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# REPORT DOCUMENTATION PAGE

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19. ABSTRACT (Continue on reverse if necessary and identify by block number)
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DD FORM 1473, 84 MAR 83 APR edition may be used until exhausted. All other editions are obsolete.

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18. Continue

Materials, Protective Equipment, Protective Clothing, Toxicity, Computerized Simulation, Data Bases, Binary Bombs, Hardened Structures, Vaccines.

DEPARTMENT OF DEFENSE
ANNUAL REPORT ON CHEMICAL WARFARE AND
CHEMICAL/BIOLOGICAL DEFENSE RESEARCH PROGRAM OBLIGATIONS
FOR THE PERIOD OCTOBER 1, 1987 THROUGH SEPTEMBER 30, 1988
RCS: DD-USDRE(A) 1065

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DEPARTMENT OF DEFENSE
ANNUAL REPORT ON CHEMICAL WARFARE AND
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FOR THE PERIOD OCTOBER 1, 1987 THROUGH SEPTEMBER 30, 1988
RCS: DD-USDRE(A) 1065

(Dollars in Thousands)

| | ARMY | NAVY | AIR FORCE | TOTAL |
|---|---|---|---|---|
| Chemical Warfare and Chemical Defense Program | 179,175 | 16,601 | 31,705 | 227,481 |
| Biological Defense Program | 61,651 | 78 | 0 | 61,729 |
| Total Program | 240,826 | 16,679 | 31,705 | 289,210 |

DEPARTMENT OF DEFENSE
ANNUAL REPORT ON CHEMICAL WARFARE AND
CHEMICAL/BIOLOGICAL DEFENSE RESEARCH HUMAN TESTING
FOR THE PERIOD OCTOBER 1, 1987 THROUGH SEPTEMBER 30, 1988

There have been no studies conducted within the Department of Defense during the reporting period that involved the use of human subjects for testing of chemical or biological agents.

ANNEX A

DEPARTMENT OF THE ARMY

ANNUAL REPORT ON

CHEMICAL WARFARE AND CHEMICAL/BIOLOGICAL DEFENSE RESEARCH PROGRAM OBLIGATIONS

1 OCTOBER 1987 THROUGH 30 SEPTEMBER 1988

RCS: DD-USDRE (A) 1065

DEPARTMENT OF THE ARMY

ANNUAL REPORT ON

# CHEMICAL WARFARE AND CHEMICAL/BIOLOGICAL DEFENSE RESEARCH PROGRAM OBLIGATIONS

SECTION I

OBLIGATION REPORT ON CHEMICAL WARFARE AND CHEMICAL DEFENSE PROGRAM

FOR THE PERIOD 1 OCTOBER 1987 THROUGH 30 SEPTEMBER 1988

DEPARTMENT OF THE ARMY

RCS: DD-USDRE (A) 1065

## DESCRIPTION OF RDTE EFFORT FOR THE CHEMICAL WARFARE AND CHEMICAL DEFENSE PROGRAM

During FY 88, the Department of the Army obligated $179,175,000 for general research investigations, development and test of chemical warfare agents, weapons systems and defensive equipment.

### FUNDS OBLIGATED

| | | | | |
|---|---|---|---|---|
| Current Fiscal Year | (CFY) | $166,142,000 | | |
| Prior year | (PY) | 13,033,000 | | |
| | | | In-House | $ 68,742,000 |
| TOTAL | | $179,175,000 | Contract | $110,433,000 |

### Breakdown of Program Areas

**1. CHEMICAL RESEARCH**

| | | | | |
|---|---|---|---|---|
| a. Basic Research in Life Sciences | CFY | $ 11,626,000 | | |
| | PY | 1,158,000 | | |
| | | | In-House | $ 6,664,000 |
| | | $ 12,784,000 | Contract | $ 6,120,000 |
| b. General Chemical Investigations Exploratory Development | CFY | $ 7,183,000 | | |
| | PY | 79,000 | | |
| | | | In-House | $ 5,210,000 |
| | | $ 7,262,000 | Contract | $ 2,052,000 |
| **TOTAL: CHEMICAL RESEARCH** | CFY | $ 18,809,000 | | |
| | PY | 1,237,000 | | |
| | | | In-House | $ 11,874,000 |
| | | $ 20,046,000 | Contract | $ 8,172,000 |

2. **LETHAL CHEMICAL PROGRAM**

| | | | | |
|---|---|---|---|---|
| a. Exploratory Development | CFY | $ 2,872,000 | | |
| | PY | -0- | | |
| | | | In-House | $ 2,542,000 |
| | | $ 2,872,000 | Contract | $ 330,000 |
| b. Advanced Development | CFY | $ 18,294,000 | | |
| | PY | -0- | | |
| | | | In-House | $ 1,570,000 |
| | | $ 18,294,000 | Contract | $ 16,724,000 |
| c. Full-Scale Development | CFY | $ 5,363,000 | | |
| | PY | $ -0- | | |
| | | | In-House | $ -0- |
| | | $ 5,363,000 | Contract | $ 5,363,000 |
| d. Testing | | $ -0- | | |
| TOTAL: LETHAL CHEMICAL PROGRAM | CFY | $ 26,529,000 | | |
| | PY | -0- | | |
| | | | In-House | $ 4,112,000 |
| | | $ 26,529,000 | Contract | $ 22,417,000 |

3. **INCAPACITATING CHEMICAL PROGRAM**

| | | | | |
|---|---|---|---|---|
| a. Exploratory Development | CFY | $ 1,274,000 | | |
| | PY | -0- | In-House | $ 1,089,000 |
| | | $ 1,274,000 | Contract | $ 185,000 |
| b. Advanced Development | | $ -0- | | |
| c. Full-Scale Development | | $ -0- | | |

| | | | | | |
|---|---|---|---|---|---|
| d. Testing | | | -0- | | |
| **TOTAL: INCAPACITATING CHEMICAL PROGRAM** | CFY | $ 1,274,000 | | | |
| | PY | -0- | | | |
| | | | | In-House | $ 1,089,000 |
| | | $ 1,274,000 | | Contract | $ 185,000 |
| **4. CHEMICAL DEFENSIVE EQUIPMENT PROGRAM** | | | | | |
| a. Exploratory Development | | | | | |
| (1) Physical Protection Investigations | CFY | $ 7,448,000 | | | |
| | PY | $ 136,000 | | | |
| | | | | In-House | $ 5,481,000 |
| | | $ 7,584,000 | | Contract | $ 2,103,000 |
| (2) Warning and Dstection Investigations | CFY | $ 4,941,000 | | | |
| | PY | $ 47,000 | | | |
| | | | | In-House | $ 1,571,000 |
| | | $ 4,988,000 | | Contract | $ 3,417,000 |
| (3) Medical Defense Against Chemical Agents | CFY | $ 21,679,000 | | | |
| | PY | $ 2,510,000 | | | |
| | | | | In-House | $ 13,072,000 |
| | | $ 24,189,000 | | Contract | $ 11,117,000 |
| **TOTAL: Exploratory Development** | CFY | $ 34,068,000 | | | |
| | PY | $ 2,693,000 | | | |
| | | | | In-House | $ 20,124,000 |
| | | $ 36,761,000 | | Contract | $ 16,637,000 |

b. Advanced Development

| | | | | | |
|---|---|---|---|---|---|
| (1) Chemical Decontaminating Materiel | CFY | $ 2,901,000 | | | |
| | PY | 3,000 | In-House | $ | 959,000 |
| | | $ 2,904,000 | Contract | $ | 1,945,000 |
| (2) Collective Protection Equipment | CFY | $ 397,000 | | | |
| | PY | $ 1,000 | | | |
| | | | In-House | $ | 350,000 |
| | | $ 398,000 | Contract | $ | 48,000 |
| (3) Individual Protection Equipment | CFY | $ 1,822,000 | | | |
| | PY | $ 2,164,000 | | | |
| | | | In-House | $ | 1,449,000 |
| | | $ 3,986,000 | Contract | $ | 2,537,000 |
| (4) Chemical Detection and Warning Materiel | CFY | $ 7,095,000 | | | |
| | PY | $ 2,025,000 | | | |
| | | | In-House | $ | 2,897,000 |
| | | $ 9,120,000 | Contract | $ | 6,223,000 |
| (5) Medical Chemical Defense Life Support Materiel | CFY | $ 10,824,000 | | | |
| | PY | $ 1,844,000 | | | |
| | | | In-House | $ | 4,579,000 |
| | | $ 12,668,000 | Contract | $ | 8,089,000 |

| | | | | | |
|---|---|---|---|---|---|
| (6) Medical Defense Against Chemical Warfare | CFY | $ 21,261,000 | | | |
| | PY | $ 1,397,000 | | | |
| | | | In-House | $ | 3,097,000 |
| | | $ 22,658,000 | Contract | $ | 19,561,000 |
| TOTAL: Advanced Development | CFY | $ 44,300,000 | | | |
| | PY | $ 7,434,000 | | | |
| | | | In-House | $ | 13,331,000 |
| | | $ 51,734,000 | Contract | $ | 38,403,000 |
| c. Full-Scale Development | | | | | |
| (1) Decontamination Concepts and Materiel | CFY | $ 1,008,000 | | | |
| | PY | $ 1,000 | | | |
| | | | In-House | $ | 691,000 |
| | | $ 1,009,000 | Contract | $ | 318,000 |
| (2) Collective Protective Systems | CFY | $ 5,788,000 | | | |
| | PY | $ 1,000 | | | |
| | | | In-House | $ | 1,783,000 |
| | | $ 5,789,000 | Contract | $ | 4,006,000 |
| (3) Warning and Detection Equipment | CFY | $ 16,593,000 | | | |
| | PY | $ 2,000 | | | |
| | | | In-House | $ | 3,200,000 |
| | | $ 16,595,000 | Contract | $ | 13,395,000 |
| (4) Individual Protection Equipment | CFY | $ 141,000 | | | |
| | PY | $ -0- | | | |
| | | | In-House | $ | 137,000 |
| | | $ 141,000 | Contract | $ | 4,000 |

