) Plan to counter/harden US equipment against the expanded foreign threat.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.37.49.A Title: Technical Vulnerability Reduction
DOD Mission Area: #551 - Electronics and Physical Science Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The objective of this program is to perform as the US Army Development and Readiness Command (DARCOM) countermeasure/counter-countermeasures (CM/CCM) focal point for ensuring that technical CM/CCM are properly evaluated and integrated during the development cycle. This is accomplished by interfacing with US Army Training and Doctrine Command (TRADOC) and US Army Intelligence Command (INSCOM) during the materiel acquisition process. The systems to be addressed are those involved in, or relying upon, the transmission, emission, reception or reflection of signals by electromagnetic, sonic, seismic, or optical means. The office will review and integrate the CCM efforts of various US Army Development and Readiness Command (DARCOM) agencies to ensure coverage of critical systems, and eliminate redundancy wherever possible. The Technical aspects of CM/CCM will be directly handled by monitoring internal or by conducting independent studies of selected systems and/or developmental items. The goal of the program is to maintain the viability of US systems in a realistic battlefield environment.

G. (U) RELATED ACTIVITIES: The interaction between TRADOC/DARCOM/INSCOM will assure that the newest technologies are combined with optimized tactics and up-to-date intelligence so as to provide effective and survivable battlefield weapons systems. This office will closely interface with vulnerability assessment activities within DARCOM, the Research and Development Laboratories, and Product/Project Managers to preclude duplication of effort and make maximum use of existing capabilities. This office closely monitors the vulnerability/susceptibility work performed by the Office of Missile Electron Warfare (OMEW) in PE 6.37.18.A (EW Vulnerability/Susceptibility).

H. (U) WORK PERFORMED BY: The organization having responsibility for this program is the US Army Development and Readiness Command Countermeasures/Countercountermeasures (DARCOM CM/CCM) office located at the US Army Electronics Research and Development Command (ERADCOM), Adelphi, Maryland.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Initiated development of computer model for dynamic chaff dipole density distribution as a function of dispersal and environmental paramenters. Evaluated laser threat to electro-optical (EO) systems and effectiveness of repeaters and other jammers against laser guided weapons; initiated actons to protect US systems with specific emphasis on Advanced Attack Helicopter (AAH)/Target Acquisition Designator System (TADS)/Heliborne Laser Fire-and-Forget Missile (HELLFIRE); contributed to HELLFIRE cost and operational effectiveness analysis (COEA). Examined sync time of Single Channel Ground Air Radio System (SINCGARS) candidates versus types of jamming. Investigated new hardening techniques for battlefield computers. Identified and quantified CM/CCM tradeoffs of various millimeter (MM)-wave techniques for Surveillance Target Acqusition Radar for Tank Location and Engagement (STARTLE). Examined GUARDRAIL V, APS-94-F radars, QUICKLOOK, and all Division level Intelligence, Surveillance and Target Acquisition Electronic Warfare

Program Element: #6.37.49.A Title: Technical Vulnerability Reduction
DOD Mission Area: #551 - Electronics and Physical Science Budget Activity: #2 - Advanced Technology Development

Command, Control and Communication (ISTA/EW) systems for CM susceptibility; identified and prioritized vulnerabilities and examined CCM trade-offs. Published and distributed CM/CCM "How to" Handbook. Developed model that incorporates EW and terrain effects on communications and radar systems. Continued signature program. Performed technical assessments of PAVEMOVER and Distatic Alerting and Cueing (DAC) radars, and supported Harry Diamond Laboratory (HDL) and US Army Armaments Research and Development Command (ARRADCOM) programs in antiradiation weapons and antiradiation missile (ARM) countermeasure (CM). Analyzed performance and effect of CM on the most promising Fire-and-Forget concepts. Extended multispectral systems and maintained threat/technology overview. Identified potential CM susceptibilities of 6.2 radar programs. Published definitions for realistic battlefield standards and developed programs to gather/reduce data.