| | | | | | |
|---|---|---|---|---|---|
| (5) Medical Chemical Defense Life Support Materiel | CFY | $ 2,847,000 | | | |
| | PY | $ 635,000 | | | |
| | | | In-House | $ | 314,000 |
| | | $ 3,482,000 | Contract | $ | 3,168,000 |
| d. Testing | | $ -0- | | | |
| **TOTAL: Full-Scale Development** | CFY | $ 26,377,000 | | | |
| | PY | $ 639,000 | | | |
| | | | In-House | $ | 6,125,000 |
| | | $ 27,016,000 | Contract | $ | 20,891,000 |
| **TOTAL: CHEMICAL DEFENSIVE EQUIPMENT PROGRAM** | CFY | $ 104,745,000 | | | |
| | PY | $ 10,766,000 | | | |
| | | | In-House | $ | 39,580,000 |
| | | $ 115,511,000 | Contract | $ | 75,931,000 |
| **5. TRAINING SUPPORT** | CFY | $ -0- | | | |
| | PY | $ -0- | | | |
| | | | In-House | $ | -0- |
| | | $ -0- | Contract | $ | -0- |
| **6. SIMULANT TEST SUPPORT** | CFY | $ 2,460,000 | | | |
| | PY | $ -0- | | | |
| | | | In-House | $ | 844,000 |
| | | $ 2,460,000 | Contract | $ | 1,616,000 |
| **7. MANAGEMENT AND SUPPORT** | CFY | $ 12,325,000 | | | |
| | PY | $ 1,030,000 | | | |
| **TOTAL: MANAGEMENT AND SUPPORT** | | $ 13,355,000 | In-House | $ | 11,243,000 |
| | | | Contract | $ | 2,112,000 |

## EXPLANATION OF OBLIGATION

1. **CHEMICAL RESEARCH**

a. **Basic Research in Life Sciences**

This research provides a science base to support:

(1) **Chemical Defense Research.** This program includes new concepts and the elucidation of mechanisms of decontamination and contamination avoidance, individual and collective protection, reconnaissance, identification, and detection, materials research, simulants, training systems and properties of chemical threat agents.

(2) **Chemical Retaliatory Research.** This area includes research related to chemical munitions and search for new classes of chemical agents.

**During FY 88:**

Acquired a computer data base of genetic sequences of deoxyribonucleic acid and proteins for use in identifying factors or sets of factors common to pathogenic organisms.

Computerized physicochemical parameters of 100 volatile anesthetics.

Completed construction of the Fourier transform mass spectrometer for the detection/identification of agents.

Installed and completed operational testing of a tandem ion mobility spectrometer for studies of laser ionization/detection of simulants at atmospheric pressure.

Applied time-resolved Raman spectroscopy to measure the rate of hydrolysis of agent simulants.

Discovered two new shear-induced precipitation mechanisms which can be used to disqualify simulants for rheological/dissemination applications.

**Clothing, Shelters and Other Material Systems**

The goal of this program is to establish potential technologies for the development of clothing and other protective material systems that will minimize the effects of chemical/biological (CB) agents and heat stress associated with wearing the protective ensemble.

**During FY 88:**

Conducted laboratory tests on the effect of mission oriented protective posture (MOPP) gear encapsulation on sensorimotor and cognitive performance, and examined the relationship between personality characteristics and anxiety while in MOPP wear.

Conducted field tests on the effects of encapsulation in MOPP gear on postural sway, peripheral vision, and gross motor performance.

Characterized a biopolymer, which is used in a specific reactive system to detoxify chemical agents, using viscosity measurement, infrared analysis, molecular weight determination, and extent of deactylation techniques. Obtained data on the reactivity of a catalytic, metal complexed biopolymer against agent surrogates and live agents.

Contracted for the development of an improved testing methodology capable of identifying and quantifying the breakdown products of chemical agents when detoxified by reactive materials.

Improved the synthesis of a soman detoxifying enzyme from a thermophilic bacterium after modifying its growth conditions. Attached the enzyme to cotton cloth and demonstrated the ability to detoxify nerve agent soman in solution.

Studied the effect of moisture on the reactivity of a biopolymer-metal catalyst for the degradation of chemical agent surrogates.

Synthesized potentially reactive barrier membranes and applied them to standard battledress and flame resistant materials.

Synthesized cyclodextrin derivatives with high potential as metal complexes for catalytic agent hydrolysis.

Determined the air permeability of several military fabrics.

Measured the hydrostatic pressure resistance of several water resistant finish, treated model fabrics and military cloths. Determined that simple models for estimating hydrostatic pressure resistance values are inadequate and that more complex theories must be evaluated.

Evaluated dispersion components of the surface free energy of several military cloths and model fabrics. Utilized data in various models to calculate the hydrostatic pressure resistance values of materials.

Degraded a high molecular weight biopolymer into smaller fractions and determined that the smaller fractions, after complexing with a metal, show similar reactivity towards chemical agents as the high molecular weight material.

**Medical Chemical Defense Research Program**

This program provides basic research by the United States (U.S.) Army to meet Joint Service and Service unique requirements for maximizing survivability and operational effectiveness of troops on the integrated battlefield. Emphasis is directed toward development of new technologies and unique methodologies required to determine and evaluate biomedical effects resulting from current and potential chemical warfare agents and therapies. Accomplishments emerging from this effort will serve as the basis for further development of new therapeutic systems for current and novel chemical warfare (CW) agents and provide tools necessary for determining mechanisms of action.

**During FY 88:**

Established several reliable new metabolic and biochemical markers for cutaneous injury induced by vesicants.

Developed methodologies to identify the pathophysiology from emerging chemical warfare threats in support of directing medical prevention and treatment strategies.

Examined ultrastructural changes as markers for acute and chronic exposure to nerve agent pretreatments.

Evaluated the feasibility of a novel enzymatic pretreatment approach to protection from nerve agent toxicity.

Established the utility of a biochemical marker for cyanide injury.

Established in vivo and in vitro screening tests for radioprotectant efficacy.

b. General Chemical Investigations: Exploratory Development

**Chemical Biological (CB) Threat Agent Chemistry and Effects**

The objectives are to identify, synthesize and study the chemical, physical, toxicological properties of chemical/biological materials and to maintain a modern technology base in the requisite disciplines in order to assess the potential threat of these materials to the U.S. CB defense posture; to analyze foreign intelligence and other potentially hazardous samples for the presence of CB agents and related materials and to advance the scientific expertise, instrumentation, and methodology to do this by the most up-to-date techniques; and to provide a current assessment of the status of CB threat agents to the Department of Defense (DOD) CB defense community.

During FY 88:

Completed a toxicity study on the effectiveness of filters in the Bradley Fighting Vehicle against toxic chemicals generated from the noncatastrophic explosion of munitions.

Received the Federal Laboratory Consortium Award for technology transfer of the Molecular Modeling Analysis Display System (MMADS). This computer software system, which permits facile theoretical chemistry studies, was provided to over thirty academic, industrial, and government laboratories.

Developed a portable field sample acquisition kit for collecting samples of material suspected of containing CB agents.

**Analysis and Integration of Chemical Defense Systems**

The objectives of this program are to develop a cohesive system of analytical models and the supporting data base to assess the challenges posed by the foreign chemical and biological threat and to evaluate chemical and biological defense systems against the threat; to develop new models to estimate the effects of chemical warfare agents on the battlefield and to use these models for the assessment of alternative concepts and designs; and to provide other Department of Defense (DOD) chemical analysts and wargamers with mathematical models and methodology for their analyses.

During FY 88:

Completed validation of the Non-uniform Simple Surface Evaporation (NUSSE3) single round, chemical munition model and established parameter input sets for predicting performance of both threat and non-threat chemical systems.

Completed a model to provide an initial capability to assess chemical cloud transport over complex terrain.

Completed a series of tank crew contamination transfer trails for tank crew members, during exit/entry and rearming operations.

Concluded tests to determine residual vapor levels from liquid contaminated military surfaces under controlled temperature and air flow conditions.

Completed an analysis of exit/entry to collectively protective systems in a chemical and biological environment to assess materiel solutions to providing adequate protection.

Developed a Battlefield Hazard Guide to provide information on the expected duration of hazard levels from chemical agents based on the response of detection equipment available to the battlefield.

Chemical Biological (CB) Simulants, Survivability and Systems Science

The objectives of this program are to establish a DOD and International Center for information and data on simulants for chemical and biological agents; to provide Nuclear, Biological and Chemical (NBC) contamination survivability technology base data and to evaluate methodology for the assessment of equipment survivability and

effects of agent and decontamination material; to identify and provide generic CB defense data and operational science data common to functional development areas; and to acquire and develop special test technologies.

**During FY 88:**

**Established the International Simulant Data Base using input from the United Kingdom, Canada, and the United States.**

**Estimated over 1200 physical properties of simulants which reduced the need and cost of experimentation.**

**Developed a new laser-based system for consistent and early detection of stress crazing and cracking in transparent materials subjected to chemical and mechanical stress.**

**Initiated a formal cooperative Cold Weather Research Agreement and held a Tri-Service Conference to address unique problems of the cold weather chemical/biological battlefield.**

**Replaced the original deterministic failure model for transparent materials stressed by chemical agents with a novel probabilistic analysis method that provides a more realistic result in terms of the probability of failure.**

**Assessed the most common and most promising conformal coatings for electronic components for their resistance to threat agents, and discovered conditions under which electrical resistance is recovered.**

## 2. LETHAL CHEMICAL PROGRAM

### a. Exploratory Development

**The objectives of this program are to develop chemical agent/munition systems to provide a dependable and credible deterrent and a safe and modern retaliatory capability; and to maintain advanced technology in chemical agent weaponry to avoid any technological lag or surprise.**

During FY 88:

Developed a systematic method for evaluation of unique chemical agents for potential use in retaliatory munitions.

Established lethal concentration-time human estimates of a unique chemical compound based on multispecies model studies.

b. Advanced Development

Tactical Weapons System:

(1) XM135 Multiple Launch Rocket System (MLRS) Binary Chemical Warhead (BCW)

Completed the validation phase of the XM135 MLRS BCW.