2. (U) FY 1981 Program: Complete development of chaff model; use model to assess the PATRIOT missile fuze. Ensure that the Battlefield Environment/Laser Designator Weapon System Simulator (BE-LDWSS) has capability to model laser jammers and repeaters. Assess effect of laser jammer/repeater/spoofer on laser-guided weapons. Investigate means to minimize interference between SINCGARS and other info links to decrease their susceptibility to jamming. Examine susceptibilities of ISTA/EW Command, Control and Communications (C3) links to exploitation by hostileks in Combat Electronic Warfare and Intelligence (CEWI) and Target Acquisition Battery (TAB). Define/optimize CCM/system parameters to maximize STARTLE survivability; identify benefits of MM-wave technology for low probability of interception (LPI), target imaging radars and communications applications. Classify capabilities/gaps in electro-optical (EO) and visual ISTA arena. Direct and execute the US Army Electro-Optical CM/CCM Plan to counter/harden against foreign threats. Incorporate spread spectrum levices into EW model. Continue to fill new signature data requirements. Influence CCM related test issues and use of enemy CM in Blue training exercises; review results of Standoff Target Acquisition System (SOTAS) Operational Test (OT II); evaluate vulnerabilities of SOTAS and PERSHING II for respective COEA's. Study state-of-the-art in advanced sensor technology for fire-and-forget systems. Continue multispectral screening threat definition/impact assessment. Reveiew selected 6.2 technology areas such as Coherent Imaging, low probability of intercept (LPI) and multistatic techniques for potential application to 6.2/6.3A Battlefield Surveillance radar programs at Harry Diamond Laboratories (HDL)/Combat Surveillance and Target Acquisition Laboratory (CSTA), Air Defense radars at MICOM, and Fire Control radar at the Armaments Research and Development Command (ARRADCOM).

3. (U) FY 1982 Planned Program: Incorporate new chaff concepts (i.e., absorbing, multispectral) into chaff model; incorporate mm wave, optics, and effect of smoke/rain/dust into electronic warfare (EW) model; quantify and prioritize counter-countermeasure (CCM) hardening techniques to Assault Breaker and Top Attack candidates and review projected response threats to US radar systems currently in development. Continue to direct and execute the US Army Electro-Optical (EO) Plan to counter/harden against foreign threats. Continue study of advanced technology for fire-and-forget systems; review 6.2 radar technology areas such as FOLPEN, ADVGSR, LPI, and IBSTC for CCM provisions against updated threat; continue

Program Element: #6.37.49.A Title: Technical Vulnerability Reduction
DOD Mission Area: #551 - Electronics and Physical Science Budget Activity: #2 - Advanced Technology Development

Fire-and-Forget assessments; continue upgrade of Laser Designator Weapon System Simulator (LDWS); complete intelligence, surveillance and target acquisition/electronic warfare command, control and communications (ISTA/EW C3) vulnerability study. continue Air Defense (AD) C3 assessment; develop field test to measure mutual inteference between Single Channel Ground Air Radio System (SINCGARS)/other systems; investigate susceptibility of information fusion and display processes for All Source Analysis System (ASAS) to jamming/false information insertion; support Division Air Defense (DIVAD) cost and operational analysis (COEA) and Program Manager for Training Devices (PM TRADE); and update lethal laser threat/recommend system "fixes."

4. (U) FY 1993 Planned Program: Continue Counter-Countermeasures (CCM) Technology Base efforts: Develop generic and system-specific models for independent CM/CCM assessments; incorporate current and projected enemy CM into the models; use models as necessary to evaluate selected US Army Battlefield systems in 6.2 and 6.3.A, thus assuring that CCM techniques will be evaluated, selected, developed and available for application to Army equipments to meet the projected threat environment. In addition, the office will continue CCM project support to selected Army systems which are found to be lacking in effectiveness due to the enemy's response or his potential ability to render these systems ineffective over the short term. CCM solutions will be presented to both the US Army Development and Readiness Command and the US Army Training and Doctrine Command (DARCOM/TRADOC) community for appropriate action.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.50.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Drug & Vaccine Development
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional To Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	2545	4786	5184	7781	Continuing	Not Applicable
A808	Drug & Vaccine Development	2545	4786	5184	7781	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This program provides advanced drug and vaccine development to meet DOD needs to protect combat forces against naturally occurring endemic diseases and biological warfare (BW) agents. The ability to prevent or treat diseases which impact on military operations and which are not of general public health importance in the United States depends upon the DOD capability to develop vaccines and/or drugs.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: The logical progression in development of effective drugs and vaccines for preventing and treating militarily important infectious diseases requires pre-clinical and clinical evaluation through multiple stages (phases) in human subjects in compliance with federal regulations. This program fulfills these requirements; it is essential for development of drugs and vaccines to be stocked and used within the DOD system.