Initiated full-scale reactor toxic chamber testing.

Continued toxicity studies for binary chemical precursors and the resulting agent.

Completed fill/close of 32 injector assemblies and placed them in long term surveillance storage.

Completed 60 percent of the process design and 30 percent of the facility design for the injector assembly fill/close and load/assembly/packing pilot line.

Completed and received approval of the Required Operational Capability (ROC) document.

Initiated software development to integrate the BCW into the MLRS system.

Awarded the XM450 fuze development contract.

(2) M687 Binary 155mm Projectile

No obligations were incurred. This item is in production.

c. Full-Scale Development

XM135 Multiple Launch Rocket System (MLRS) Binary Chemical Warhead (BCW)

Conducted a Milestone II In Process Review and received approval to enter full-scale development phase.

Awarded a full-scale development contract.

d. Testing

(1) Materials Tests in Support of Joint Operational Plans and/or Service Requirements.

No obligations were incurred.

(2) Army Material Suitability Tests.

No obligations were incurred.

3. INCAPACITATING CHEMICAL PROGRAM

a. Exploratory Development

The objectives of this program are to discover new quick acting physically incapacitating compounds which are effective by inhalation and absorption through the skin; and to synthesize and evaluate potent analgesics and volatile anesthetics.

During FY 88:

Completed all primary screening studies on opioids.

Initiated inhalation effectiveness studies.

b. Advanced Development No obligations were incurred.

c. **Full-Scale Development** No obligations were incurred.

d. **Testing** No obligations were incurred.

4. **CHEMICAL DEFENSIVE EQUIPMENT PROGRAM**

a. **Exploratory Development**

(1) **Physical Protection Investigations**

**Chemical and Biological Decontamination and Contamination Avoidance**

The objectives of this program are to investigate procedures, designs, and materials to enhance survivability of troops in a chemical, biological, and radiological environment; to develop equipment to decontaminate personnel, personal items, and military equipment; to improve the efficiency of the decontamination process; and to develop methods of avoiding or minimizing contamination.

During FY 88:

Completed the fifth of five contracts awarded in FY 85 to investigate new concepts for decontaminating aircraft. Four of the efforts are promising and one, a commercially available sacrificial coating (currently used by the nuclear industry), has been incorporated into the decontamination program.

Continued efforts in the development of a self-stripping coating. Awarded and completed two contracts to evaluate various characteristics of the basic formula.

Conducted a front end analysis to determine the contamination avoidance of air drop equipment and supplies.

Reduced the volume of a cargo parachute by 60 percent and packaged it in a chemical protected package.

Initiated a Joint Service effort with the U.S. Air Force to avoid contamination of aircraft interiors.

**Individual Protection**

The objectives are to evolve concepts for individual protection against potential threat agents for Joint Service application; to develop a technical base to study the mechanism of chemical biological protective materials; and to maintain a center of excellence in respiratory protection.

Initiated the exploratory development phase of the Aircrewman's Protective Mask program and the Respiratory Protective System 21 Program.

Implemented Computer Aided Design/Computer Aided Manufacture (CAD/CAM) as a design tool in the development of prototype components for individual protective equipment.

Developed an improved version of a prototype voice amplification device.

Developed a new mask lens system which will provide improved visual acuity and peripheral vision.

Designed and fabricated concepts for novel lens attachment mechanisms to improve optical compatability with weapons sight and night vision devices

Initiated an effort to establish a vapor protection factor test capability for evaluation of full ensembles.

Expanded the Advanced Protective Systems Integration Laboratory's capability to include detailed anthropometric measurement of the human head under static and dynamic conditions. The data collected will be used as design drivers for CAD/CAM and improved sizing of future respiratory protective systems.

Evaluated commercial closed-circuit breathing systems for the Self-Contained Toxic Environment Protective Outfit (STEPO). Identified the most suitable candidate to meet STEPO requirements.

Conducted chemical agent evaluations on developmental materials for Joint Service applications.

Tested standard and advanced chemical protective ensembles and compared the effects of different clothing combinations on speech communication and hearing, body mobility, and psychomotor coordination.

Performed both fresh water and salt water purification devices early user tests and experimentation. Initiated redesign of the devices to correct deficiencies and transitioned the projects to Advanced Development.

Developed prototype personal hygiene and waste management kits for within-suit use in advanced concept chemical protective ensembles.

Developed improved and modified chemical protective materials for future protective suits requiring reduced weight, bulk, and protection.

Developed a new permeation test methodology to screen barrier materials for their effectiveness against chemical warfare simulants after petroleum, oil, and lubricants exposure.

Evaluated the feasibility of integrating a permeable material hood onto the chemical protective overgarment.

Completed contracts to develop and spin detoxicant fibers or fabrics. Incorporated detoxicant materials into waterproof/breathable or microporous Teflon coatings.

Conducted statistical analysis of agent testing data for a reactive detoxification material. Analyzed the development of the detoxification for cost and operational effectiveness.

Investigated the effects of using Freon and other dry cleaning solvents on the functional properties of chemical protective clothing and equipment.

Identified new elastomers with improved protection, extended low temperature flexibility and improved flame resistance for use in chemical protective boots, gloves and coated fabrics.

**Collective Protection**

The objectives of this program are to evolve concepts for collective protection against present and future threat agents for Joint Service application; and to develop and maintain a technical base on the mechanisms of protection against chemical and biological agents.

**During FY 88:**

Continued efforts to develop a pressure swing adsorption prototype for a test bed. Completed design, fabricated, and conducted limited simulant tests.

Continued studies to eliminate the use of chromium, a hazardous material, from the current military adsorbent carbon. Determined and evaluated five promising formulations as alternate impregnants. Selected one formulation for further development.

Continued studying the mechanisms involved in the destruction of chemical agents by electric discharge plasmas. Conducted studies of potential post treatment methods of the by-products. Initiated development of a 30 cubic feet per minute reactor.

Conducted a field test of the M1A1 tank within an area contaminated with a chemical simulant to determine the effectiveness of rearming procedures, and field tested an experimental NBC hatch sealer for open-hatch operations.

Continued testing a regenerative filter system as a potential candidate for Advanced Collective Protection Equipment (ACPE).

Integrated and conducted road tests of the temperature swing regenerable filter system prototype on a tank test bed.

Continued to quantify the performance of adsorbents against potential new threat agents at various environmental conditions.

Identified an impregnant that significantly increases the performance of air filtration systems against weakly adsorbed agents.

Initiated an accelerated development program to optimize the recently identified sorbent.

(2) Warning and Detection Investigations

**Reconnaissance, Detection, and Identification**

The objectives of this program are to evolve new and improved concepts, methods, and materials for point detection, identification and warning for all chemical and biological agents for Joint Service applications; to develop concepts for product improvement programs to upgrade standard chemical and biological agent point detectors; and to update and maintain a Reconnaissance, Detection, and Identification (RDI) Master Plan.

During FY 88:

**CB Mass Spectrometer Technology:**

Obtained phase I CB Mass Spectrometer breadboard delivery, and demonstrated the breadboard during the final phase I Quarterly Program Review.

Fabricated a three-stage breadboard virtual impactor and initiated an in-house evaluation.

Initiated biomaterial profiling studies using pyrolytic chemical components of several bacterial strains.

**Stand-off Detection Technology:**

Conducted a field test of thermal imagers and the XM21 Remote Sensing Chemical Agent Alarm in motion.

Developed and tested the new high performance moving background algorithm based on time domain pattern recognition techniques.

Initiated a miniature frequency agile carbon dioxide laser design effort.

Established a Memorandum of Understanding (MOU) with France for a cooperative research and development program to develop and field a Stand-off Laser Chemical Agent Detection System. As a result, funds were received from a congressional set-aside (referred to as Nunn funds) to supplement the initial conduct of the effort.

**Bio-Chemical (BC) Detector Technology:**

Completed phase I of the BC detector contract which consisted of a total assessment of applicable technologies, such as air sampling, microsensors, bioreagent interfaces, and central processing; and initiated phase II, design of a BC detector breadboard.

Initiated planning for a trilateral collaborative development program for an all agents detector with the United Kingdom and Canada. Concurrently, an application was made through the appropriate channels for consideration of supplemental funding, e.g., Nunn funds, to support this effort as soon as an agreement is reached between the three countries.

Held the 3rd Joint Services Technical Working Group meeting for CB Mini-Microsensors.

(3) Medical Defense Against Chemical Agents

This program supports the Joint Service and Service unique exploratory development for medical chemical defense. It emphasizes the prevention of casualties through application of drugs or chemical compounds for prevention or treatment of the toxic processes of conventional and novel CW agents. A majority of the resources supports development of prophylactic/pretreatment compounds, antidotes, skin decontaminants, and therapeutic agents that will counteract the lethal, physical, and behavioral decrements of CW agents. The remainder of the resources supports development of medical materiel that insures adequate patient care, field resuscitation, and patient management procedures.

During FY 88:

Expanded a computer-assisted drug modeling capability and initiated specific synthesis of drugs to improve medical countermeasures to chemical warfare agents.

Developed decision tree networks for the rapid selection of candidate antidotes, pretreatments, and topical protectants against CW threat agents.

Continued the active screening of compounds for efficacy against CW threat agents.

Performed toxicity studies on CW threat agents to be used in development of exposure criteria.

Determined the effects of maintaining normal arterial oxygenation and other respiratory parameters on agent-induced respiratory arrest.

Designed and synthesized transition metal complexes as <u>in vivo</u> cyanide scavengers for treatment of cyanide poisoning.

Improved screening methods for selecting candidate decontamination systems that are effective against mustard and lewisite.

b. <u>Advanced Development</u>

(1) <u>Chemical Decontaminating Material</u>

Non-aqueous Equipment Decontamination System (NAEDS):

This system is being developed to decontaminate small items of equipment, avionics, communication, electronic and optical equipment, personal equipment, and weapons. Two versions will be fielded: an interim item for use at fixed sites only and a mobile, fully militarized item which will be trailer mounted for use anywhere on the battlefield.

During FY 88:

Completed agent testing to determine decontamination efficacy.

Initiated work for the development of the Technical Data Package, Technical Manuals, Technical Orders, Integrated Logistics Support, and provisioning.

Initiated and completed efforts to evaluate a mobile NAEDS concept. It is technically infeasible to mount a 1 1/4 ton mobile NAEDS on a High Mobility Multi-Wheeled Vehicle (HMMWV). Efforts continue to examine concepts mounted on 2-1/2 and 5-ton trucks and trailers.

Continued coordination with the Laundry and Decontamination Dry Cleaning System development program.

**Modular Decontamination System (MDS):**

This system is designed to fill the washing, decontaminant application, and rinsing requirements of a vehicle decontamination line. The system will provide hot water and high pressure water for cleaning and rinsing vehicles and will provide a capability to dispense standard chemical decontaminants and new decontaminating emulsions. The system will provide higher mobility, flexibility, and reliability than currently fielded decontamination systems.

**During FY 88:**

Defined requirements for the system under an Operational and Organization (O&O) Plan and a draft Required Operational Capability (ROC).

Conducted planning required to initiate the development program, e.g., Acquisition Strategy and Plan, Baseline Cost Estimate, and a Test and Evaluation Master Plan.

Completed breadboard prototypes for two of the system modules under an in-house design effort.

Awarded two task orders, one for continued design of decontaminant dispensing modules and one for market investigations for components of the modules.

**Laundry and Dry Cleaning Decontamination System (LADDS):**

**This system is being developed to perform non-aquaeous dry cleaning and decontamination of clothing and individual equipment items exposed to vegetable stains, dirt, sweat, petroleum products and to NBC contamination. The proposed system will eliminate the present dependency for water, reduce the resource requirements of current systems, and increase the rate at which chemical agents are decontaminated.**

**During FY 88:**

**Completed laboratory analysis of the LADDS's chemical agent decontamination capability and analyzed data.**

**Awarded a contract for operation and maintenance manuals.**

**Initiated the demonstration/validation phase.**

**(2) Collective Protection Concepts**

**Standard Integrated Command Post System (SICPS): (formally known as Light Weight Integrated Shelter System)**

**The SICPS will integrate chemical and electromagnetic protection into a shelter system to fit on the High Mobility Multi-Purpose Wheeled Vehicle and the Commercial Utility Cargo Vehicle. The shelter will be integrated with power, air conditioning, ventilation, lights, and racks to support the communications and electronics equipment utilized for command, control, and communications and intelligence (C3I) missions.**

**During FY 88:**

**Completed soft wall shelter prototype development.**

**Fabricated six (three from each contractor) integrated (soft and hard wall) shelter prototypes and conducted technical feasibility tests to evaluate prototype design features.**

Selected one contractor to continue in the development of additional integrated prototypes.

**Five Soldier Crew Tent for Combat Vehicle Crewmen:**

The Five Soldier Crew Tent for Combat Vehicle Crewmen will be a lightweight, quickly erectable/collapsible, crew size tent providing environmental protection for combat, combat support, and combat service support units. The system will replace tents currently in the inventory that are too heavy/bulky, much slower to erect/strike, and do not allow the required degree of liquid protection in a chemical environment.

**During FY 88:**

Received type classification approval for use in an uncontaminated environment. CB protection requirement cound not be met at this time.

**Chemical-Biological Hardened Shelter System:**

The objective of this program is to develop shelters/tentage which provides collective protection for personnel against chemical and biological agent attack. The area of concentration ranges from the highly mobile Battalion Aid Station level to the less mobile large shelter field Corps Hospital level.

**During FY 88:**

Delivered the first generation Battalion Aid Station prototype to the test site for simulant agent testing.

Completed testing the first generation trailer mounted power support system and discovered hardware deficiencies.

Prepared the scope of work for an improved second generation power support system.

**NBC Contamination Survivability:**

The objectives are to provide technical support and guidance to materiel developers in implementing both DOD Instruction 4245.13, Design and Acquisition of Nuclear, Biological and Chemical (NBC) Contamination-Survivability Systems and AR 70-71, NBC Contamination Survivability of Army Materiel; to conduct general studies on NBC vulnerability/survivability; and to identify technical base studies to fulfill knowledge gaps and enable systems and personnel survival in the NBC environment.

**During FY 88:**

Continued a study to analyze and assess the NBC survivability of military equipment, both existing and developmental.

Continued to provide data to project managers within U.S. Army Materiel Command on the characteristics of AR 70-71, the interaction of chemical agents and decontaminants on materiel, and techniques available to mitigate their effects and foster survivability.

Continued to provide technical assistance to project managers in developing statements of work, requests for proposal inputs, and system specifications; and assisted in the source selection process.

(3) <u>Individual Protection Concepts</u>

**Ground/Air Microclimate Cooling System:** (formally Aircrew Microclimate Cooling Program)

This program will provide auxiliary cooling equipment for dissipating metabolic heat while performing operational tasks on and off vehicles/aircraft in hot dry/wet environments. Cooling will be accomplished by circulating through a garment, chilled liquid or chemical/biologically filtered conditioned air supplied by the vehicle cooling unit or individually worn backpack.

**During FY 88:**

Conducted climatic chamber tests which indicated that each circuit (air and liquid) of the hybrid air/liquid vest performed comparably to existing separate air and liquid garments.

Initiated a development effort with industry for a lighter weight, less expensive hermetic compressor.

**Nuclear, Biological and Chemical - Protective Covers (NBC-PC):**

The NBC-PC will provide a lightweight, disposable barrier to protect supplies and equipment from liquid chemical/biological attack and ambient temperature radiological fallout. This design will ease the burden of decontamination throughout the Army providing a barrier between the contaminants and the supplies/equipment.

**During FY 88:**

Continued environmental and agent testing.

Procured and initiated physical property testing of NBC-PC's with woodland camouflage pattern and revarsible colors (green/white).

**Multipurpose Overboot (MULO):**

The MULO is to replace the current chemical protective footwear cover and the wet weather overshoe by combining the salient characteristics of each boot into a single item. Flame resistance, decontaminability, and resistance to petroleum, oils, and lubricants are to be considered in designing the MULO.

**During FY 88:**

Evaluated two prototype designs using two different material blends along with the Canadian overboot in a wear test.

**Water Purification Unit for Small Groups (WPUG):**

The WPUG will provide small groups of soldiers with the capability of purifying salt and brackish water by removing all known pathogens, salt, visible dirt and NBC contamination. The unit will be compatible with all U.S. Army individual water containers without significantly increasing the individual load.

**During FY 88:**

Completed engineering changes to adapt commercial design.

Procured developmental prototypes and conducted early User Tests and conducted modified reverse osmosis trials.

Initiated a contract to procure prototypes for NBC testing.

**Self-contained Toxic Environment Protective Outfit -Interim: (STEPO)**

The STEPO-I will provide two hours of protection for depot workers in immediate danger of life and health situations. Current off-the-shelf technologies will be utilized to expedite this effort.

**During FY 88:**

Evaluated commercial available suits, rebreathers, ice vests, and emergency breathing apparatus and finalized system modifications.

Awarded contracts to procure test quantities of equipment items.

**Self-contained Toxic Environment Protective Outfit (STEPO):**

STEPO will provide four hours of protection against chemical/biological agents, industrial chemicals, petroleums, oils, and lubricant (POL) products and radioactive particles for use by explosive ordnance disposal and depot workers. The suit will be integrated with a non-filtered four hour breathing system and microclimate cooling equipment.

**During FY 88:**

Completed a domestic market/International Materiel Survey.

Initiated the engineering design phase and commenced design reviews.

Identified prospective equipment for future procurement actions.

(4) Chemical Detection and Warning Materiel

**Automatic Liquid Agent Detector (ALAD): XM86**

The ALAD is an automatic liquid chemical agent detector unit that detects a single drop of threat material such as thickened nerve and blister agent. The detection mechanism is based on the physical chemical interaction of the agent with a special paint resin in which there are very fine elemental silver flakes suspended. This silver-bearing paint acts as an electrical conductor, which swells when attacked by an agent, causing physical separation of the conductive silver flakes and a resulting change in the electrical resistance of the detector grid. This change activates an alarm function. The major components are the detector unit and the insertable sensor element.

The ALAD program was officially made two separate programs, one to address the liquid agent threat (ALAD) and one to address the development of a dedicated chemical warning communication line Chemical Agent Detector Network (CADNET). The ALAD is intended for use in Combat Support, Combat Service Support, and Fixed Site mission profiles.

The objective of this program is to complete development, and test and evaluation of an ALAD under a joint program with the U.S. Air Force (USAF). The ALAD will be designed and fabricated to meet the requirements of both Services. The USAF is the lead Service for the joint USAF-Army program.

**During FY 88:**

Terminated Army participation in the Joint Service development of the ALAD in Jan 88 due to lack of funds and the low priority of need for the item.

Scheduled award of the U.S. Air Force production contract for early Nov 88.

Retained Army option to buy ALAD in the USAF contract. The Army may exercise this option, should funding be restored.

Prepared a draft summary technical report on the Army ALAD program. The report will be published in early FY 89.

**Chemical Agent Detector Network (CADNET): XM23/XM24**

The objective of this project is to provide a rapid warning and reporting system for nuclear, biological and chemical (NBC) detectors and disseminate critical NBC information on the battlefield. The CADNET rapidly alerts infantry and vehicle mounted battlefield units to an alarm from a nuclear, biological, or chemical (NBC) detector. The CADNET passes the NBC alarm from fielded NBC detectors to the Command and Control (C2) radios on the battlefield. The alarm originates at the NBC detector and is transmitted via the XM23 (detector/transmitter interface) back to the XM24 (receiver audio interface) via radio frequency or field wire for retransmission over the C2 radio system. An M42 Alarm Unit immediately alerts all unit personnel to don mission oriented protective posture (MOPP) gear, and an audible alarm is produced on the C2 radio in the background of voice communication.

During FY 88:

Designed and developed an applications specific integrated circuit to reduce overall volume and increase reliability.