Program Element: #6.37.50.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Drug & Vaccine Development
Budget Activity: #2 - Advanced Technology Development

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in Thousands)

	FY 1980	FY 1981	FY 1982	Additional To Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	2545	4786	5184	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	2545	5140	5939	Continuing	Not Applicable

The reduction in FY 1981 funds results from decrements by the House Appropriations Committee. The funding level difference in FY 1982 is attributable to prioritization decision in the budget process.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable.

Program Element: #6.37.50.A Title: Drug & Vaccine Development
DOD Mission Area: #522 - Environmental and Life Sciences (ED) Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The DOD has a continuing requirement for safe and effective drugs and vaccines to protect soldiers against endemic and epidemic diseases which may impair combat operations in any geographical region. To assure strategic mobility, drugs and vaccines must be available to protect against diseases encountered should contingency plans be activated. This program provides the source for pilot manufacturing and safety and efficacy testing of militarily critical drugs and vaccines to meet DOD specific needs. The primary thrust is testing and evaluation of vaccines, antitoxins, and drugs effective against viral, rickettsial, bacterial, and protozoal diseases including those caused by potential BW agents.

G. (U) RELATED ACTIVITIES: This program element/project is supported by basic research done in Program Element 6.11.02.A, Defense Sciences Research, Project BS10, Military Diseases, Injuries, and Health Hazards, and Program Element 7.27.70.A, Military Disease Hazards Technology, Project A870, Risk Assessment of Military Disease Hazards, and A871, Prevention of Military Disease Hazards. Duplication of effort is avoided by coordination and collaboration with the Air Force, Navy and Uniformed Services University of the Health Sciences. Coordination with other intergovernmental agencies including the National Institutes of Health insure information exchange at the working and administrative levels to avoid duplication of effort.

H. (U) WORK PERFORMED BY: One third of the research will be conducted by in-house laboratories of the Walter Reed Army Institute of Research, Washington, DC; the US Army Medical Research Institute of Infectious Diseases, Fort Detrick, Frederick, MD; and the US Army Medical Component, Armed Forces Research Institute of Medical Sciences, Bangkok, Thailand. The remaining work is accomplished through extramural contracts awarded to the Salk Institute, Swiftwater, PA: Bio-Med, Inc., Silver Spring, MD: Hazelton Laboratories, Vienna, VA; Research Triangle Institute, Research Triangle Park, NC; University of Iowa, Iowa City, Iowa; and the University of Maryland School of Medicine, Baltimore, MD.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: The Bureau of Biologics, FDA, licensed the live, oral adenovirus type 4 and 7 vaccines. This step marked the successful culmination of a long-term research effort. These vaccines prevent upper respiratory diseases that are a major cause of lost training time during training and mobilization. Testing of mefloquine was completed and the drug was shown to be safe and effective in the treatment of malaria caused by Plasmodium falciparum. This new drug is effective in a single oral dose and will reduce lost time otherwise required by prolonged treatment. Additional lots from an experimental Rift Valley fever vaccine were prepared to replenish stocks depleted in fulfilling requests from other nations at risk in the Middle East. The use of this vaccine has provided an unique opportunity to extend field tests.

Program Element: #6.37.50.A
DOD Mission Area: #522 - Environmental and Life Sciences (ED)

Title: Drug & Vaccine Development
Budget Activity: #2 - Advanced Technology Development

2. (U) FY 1981 Program: Further human testing of the drug, Halofantrine, will be initiated and recommendations made for further clinical trials; this new drug will provide greater flexibility for treatment of chloroquine-resistant malaria. Phase II testing of E. coli vaccine in volunteers will be completed and recommendations for subsequent tests will be prepared. Final field trials of mefloquine, a drug highly effective against drug resistant malaria, will be initiated. The testing of promising new anti-parasitic drugs will continue as they become available. Pilot vaccine lots for chikungunya virus (a potential BW agent) will be prepared.

3. (U) FY 1982 Planned Program: The field trials of the antimalarial drug, mefloquine, will be completed. Two new antimalarial drugs will enter phase I testing in FY 1982. Clinical testing of a vaccine against dengue serotypes 1, 3, and 4 will begin. Testing of the Gonococcus vaccine in volunteers will begin. Phase III testing of E. coli vaccines will be initiated. Advanced clinical trials of the antimalarial drug, Halofantrine, will commence. A new antimalarial drug, WR 1800409, will be tested for safety and efficacy in patients with malaria. Antiviral drugs against BW agents will enter phase I testing in FY 1982.