Submitted revised Basis of Issue Plan feeder data.

Completed XM23 Engineering Design Test (EDT) hardware build.

Assembled initial XM24 interface hardware.

Completed the EDT Plan and initiated testing.

**Multipurpose Integrated Chemical Agent Detector (MICAD): XM25**

The MICAD system is an integrated chemical agent detection system that will provide an inside and/or outside detector/monitor capability to air and ground combat vehicles and tactical vehicles, vans, and shelters with positive pressure collective protection equipment (PPCPE), or without PPCPE if an automatic communication network is available. The MICAD system will consist of the detector, a control panel, and a sampling system. The detector portion of the MICAD system will utilize an XM22 Automatic Chemical Agent Alarm (ACADA). The MICAD will provide an automatic and continuous point sampling/detection capability, both externally and internally, to the host system for those chemical agents detectable by the ACADA. The ACADA will detect all nerve agents, blister agents (mustard and lewisite), and will be capable of being reprogrammed to incorporate new threat agents. The system will provide an electronic signal to activate future automatic collective protection equipment when agent presence is detected, and will interface with the communication system and headphones within the vehicle, van, or shelter. The MICAD will electronically signal the vehicle, van, or shelter, warning of agent presence and will disseminate critical NBC information to the automated Battlefield Management System (BMS). This will allow the combat vehicle fleet to be part of the detection and warning network, vastly expanding CW intelligence gathering. The MICAD will be powered by and configured as an integral part of the host application.

**During FY 88:**

Suspended efforts on this program until adequate funding is available which is currently scheduled for FY 90.

**Automatic Chemical Agent Alarm (ACADA): XM22**

The objective is to develop a multi-chemical agent alarm for all Services with the capability to serve as a point sampling alarm, as a monitor inside collective protected shelters, and as a survey instrument to detect contaminated surfaces.

**During FY 88:**

Completed a design fix and verification effort initiated in FY 87, which corrected performance deficiencies uncovered during FY 86 testing.

Completed bench testing of the redesigned ACADA pneumatic system (cell, pump, and scrubber modules).

Conducted a Joint Service Preliminary Design Review to evaluate performance of the redesigned pneumatic system.

Completed fabrication of five redesigned ACADA brassboard units.

Conducted a Joint Service Critical Design Review to evaluate performance of the redesigned ACADA system.

Initiated fabrication of an additional five ACADA brassboard units and initiated agent and interference testing to refine the ACADA detection algorithm.

**Fixed Site Chemical Detection and Warning System (FSCDWS):**

The objectives of this project are to provide a system to warn of a chemical attack on a fixed type of installation, and to provide a dewarn in the event the attack is non-chemical. The FSDWS is an integrated system consisting of a chemical detector network linked to a communication and computer system. The chemical detector network uses point and remote detectors. Data from the impact areas, class and physical state of the chemical agent, and meteorological data will be transmitted over the communications network to a central command control computer where an evaluation of the chemical hazard will be made. The command control computer is capable of managing the detector network traffic, including polling the detectors for alarms and diagnostic information.

**During FY 88:**

Developed a system concept formulation package for the Air Force FSDWS.

Developed a complete software functional specification of a FSDWS for the Air Force.

Completed an evaluation of the Facility Intrusion Detection System with respect to the FSDWS.

Developed a system specification for the Air Force.

Fabricated, installed, and demonstrated a fixed site system at Hahn Air Force Base, Germany.

Coordinated with the Navy with respect to applying the Air Force FSDWS concepts to their requirements.

(5) Medical Chemical Defense Life Support Materiel

Nonsystem:

The purpose of this program is to support the Department of Defense non system advanced development for medical chemical defense. It utilizes technology and further screens candidate compounds. Analytical and stability studies are performed on advanced candidate compounds. It also supports development of "breadboard" materiel models.

During FY 88:

Developed drug assays for use in studies on a potential second generation pretreatment.

Evaluated cyanide pretreatment compounds.

Conducted preclinical studies on a second generation nerve agent pretreatment.

Performed scaled-up synthesis of candidate anti-chemical warfare drugs under Food and Drug Administration Good Manufacturing Practices regulations to support the drug development mission.

Initiated validation of performance assessment methodology for predicting performance decrements caused by drugs.

(6) Medical Defense Against Chemical Warfare

The objective of this program is to achieve a modern and viable capability for fielding medical defense against CW agents to meet the Joint Service Requirements. The advanced development includes specific prophylactic/pretreatment, antidotal and therapeutic drugs as well as skin decontaminants and specialized medical materie . for diagnosis and management of both chemical and chemical/conventional casualties, which will provide the soldier maximum protection and survivability on the integrated battlefield. This project provides for hardening of conventional medical equipment in a chemical environment and determination of soldier performance decrements and limits. It supports advanced drug development efforts on formulation stability, final dosage studies, and limited safety studies and preclinical toxicity studies.

During FY 88:

Completed an oral toxicity study of pyridostigmine.

Determined the bioavailability and pharmacodynamics of a candidate pretreatment of cyanide.

Screened two candidate decontamination systems against percutaneously applied CW threat agents.

Used a streamlined process to develop an anticonvulsant antidote for nerve agents.

Tested prototypes of an advanced life detector to differentiate the living from the dead on the battlefield.

Tested prototypes of a vital signs monitor for use during casualty evacuation.

Conducted technical testing of several types of multichambered autoinjectors as possible replacement for the current autoinjectors (Mark I).

c. Full-Scale Development

(1) Decontamination Concepts and Materiel

**Improved Chemical/Biological Agent Decontaminant (ICBAD):**

The Improved Chemical/Biological Agent Decontaminant is a new decontaminant based on a decontaminating emulsion developed by the Federal Republic of Germany. Standard and developmental power driven decontaminating apparatuses will be used to mix ICBAD and apply it to vehicles, equipment, materials, and aircraft to reduce or eliminate hazards from chemical and biological agent contamination.

**During FY 88:**

Purchased test materials, packed them in ICBAD containers, and shipped them to various test sites for storage under environmental conditions to certify that the containers can protect the contents under the required climatic conditions for the storage time required.

Conducted emulsion preparation testing, transportation testing of containers, and chemical analysis of container contents after storage.

Initiated preparation of specifications and packaging information for components.

Efforts were suspended (except for the environment storage testing) until the Modular Decontamination System's continuous mixer module development is initiated in FY 90. This will provide an on-line decontaminant mixing and dispensing system which will decrease the time required to process equipment through the decontamination station.

**Decontamination Kit, Individual Equipment, M280: Pre-planned Product Improvement (P3I)**

The M280 Pre-planned Product Improvement (P3I) Program item will be used to decontaminate an individual soldier's equipment and consists of a container, less than 1 cubic foot in size and less than 40 pounds in weight, containing (20) foil-packed decontaminant impregnated towelettes similar to those used in the M258A1 Personal Decontaminating Kit, but larger. The M280 P3I program is designed to improve the M280 Decontamination Kit, Individual Equipment (DKIE). These improvements include redesign of packet II to remove glass and redesign of the squad container. The P3I will increase the operational capability of the system.

**During FY 88:**

Awarded two tasks, one to redesign packet II to eliminate glass and one to redesign the squad container holding the individual packets.

Fabricated prototypes of the redesigned two compartment packet II. Completed redesign of the squad container.

Terminated the P3I Program after initial tests indicated that there was no increase in the operational capability of the M280.

(2) Collective Protection Systems

**Modular Collective Protection Equipment (MCPE):**

The modular collective protection equipment consists of a family of end items: three different sized filter units, four protective entrances and a static frequency converter. The MCPE will provide nuclear, biological, and chemical protection by providing filtered air under positive pressure to vans, vehicles, and shelters to prevent the infiltration of toxic chemicals, biological agents, and radioactive particles. A collapsible protective entrance which is pressurized in the same manner provides entry/exit capabilities for these vans, vehicles, and shelters. Pressurization is provided by the filter units and is automatically maintained. Generally, the basic units are installed outside the protected area while the controls are located inside.

**During FY 88:**

Continued the development of the XM93 100 cfm filter unit, the motor controller and the protective entrances.

Completed development testing at five Test and Evaluation Command sites.

Initiated development testing at a sixth Test and Evaluation Command site.

Completed redesign and retest of hardware to correct identified failures.

Provided design application support to several combat, command, communication and control systems for integration and testing of MCPE.

**Simplified Collective Protection Equipment (SCPE): Pre-planned Product Improvement (P3I)**

The SCPE P3I program will expand the capability of the current system (Collective Protection Equipment: NBC, Simplified, M20) by incorporating improvements specified in the M20 Letter Requirement. Requirements to be satisfied are: a liquid resistant liner material; a medical airlock for litter patients; an increased entry/exit rate; an interface with existing environmental control units.

**During FY 88:**

Completed preliminary design and fabricated prototype hardware.

Conducted engineering field tests of prototype hardware.

Redesigned and retested to eliminate design problems.

Conducted a critical design review and initiated preparation of final technical data package.

**Chemical/Biological Hardened Rigid Wall Shelter (Nonexpandable):**

The Chemical/Biological Hardened Rigid Wall Shelter (Nonexpandable) will provide the capability to protect sophisticated communications and computer systems from electromagnetic interference and provide a shirt-sleeve environment for equipment operators during chemical/biological warfare utilizing modular collective protection equipment.

**During FY 88:**

Completed transportability and environmental testing.

Subjected the shelter to entry and exit tests using simulants.

Completed analysis of shelter materials and construction techniques.

**Chemical/Biological Hardened Expandable Rigid Wall Shelter:**

The Chemical/Biological Hardened Rigid Wall Shelter will provide chemical and biological protection for the one-side expandable and two-side expandable tactical shelters and the personnel and equipment operating inside the shelter.

**During FY 88:**

Initiated prototype fabrication of a two-sided expandable CB hardened shelter.

Completed in-house design changes of the prototype which included improvements in system weight, noise suppression, and an improved seal/gasket material.

Awarded two contracts, one for the preparation of Level 2 drawings and one for the preparation of technical manuals.

(3) Warning and Detection Equipment

Reconnaissance System, Nuclear-Biological-Chemical (NBCRS): XM87

The objective is to develop a system which integrates a variety of sensors/detectors and auxiliary subsystems into a host vehicle dedicated to conducting nuclear, biological, and chemical (NBC) reconnaissance. This system will collect and report NBC contamination faster and more accurately than is currently possible. The NBCRS will be composed of chemical and nuclear detectors, a navigation system, a central data processor, digital communication devices, a life support system which provides vehicle overpressure and heating and cooling for the crew members, a mechanized sampling and collection system, a marking system, and a meteorological system. The program will be conducted as a Nondevelopment Item (NDI), using contractor provided systems for an evaluation, and selection of a single NDI system for follow-on improvement and production.

**During FY 88:**

Revised the FY 87 approved Acquisition Strategy and received approval of the new FY 88 version.

Issued a competitive Request For Proposal.

**Remote Sensing Chemical Agent Alarm, (RSCAAL): XM21**

The objective of this project is to develop a first-time, automatic stand-off capability for Joint Service use to detect nerve and blister agent vapor clouds at distances up to five kilometers. The alarm will automatically scan a 60 degree horizontal arc and operate unattended. The XM21 will be used in three mission profiles, reconnaissance (mounted on the XM87 Nuclear, biological and Chemical Reconnaissance System (NBCRS), surveillance, and fixed sites.

**During FY 88:**

Completed update of the Joint Service Operational Requirement.

Completed update of Test and Evaluation Master Plan.

Completed fabrication of developmental prototypes and initiated Technical Test II.

**Chemical Agent Monitor (CAM)**

The objective of this project is to conduct an International Materiel Evaluation (IME) of the United Kingdom developed CAM to achieve early fielding (FY 89) of a contamination monitor. the CAM will detect, locate, and identify chemical agent vapor contamination emanating from equipment, personnel, and surfaces. The CAM detection principle is based on ion mobility spectrometry. Microprocessor techniques are used to detect, identify, and indicate the relative amount of contamination and reject interferences.

**During FY 88:**

Awarded an FY 86 funding appropriation CAM limited production contract.

Type classified the CAM as standard A.

(4) <u>Individual Protection Equipment</u>

**Coat and Trousers, Chemical Protective, Aircrew, Flame Resistant:** (formally Aircrew Uniform Integrated Battlefield (AUIB)

The AUIB ensemble is designed to provide chemical and flame protection in one uniform; thereby, reducing both weight and bulk over the current system and providing increased man-machine interface capabilities. In addition, the AUIB ensemble is being designed to interface with microclimate conditioning equipment as well as aviation life support equipment.

**During FY 88:**

Completed development and prepared for Type Classification Review Panel and next scheduled Clothing Advisory Group/Army Clothing and Equipment Board.

Changed the nomenclature to Coat and Trousers, Chemical Protective, Aircrew Flame Resistant in order to support the logistics of proper fitting the coat and trousers upon fielding.

**Suit, Contamination Avoidance and Liquid Protective (SCALP):**

The SCALP overgarment will be a lightweight, expendable, inexpensive suit which provides a barrier to water, liquid chemical agents, toxins, decontaminants and POL when worn over the chemical protective ensemble (CPE). The SCALP will prevent gross liquid agent contamination of CPE during short-term operations outside collectively protected systems.

**During FY 88:**

Identified material deficiencies during operational testing in cold regions.

Identified new materials and procured prototypes.

Established a technical data package.

**Aircrew Chemical (CB) Protective Mask, M43: Pre-planned Product Improvement (P3I)**

The M43 CB Protective Mask was developed on a greatly accelerated schedule in order to meet the fielding dates of the AH-64 aircraft. Certain technical requirements were considered to be to difficult to meet within the imposed shortened development schedule. The Acquisition Strategy called for a Pre-planned Product Improvement Program to address improved capabilities in nuclear survivability, chemical decontamination, corrective optics, and equipment integration. The Pre-planned Product Improvement Program is scheduled for a three year effort.

**During FY 88:**

Awarded a contract in support of the design, fabrication, evaluation, and development of a M43A1 pre-procurement package. The Critical Design Review was completed on 14 Sep 88 and Technical Testing is anticipated to start in Jan 89.

**Hands Drinking System (HDS):**

This program will develop a lightweight, expendable, pressurized hydration system to deliver liquids from the canteen to the soldier while wearing a protective mask with a drinking capability. The HDS will be compatible with existing standard issue items.

**During FY 88:**

Received an approved requirements document.

Conducted a market survey.

Initiated a Nondevelopmental Item procurement.

**(5) Medical Chemical Defense Life Support Materiel:**

The purpose of this program is to complete the technical data packages necessary for the fielding and logistical support requirements for medical equipment, supplies and drugs essential to counteracting the threat on the integrated battlefield. This effort will fund full-scale development of drugs and medical materiel through low-rate

initial production. Additionally, foreign medical material may be acquired for exploitation of advanced technology and development to meet medical chemical defense goals.

During FY 88:

Completed development of a new CW threat agent protective patient wrap, a decontaminable folding litter, and a chemical warfare protective covering for use with the field bandage.

Began full-scale development of a safe and effective skin decontaminating system for Joint Service use to replace the M258A1 Personal Decontamination Kit and M259A1 Training Aid.

Worked on a Pre-planned Product Improvement for the new gas mask optical correction system.

d. Testing

(1) Material Test in Support of Joint Operational Plans and/or Service Requirements:

No obligations were incurred.

(2) Army Material Suitability Tests

No obligations were incurred.

5. TRAINING SUPPORT

No obligations were incurred.

6. SUMMARY TEST SUPPORT

Efforts were directed toward planning, conducting, and reporting on joint tests and operational research studies performed to meet the requirement of the Commander-In-Chief of the Unified and Specified Commands. These tests and studies provide

useful data on chemical systems and chemical/biological defense materials for the user.

During FY 88:

**Simulant Review Selection:** Continued to develop nontoxic materials for use as agent simulants.

**Weathering Factors:** Continued a study of weathering factors under various climatic and operational conditions and evaluated the nature of surface types and their effects on relative persistence of chemical agents.

**Quick Response and Planning Digest:** Continued to provide quick responses in the form of literature searches and technical evaluations to inquiries from Department of Defense elements.

**Effect of High Water Pressure on Composite Materials:** Completed a study of the effects of water pressure on the composite materials of rotary wing aircraft.

**Threat Nations Defensive Equipment:** Completed an investigation of the effects of NBC defense equipment used by threat nations on individual and unit performance.

**Joint Chemical Biological (CB) Technical Data Source Book:** Continued the preparation of a series of volumes addressing the analysis of CB weapons and defense systems.

**Chemical Protection Afforded by Standard Uniforms:** Initiated a study to define the protection levels against threat agents provided by standard clothing items and protective ensembles.

**Evaluation of Nighttime Chemical Warfare (CW) Agent Detection:** Began a laboratory test to determine acceptable methods for using CW detection equipment at night.

**Effects of Extended Flight on Aircraft:** Began a study to determine levels of contamination expected after extended flights and any hazards associated with contamination.

**Ship Vulnerability to Chemical Attack:** Continued a study to evaluate naval ship vulnerability to chemical attack to validate a model.

**Aircraft Decontamination:** Initiated testing to identify decontaminants, procedures for dispensing, and determining the amount(s) of water needed to effectively decontaminate (both hasty and deliberate) aircraft and aerospace equipment under sortie surge conditions.

**Wetting and Drying Parameters, M1 Tank:** Completed a study to determine which experiments are necessary to determine the wetting and drying parameter mechanisms for agent behavior within enclosed vehicle compartments.

**Outside Continental United States to Continental United States (OCONUS to CONUS):** Initiated a study to determine the procedures required to ensure that personal belongings and human remains may be returned to CONUS after exposure to CW/BW agents.

**Mission Oriented Protective Posture (MOPP) Effects on Civilian Workforce:** Began an investigation on the effects of heat stress on people of advanced age while working and wearing full protective gear.

**NBC Defensive Equipment Transport:** Began an investigation on the capabilities of units and individuals to transport NBC defensive equipment.

**CW Risk Assessment Methodology for Special Operations Forces:** Initiated a project to provide special operations forces and other forces with a documented planning and operational tool to support operations in a chemical environment.

**Helicopter Operations - Toxic Environment, UH-60 Blackhawk:** Initiated testing to determine interior hazard resulting from exterior exposure to agent in various situations (i.e. hovering, flying, and stationery).

**Commercial Field Expedient Decontaminants:** Completed a study to identify field expedient materials and/or commercial materials available from the host country (wherever the battle is taking place).

**Characterization of a Chemical Battlefield:** Continued an evaluation of the chemical battlefield in terms of the expected contamination density and the duration of effects from threat munitions.

**Collective Protection:** Completed a comprehensive study of collective protection requirements, capabilities, and logistics support with special emphasis on the M51 Shelter.

**Agent Transfer of Armored Vehicles:** Completed a study on the factors influencing the transfer of agents from contaminated armored vehicles.

**Operational Effectiveness Matrix, Individual Protection:** Continued a study to predict battlefield situations in which troop performance is degraded more by wearing protective gear than by chemical agents.

**Effects of Rapid Temperature Change on the MC-1 Bomb:** Continued a study of the effects of extreme temperature changes experienced during flight and delivery and how they effect the toxicity and dispersal patterns of agents.

**Shipboard Contamination Flow:** Completed phase I of a study to determine the time-history agent concentration over the inner and outer surfaces of a Navy ship to obtain model validation and verification.

7. **[redacted] AND SUPPORT**

The objectives of this program are to provide maintenance support of laboratories; to conduct studies and analyses in support of research and development programs; and to support military construction of RDTE facilities.

**During FY 88:**

Purchased several large pieces of state-of-the-art laboratory equipment.

Awarded fourteen new Small Business Innovative Research type contracts.

Continued to purchase various computer network system upgrades.