4. (U) FY 1983 Planned Program: Ongoing studies with existing drugs will continue and 1 to 3 new drugs should enter phase I testing each year. Work on dengue fever will proceed in an effort to produce one vaccine effective against all four types. Studies will continue on the gonococcal and E. coli vaccines.

5. (U) Program to Completion: This is a continuing program.

FY 1982 RDTE CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.51.A
Title: Medical Defense Against Chemical Warfare
DOD Mission Area: #552 - Environmental and Life Sciences (ATD)
Budget Activity: #2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTING): ($ in Thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	0	3000	3000	Continuing	Not Applicable
993	Medical Defense Against Chemical Warfare	0	0	3000	3000	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: This new advanced development program element is essential for the modernization and development of the Department of Defense capability to provide medical defense against chemical warfare agents. The US Army Medical Department, acting as the Department of Defense executive agent, has the responsibility for developing medical life support materiel to meet joint service requirements to meet the threat of the chemical battlefield. The chemical threat will be met by the development and ultimate fielding of an Integrated Medical System for Individual Protection which will minimize soldier vulnerability and maximize soldier survivability. The Integrated Medical System for Individual Protection will provide soldier chemical warfare agent antidotes, patient decontamination, and a system of chemical warfare casualty management, all of which are vital to prevent a loss of tactical advantage on the integrated battlefield.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: The requested funds will be used to establish an extramural program for the advanced development of resuscitative life support materiel for sustaining life on the chemical warfare battlefield. This effort will focus on contractual development efforts to provide field resuscitators/ventilators capable of supporting one to eight casualties and capable of being used by non-medical, as well as medical personnel. In addition, advanced development work will be initiated in a first generation patient decontamination system, and specific materiel items for medical management of chemical warfare casualties.

Program Element: #6.37.51.A
DOD Mission Area: #552 - Environmental and Life Sciences (ATD)

Title: Medical Defense Against Chemical Warfare
Budget Activity: #2 - Advanced Technology Development

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in Thousands)

	FY 1980	FY 1981	FY 1982	Additional to Completion	Total Estimated Cost
RDTE					
Funds (current requirements)	0	0	3000	Continuing	Not Applicable
Funds (as shown in FY 1981 submission)	New start in FY 1982				

Project 993: This is a new start in FY 1982 and represents the US Army Medical Department's first advanced development program for medical defense against chemical agents. Consequently, no funding was requested in the FY 1981 submission nor were any funds received prior to those requested in the current FY 1982 submission.

E. (U) OTHER APPROPRIATION FUNDS: ($ in Thousands) None.

Program Element: #6.37.51.A
DOD Mission Area: #552 - Environmental and Life Sciences (ATD)

Title: Medical Defense Against Chemical Warfare
Budget Activity: #2 - Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: The mission for medical chemical defense and the US Army Biomedical Laboratory were transferred from the US Army Materiel Development and Readiness Command to the US Army Medical Department on 1 July 1979 as the result of recommendations of an ad hoc review of the Chemical Warfare/Chemical Biological Defense Research and Development Program. The only program/project transferred with the mission were those in exploratory development and basic research, both on a one time basis only. This new advanced development program is absolutely essential for the development and fielding of an Integrated Medical System for Individual Protection. This project represents the entire medical systems advanced development effort for defense against chemical agents. Funding is required to carry those concepts and materiel showing promise during exploratory development to the next stage of development for test and evaluation of potential chemical warfare agent antidotes, prophylaxes, pretreatment compounds, therapeutics, and anti-radiation drugs, and new life support hardware for soldier self-help first aid, for maintenance of life support during evacuation, and for treatment of chemical casualties and evaluation of foreign life support materiel for potential US exploitation and use. Advanced development funding is required for pharmaceutical reformulation, toxicological evaluation, preclinical animal studies, and phase I clinical studies of safety and bioavailability in humans, of candidate anti-chemical agent and anti-radiation drugs. Advanced development funding is also required to support the development production and maintenance of standard stocks of pharmaceutical grade compounds for RDT&E purposes as required by federal regulatory statutes to determine efficacy and safety of candidate drugs prior to submission of a new drug application (NDA) to the Food and Drug Administration (FDA) for approval for use in humans.