**Systems Integration**

The objective of this program is to expedite/ensure the application of protection and decontamination hardware onto combat and combat/support systems. Development of

mission effective NBC systems architecture is a major thrust with associated actions toward incorporation of all aspects of NBC protection and survivability technology. Development of enhanced customer programs to address protection and decontamination needs of all Services, other government agencies, and allied nations is our goal.

During FY 88:

Established a Systems Integration Office.

Addressed NBC survivability/readiness concerns to 51 major combat/combat support weapon systems.

Established applications, system integration, and survivability programs with several major programs including: Joint Surveillance Target Attack Radar System, (JSTARS), Joint Tactical Information Distribution System (JTIDS), Enhanced Position Location Reporting System (EPLRS), and Corps Theater ADP Service Center II (CTASC-II).

Established a project manager funded production program for Modular Collection Protection Equipment application.

SECTION II

OBLIGATION REPORT ON BIOLOGICAL DEFENSE RESEARCH PROGRAM

FOR THE PERIOD 1 OCTOBER 1987 THROUGH 30 SEPTEMBER 1988

DEPARTMENT OF THE ARMY

RCS: DD-USDRE (A) 1065

## DESCRIPTION OF RDTE EFFORT FOR THE BIOLOGICAL DEFENSE RESEARCH PROGRAM

During FY 88, the Department of the Army obligated $61,651,000 for biological research investigations and the development and test of physical and medical defense systems.

### FUNDS OBLIGATED

| | | | |
|---|---|---|---|
| Current Fiscal Year | (CFY) | $ 56,910,000 | |
| Prior Year | (PY) | 4,741,000 | |
| | | | In-House $ 26,791,000 |
| TOTAL | | $ 61,651,000 | Contract $ 34,860,000 |

### Breakdown of Program Areas

1. BIOLOGICAL DEFENSE RESEARCH

| | | | |
|---|---|---|---|
| a. Basic Research in Life Sciences | CFY | $ 374,000 | |
| | PY | -0- | |
| | | | In-House $ 374,000 |
| | | 374,000 | Contract $ -0- |
| b. Medical Biological Defense | CFY | $ 8,454,000 | |
| | PY | 474,000 | |
| | | | In-House $ 4,271,000 |
| | | $ 8,928,000 | Contract $ 4,657,000 |
| c. Exploratory Development | CFY | $ 5,886,000 | |
| | PY | -0- | |
| | | | In-House $ 2,349,000 |
| | | $ 5,886,000 | Contract $ 3,537,000 |
| TOTAL: BIOLOGICAL DEFENSE RESEARCH | CFY | $ 14,714,000 | |
| | PY | $ 474,000 | |
| | | | In-House $ 6,994,000 |
| | | $15,188,000 | Contract $ 8,194,000 |

| | | | | |
|---|---|---|---|---|
| 2. | [redacted] | | | |
| | a. Exploratory Development | CFY | $ 15,502,000 | |
| | | PY | 339,000 | |
| | | | | In-House $ 7,980,000 |
| | | | $ 15,841,000 | Contract $ 7,861,000 |
| | b. Advanced Development | CFY | $ 17,251,000 | |
| | | PY | 2,477,000 | |
| | | | | In-House $ 6,684,000 |
| | | | $ 19,728,000 | Contract $13,044,000 |
| | c. Full-Scale Development | CFY | $ 5,950,000 | |
| | | PY | 1,236,000 | |
| | | | | In-House $ 1,425,000 |
| | | | $ 7,186,000 | Contract $ 5,751,000 |
| | d. Testing | | -0- | |
| TOTAL | [redacted] | CFY | $ 38,703,000 | |
| | | PY | $ 4,052,000 | |
| | | | | In-House $16,089,000 |
| | | | $ 42,755,000 | Contract $26,666,000 |
| 3. | [redacted] | CFY | $ -0- | |
| | | PY | -0- | |
| | | | -0- | In-House $ -0- |
| | | | | Contract -0- |
| 4. | [redacted] | CFY | $ 3,493,000 | |
| | | PY | 215,000 | |
| | | | | In-House $ 3,708,000 |
| | | | $ 3,708,000 | Contract -0- |

1. BIOLOGICAL DEFENSE RESEARCH

a. Basic Research in Life Sciences

The objective of this program is to support the Biological Defense Program and to maintain a technology base for non-medical aspects of biological defense. Effort is also directed toward the appraisal of new concepts for the rapid detection, identification, and decontamination of and protection from biological threat agents.

During FY 88:

Completed construction of a Fourier transform mass spectrometer for evaluating biological mass spectrometric detection methodologies.

Used an improved aerosol penetration device to demonstrate that the penetrability of protein (bacterial toxin surrogates) through battledress overgarment fabric is greatly influenced by moisture sorption.

b. Medical Biological Defense

Basic Research

The objectives of the basic research effort are to define the basic mechanisms of action and physiological effects of low molecular weight peptides and toxins; to determine the physiochemical nature of toxins of biological origin; to develop the technological base with which to medically counteract the threat posed by known or newly discovered agents of biological origin (toxins, bacteria, rickettsia or viruses); and to exploit existing and new technologies for the development of generic drugs, vaccines, or other therapeutic and prophylactic measures against these potential agents. This effort provides the basic scientific information necessary for the development of improved systems for the medical diagnosis, treatment, and prevention of biological agent casualties.

During FY 88:

Developed monoclonal antibodies to several snake phospholipase A2 (PLA2) neurotoxins and identified one that was extremely effective in neutralizing crotoxin.

Using rabbit antisera raised against fourteen PLA2 neurotoxins, made the novel observation that this family of toxins could be classified into three serogroups, which suggests the feasibility of developing class or subclass generic vaccines or therapies.

Tested various drugs for protective activity against presynaptic PLA2-type neurotoxins and identified five drugs with varying degrees of promising activities; the two most effective compounds were chloroquine and quinacrine.

Produced antibodies against several peptide fragments of botulinum toxin and found that they cross-reacted with native, intact toxin; however, they did not neutralize toxicity.

Developed and performed preclinical studies on synthetic peptide vaccine candidates that show promise in providing protection against the conotoxin group of acetylcholine receptor toxins.

Developed and used over two hundred monoclonal antibodies to Crimean-Congo hemorrhagic fever virus to identify antigenic sites on structural and non-structural viral proteins that are important for neutralization and protection.

Identified synthetic peptide analogs of the Rift Valley fever virus glycoproteins capable of inducing a protective immune response.

Demonstrated the feasibility of recombinant vaccinia virus vaccines using a variety of different Rift Valley fever virus gene inserts and multiple protection models.

Demonstrated that recombinant vaccinia viruses containing appropriate gene fragments coding the Rift Valley fever virus surface peptides showed promise as potential vaccine candidates.

Prepared genetically engineered recombinant vaccinia viruses expressing selected Hantaan virus genes which may show promise for protection against hemorrhagic fever with renal syndrome.

Investigated the feasibility of using vaccinia virus for expression of the protective antigen gene of anthrax as a potential human vaccine.

Demonstrated, using a rat pulmonary adsorption model, that both insulin and interleukin-1 were effective in producing their characteristic systemic responses when given in aerosol form.

Initiated chemical synthesis of antiviral compounds modified so that they have enhanced transport through the blood brain barrier, and synthesis of several prodrug derivatives of ribavirin was accomplished.

Developed methods that improve, by 100 fold, the efficiency of creating human cell hybridomas for the development of human monoclonal antibodies.

Demonstrated, for the first time, a botulinum toxin target site within neuronal cells, and successfully established an in vitro cultured cell system for determination of botulinum toxin activity.

Developed binding assays and antibody-based detection assays for brevetoxin, in support of efforts to understand the basic mechanisms of action of the blue-green algal toxins and to develop detection methodologies.

c. Exploratory Development

The objective of this program is to support development of non-medical defensive materiel against biological agent directed toward the appraisal of new concepts for the rapid detection, identification, decontamination and physical protection of/from biological threat agents.

During FY 88:

Completed a sensitivity analysis of the factors which influence the on-target effectiveness produced by potential threat biological agents.

Established screening techniques for biomaterials.

Conducted the 4th Receptor/Biosensor Conference which was co-sponsored with the Centre d'Etudes du Bouchet, France. Proceedings will be published as a technical report.

Established a deoxyribonucleic acid (DNA) library for subunits of acetylcholine receptor and the calcium ion channel.

Determined the extent of particle reaerosolization from garments during doffing operations for use in hazard assessment studies.

Completed a critical analysis of the implications of microencapsulation technology on biological defense operations.

Assessed the percutaneous hazard posed by agents of biological origin. Determined that current protective clothing provides adequate protection against currently available toxic biological substances.

Evaluated surrogates as simulants for aerosolized toxins and determined the controlling penetration factors of protective military materials.

2. [redacted]

a. Exploratory Development

The objectives of the exploratory development program are to develop safe and effective vaccines/toxoids against agents of biological origin that are potential threats; to develop novel anti-agent drugs by identifying potential targets for pharmacological intervention; to develop generic anti-agent drugs that have a broad spectrum of activity and are effective against entire classes of toxins or organisms; to investigate molecular and biological properties of agents and to identify characteristics useful for diagnosis, propbylaxis and therapy of associated diseases; to elucidate the pathogenesis of infections or intoxications induced with experimental aerosols to determine the sequence of events leading to protective immunity; to exploit biotechnological approaches to produce more effective and broad-spectrum vaccines; and to develop improved methods and technologies for rapid diagnosis and identification of biological agents.

During FY 88:

Defined, in a model system, the pharmacokinetic parameters of distribution and clearance for trichothecene toxins, microcystin, and brevetoxin.

Developed an in vitro model for use in screening potential drugs for efficacy against microcystin toxicity.

Developed analytical chromatographic procedures, using high pressure liquid chromatography and gas chromatography/mass spectroscopy, with detection limits on the order of 100 picograms to 1 nanogram for various low molecular weight toxins. Used these procedures to validate laboratory decontamination methodologies developed for this group of toxins.

Developed improved techniques for purification and characterization of dinoflagellate and blue-green algae toxins in order to support research efforts on development of detection methodologies and therapies for these families of toxins.