G. (U) RELATED ACTIVITIES: This Program Element/Project is supported by basic research done in Program Element 6.11.02.A, Defense Research Sciences, Project BS10, Military Diseases, Injuries, and Health Hazards, and by exploratory development done in Program Element 6.27.34.A, Medical Defense Against Chemical Agents, Project A875, Medical Defense Against Chemical Agents. Duplication of effort within the Army is avoided by central management of the program on the Medical Aspects of Chemical Defense by the US Army Medical Research and Development Command. Duplication of effort across the services is avoided by coordination and collaboration with the Air Force and Navy, as required of the Army as the Executive Agency for the DOD chemical defense effort. All work is coordinated with quadripartite nations through meetings and data exchange annexes.

H. (U) WORK PERFORMED BY: This is a new start in FY 1982. No contractors are currently funded by this Program Element/Project.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: Not Applicable.

Program Element: #6.37.51.A
DOD Mission Area: #552 - Environmental and Life Sciences (ATD)

Title: Medical Defense Against Chemical Warfare
Budget Activity: #2 - Advanced Technology Development

2. (U) FY 1981 Program: Not Applicable.

3. (U) FY 1982 Planned Program: This will be the first year of the advanced development effort to provide an effective medical system for maximizing safety and survivability of the soldier on the chemical warfare battlefield. The funding will support initial work in three thrust areas: soldier chemical agent antidote development, patient decontamination, and medical management of chemical warfare casualties. The major thrust of the FY 1982 systems advanced development program will be work on field resuscitative materiel. Emphasis will be on development of a resuscitator/ventilator capable of field use, to support large numbers of chemical agent casualties expected from a mass casualty situation. Currently the US is without such capability and respiratory arrest is a primary cause of death from chemical agent poisoning. Additional efforts will be initiated on a first generation patient decontamination system, and specific materiel items (e.g., patient agent detectors, chemically hardened medical supplies) for the management of chemical warfare casualties.

4. (U) FY 1983 Planned Program: Drug development efforts will be initiated and development of field resuscitative materiel will continue. In addition, new programs will be established for the toxicological assessment of decontamination materiel, and advanced development of a patient decontamination shower.

5. (U) Program to Complete: This is a continuing program.

FY 1982 CONGRESSIONAL DESCRIPTIVE SUMMARY

Program Element: #6.37.52.A
DOD Mission : 552 - Environmental and Life Sciences
Advanced Technology Development

Title: Demilitarization Concepts
Budget Activity: 2 - Advanced Technology Development

A. (U) RESOURCES (PROJECT LISTINGS): ($ in thousands)

Project Number	Title	FY 1980 Actual	FY 1981 Estimate	FY 1982 Estimate	FY 1983 Estimate	Additional to Completion	Total Estimated Cost
	TOTAL FOR PROGRAM ELEMENT	0	0	11921	7000	Continuing	Not Applicable
A994	Demilitarization Concepts	0	0	11921	7000	Continuing	Not Applicable

B. (U) BRIEF DESCRIPTION OF ELEMENT AND MISSION NEED: Toxic Munitions which are obsolete or leaking agent pose a growing potential hazard to the public and the environment. Experiences with design, construction, and operation of Chemical Demilitarization facilities and equipment have confirmed the criticality for innovative and new technology to maximize safety and efficiencies and reduce costs. Energy-efficient technology must be considered and incorporated into all future chemical demilitarization designs. Current and increasingly restrictive environmental constraints require advancement in the state-of-the-art for control of emissions. A concerted effort must be devoted to maximize the safety aspects of all facets of chemical demilitarization operations. Detectors of sublethal levels of hazardous toxic agents in work area emission streams must incorporate the latest state-of-the-art technology to prevent exposure of workers, transients, and the civilian population to even minute quantities of agent. Ultimate disposal of waste products under existing and new standards must also be addressed. Concepts for future demilitarization plants to dispose of material identified for disposal will require capacities two to six times larger than the existing Chemical Agent Munitions Disposal System (CAMDS) facility. The eventual task of disposing of the current chemical agent stockpile will require capacities many times larger than even these planned facilities. Projected costs for stockpile disposal exceed $2 billion using current technology. This research area provides the technology to support the ongoing and future chemical demilitarization requirements.

C. (U) BASIS FOR FY 1982 RDTE REQUEST: The funds requested for FY 1982 will permit initiation of development with the subsequent incorporation of state-of-the-art technology into the stockpile disposal plant design scheduled for initiation in FY 1985. Design of additional plants will continue into the 1990's if multiple demilitarization sites are selected to dispose of the deteriorating chemical agent stockpile. No project has been canceled or deferred. This is a new start program. The total development costs cannot accurately be determined because they are dependent upon the number of basic technology concepts which must be pilot tested and the extent of ancillary facilities required to support the basic concepts and meet projected environmental and safety requirements.

Program Element: #6.37.52.A
DOD Mission : 552 - Environmental and Life Sciences
Advanced Technology Development

Title: Demilitarization Concepts
Budget Activity: 2 - Advanced Technology Development

D. (U) COMPARISON WITH FY 1981 RDTE REQUEST: ($ in thousands)

The FY 1982 submission is the first submission. This revision is submitted in support of the FY 1982 Budget Amendent.

E. (U) OTHER APPROPRIATION FUNDS: Not Applicable

Program Element: #6.37.52.A Title: Demilitarization Concepts
DOD Mission : 552 - Environmental and Life Sciences Budget Activity: 2 - Advanced Technology Development
Advanced Technology Development

F. (U) DETAILED BACKGROUND AND DESCRIPTION: This new start program is designed to provide improved technology necessary to efficiently demilitarize existing stockpiles of obsolete chemical munitions and agents and eventually the entire current chemical stockpile. Existing facilities incorporate agent destruction processes developed more than a decade ago. This was necessitated by tight schedules and the absence of research efforts prior to process development. The eventual task of chemical agent stockpile demilitarization necessitates higher capacity and more efficient, yet environmentally safe, disposal facilities. Current developments in response to national hazardous waste disposal problems provide a multitude of potential chemical destruction processes which should be considered prior to design of future large-scale demilitarization facilities. The major thrust of this R&D effort will initially be devoted to development of alternative agent destruction processes. Current processes are labor and energy intensive and produce large quantities of byproducts which are difficult to dispose of because of environmental concerns. Emphasis will be placed on conversion to reusable materials or production of landfillable byproducts. Energy recovery concepts will be included in any alternative system. Concurrent with agent destruction studies, advanced munitions processing concepts will be evaluated and developed including more efficient methods of munition disassembly. An ultimate goal is to develop a concept for a system capable of destroying both chemicals and explosives in a single, efficient operation. In support of advanced demilitarization designs, ancillary systems must be developed to prevent hazards to personnel in work areas and insult to the environment, and more efficient methods must be developed to dispose of existing and future byproducts, preferably by recycling, and to decontaminate equipment and metal parts prior to release.

G. (U) RELATED ACTIVITIES: There are currently no related projects. No unnecessary duplication of effort will occur within the Army or the Department of Defense. Open interchange of ideas with the Environmental Protection Agency (EPA) and other non-Defense agencies will be used to avoid duplication in the hazardous materials destruction process area. Large-scale destruction of toxic chemical agents and munitions is solely the responsibility of the US Army Toxic and Hazardous Materials Agency.

H. (U) WORK PERFORMED BY: This is a new start program for FY82. Contractors will be selected by competitive procurement procedures. All contracts will be monitored by the US Army Toxic and Hazardous Materials Agency.

I. (U) PROGRAM ACCOMPLISHMENTS AND FUTURE PROGRAMS:

1. (U) FY 1980 and Prior Accomplishments: None (new program in FY 1982).

2. (U) FY 1981 Program: None (new program in FY 1982).

Program Element: #6.37.52.A
DOD Mission : 552 - Environmental and Life Sciences
Advanced Technology Development

Title: Demilitarization Concepts
Budget Activity: 2 - Advanced Technology Development

3. (U) FY 1982 Planned Program: The primary thrust of this program will be directed toward agent destruction alternative studies to identify potential technologies for application to chemical demilitarization process design. Advanced munitions processing concepts will be initiated. Advanced methods will be evaluated for final disposition of existing demilitarization waste. Environmental monitoring and investigative studies will be initiated to identify current advanced state-of-the-art analysis techniques for incorporation into prototype monitoring systems designs.

4. (U) FY 1983 Planned Program: Detailed evaluation of alternative agent destruction processes will be completed, including laboratory verification of chemical reactions efficiencies, material and energy balances, and product identification and characterization. Pilot design will commence for those technologies offering the most benefit and least risk for incorporation into planned chemical demilitarization facility design. Prototype advanced munitions processing equipment will be designed, fabricated, and evaluated. Prototype environmental monitoring systems will be designed and fabricated. Pilot-scale demilitarization waste disposal demonstrations will be initiated.

5. (U) Program to Completion: Completion of pilot and prototype testing and development of detailed design data for chemical demilitarization processes will continue into FY 1987.

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Army Research, Development, Test and Evaluation Budget backup for estimates submitted to Congress in January 1981 for FY 1982.

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LME