Demonstrated, in a model system, that passively acquired anti-cobrotoxin antibodies were protective against an aerosol challenge of toxin, and that synthetic peptide analogs of cobrotoxin were capable of inducing protective, toxin-neutralizing antibodies.

Developed immunological detection systems, employing rabbit and goat polyclonal sera, for cobrotoxin, ricin and conotoxin, and prepared synthetic peptides that showed potential for use as experimental immunogens in providing protection against the toxin ricin.

Determined that 3,4-diaminopyridine was only effective in treatment of type A botulinum toxin, and that it was ineffective in treating exposure to other serotypes of toxin, thus supporting the hypothesis that the various serotypes of botulinum toxin have different mechanisms of action.

Identified an intracellular site of action of tetanus toxin which affords new approaches in the development of specific therapeutic approaches for related potent neurotoxins such as botulinum toxin.

Found that the lipid-sugar coating derived from phase I Q fever rickettsia induced protective immunity against aerosol challenge.

Contrasted immunization with B. subtilis clones expressing the protective antigen component of anthrax toxin with the standard vaccine, and found that the levels of protection from challenge were comparable in the model system used.

Compared protection in animals provided by immunization with purified protective antigen of anthrax plus a commercial adjuvant versus the standard vaccine. Preliminary studies show equivalent survival after challenge with virulent organisms.

Demonstrated that passive immunity provided by monoclonal antibodies to the two glycoproteins of Rift Valley fever virus provide complete protection of mice against an aerosol challenge of virus.

Initiated studies of immunomodulator stimulation of macrophage antiviral activity against Semliki forest virus, Banzi virus, and Caraparu virus.

Demonstrated that combination chemotherapy of Caraparu virus with ribavirin and recombinant murine gamma interferon yielded significantly decreased animal mortality and increased the mean survival time.

Field tested a nucleic acid probe for Rift Valley fever virus during an outbreak of Rift Valley fever in Senegal, Africa. Comparison with antigen detection and virus isolation methods showed that the probe was comparably effective in identification of the virus in clinical specimens.

Developed a generic, enzyme-based immunodetection assay for diagnosis of Leptospira infections and clinically tested the assay in several countries where leptospirosis complicates identification of outbreaks of serious viral diseases.

Developed a model system using monoclonal antibodies for targeting antiviral drugs to virally infected cells in order to increase drug efficacy and to develop improved therapeutic approaches.

Demonstrated, for the first time in the laboratory, successful infection of Hyalomma truncatum ticks with Crimean-Congo hemorrhagic fever (CCHF) virus and demonstrated both vertical and horizontal transmission of virus.

Studied transmission of dengue-2 virus by Aedes aegypti mosquitoes and showed that concurrent ingestion of virus and microfilarie of Brugia malayi enhanced the transmission of dengue.

Validated the use of satellite data as a forecasting tool for outbreaks of Rift Valley fever in endemic areas by virtue of the high correlation between the satellite-derived green vegetation index and the ecological parameter of rainfall that is associated with Rift Valley fever activity.

Industrial Base for Biological Defensive Systems

b. Advanced Development (Nonsystems)

The objectives of this program are to perform requisite preclinical testing of drugs and vaccines necessary for their development into products safe for human use; to develop, test, and perfect methods for rapid detection and identification of biological agents that will subsequently be added to the rapid diagnostic systems; and to develop the laboratory methodologies necessary for pilot production of vaccines.

During FY 88:

Implemented an automated methodology for in vitro screening of potential antiviral compounds against 16 different viruses and found it to be more reproducible and accurate than the previously used manual methods.

Completed preclinical studies with the immunomodulators Ampligen (trade mark) and lysine-stabilized polyriboinosinic-polyribocytidylic acid (ICLC) and transitioned these two compounds for phase I and phase II clinical trials.

Initiated screening procedures for prospective new Lassa fever-immune serum donors at additional blood banks in Africa.

Developed an antigen-capture assay for Junin virus (Argentine hemorrhagic fever) and demonstrated it to be as sensitive as the virus isolation assay for confirmation of infection. In addition, this assay appears to detect positive sera over a greater time period of infection.

Developed and validated enzyme-linked immunosorbent assay (ELISA) tests for detection of immunoglobulin M antibody against Hantaan virus (Korean hemorrhagic fever) as well as the Junin virus.

Initiated efforts to expand the ELISA-based antigen capture assays to a broad spectrum of antigens and to implement newly developed, more sensitive reagents such as antigens prepared in genetically engineered systems and monoclonal antibodies.

Developed improved immunopathology procedures for mouse hepatitis, Hantaan, yellow fever, and dengue viruses. For the first time, Hantaan virus antigens were visualized successfully in cultured cells and in human tissue specimens using both polyclonal and monoclonal antibodies.

Produced anti-saxitoxin antibodies in rabbits, sheep and horses. Antibodies will be tested for prophylactic and therapeutic efficacy in model systems.

Established in vitro model systems of liver cells for use in microcystin toxicity testing and identification of potential therapeutic compounds.

Demonstrated the prophylactic and therapeutic efficacy of an anti-brevetoxin antibody during preclinical studies.

Evaluated the immune status of 219 individuals receiving Botulinum Pentavalent Toxoid by comparison of their neutralising titers to their antibody levels as determined by ELISA. The wide dispersion of values obtained using the ELISA test suggest that it is not adequate for use in predicting neutralizing antibody levels.

Demonstrated, during a preclinical study, that gamma-radiation killed coxiella burnetii (Q fever richettsiae) were as effective as formalin-inactivated organisms in immunising and protecting against lethal challenge.

Demonstrated, in a preclinical study, that the killed Rift Valley fever vaccine provided protection against both experimental aerosol and subcutaneous challenges only if intraperitoneal immunization with the killed vaccine had been done prior to the challenge.

Conducted preclinical cross-protection studies of Junin vaccine and found that the vaccine provides 100% protection against lethal challenge with Machupo virus (a related hemorrhagic fever virus).

Drug and Vaccine Development:

The objectives of this program are to develop feasible methodology for large-scale production of drugs and vaccines to be used in protection against biological agents; to prepare pilot quantities of specific vaccines for human safety and efficacy biological agent testing; to conduct phase I and II clinical trials of drugs and vaccines developed for protection/therapy; and to develop prototype rapid diagnostic systems to be used in identification of biological agents.

During FY 88:

Initiated efforts to prepare pilot lots of toxoids of botulinum toxins types F and G suitable for human use.

Completed a validation process required by the Food and Drug Administration for gamma-irradiation inactivation of the Q fever vaccine. Completed preclinical safety and efficacy testing of the vaccine.

Initiated preclinical efficacy studies of a live, recombinant vaccine for Venezuelan equine encephalomyelitis.

Expanded phase II clinical testing of Chikungunya vaccine in medical research volunteers.

Continued support of a production facility for experimental vaccines, monoclonal antibodies and other non-commercial research and diagnostic reagents that require specialized biocontainment facilities for their production.

Continued collection of immune plasma and evaluation of plasma and ribavirin therapies for treatment of Lassa fever, and determined that purification of immunoglobulin from plasma removes potentially contaminating viruses.

c. Full-Scale Development:

The objectives of this program are to standardize a production process for a specific vaccine or drug in order to produce sufficient quantities necessary to perform phase III clinical trials; to conduct phase III clinical trials of drugs/vaccines for

protection against biological agents and to standardize a production process for a specific system for rapid diagnosis of biological agents.

**During FY 88:**

Initiated a new preparation of Rift Valley fever vaccine.

Initiated field clinical trials of the Junin vaccine for Argentine hemorrhagic fever in endemic areas of Argentina.

Continued data analysis of field trials of the antiviral drug ribavirin used in treatment of hemorrhagic fever with renal syndrome (Korean Hemorrhagic fever) in studies conducted in two areas where the disease occurs naturally. Results indicate efficacy of the drug in preventing morbidity and mortality in cases of severe disease.

Initiated testing of new lots of the live, attenuated tularemia vaccine intended for use in protecting "at risk" laboratory workers and military personnel.

d. Testing

No obligations were incurred.

3. [redacted]

No obligations were incurred.

4. [redacted]

The objectives of this program are to provide maintenance support of laboratories; to conduct studies and analyses in support of research and development programs; and to support military construction of research, development, test and evaluation facilities.

**During FY 88:**

Provided professional and administrative support in production of the Department of Defense Draft Environmental Impact Statement on the Biological Defense Research Program.

Implemented enhancements in laboratory safety and security systems.

Provided necessary maintenance and improvements to biosafety level 3 and biosafety level 4 laboratories designed to ensure that they provide maximal possible protection for "at risk" personnel and the environment from hazardous agents of biological origin.

Continued major equipment purchases and upgrades to provide state-of-the-art laboratory equipment in support of Biological Defense Research Program.

ANNEX B

DEPARTMENT OF THE NAVY

ANNUAL REPORT ON

CHEMICAL WARFARE AND CHEMICAL/BIOLOGICAL DEFENSE RESEARCH PROGRAM OBLIGATIONS

FOR THE PERIOD OCTOBER 1, 1987 THROUGH SEPTEMBER 30, 1988

RCS: DD-USDRE(A) 1065

OBLIGATION REPORT OF RESEARCH, DEVELOPMENT,
TEST AND EVALUATION FUNDS FOR THE PERIOD
1 OCTOBER 1987 THROUGH 30 SEPTEMBER 1988
REPORTING SERVICE: DEPARTMENT OF THE NAVY
DATE OF REPORT: 30 SEPTEMBER 1988
RCS: DD-USDRE(A)1065

## DESCRIPTION OF RDT&E,N EFFORT FOR THE CHEMICAL WARFARE PROGRAM

During FY88, the Department of the Navy obligated $16,601,000.00 for general research investigations, development and test of chemical warfare agents, weapon systems, defensive equipment, and biological defense.

FUNDS OBLIGATED
($000)

| | | | | |
|---|---|---|---|---|
| Current Fiscal Year | (CFY) | $ 13,167 | | |
| Prior Year | (PY) | 3,434 | | |
| | | | In-House | $10,837 |
| TOTAL | | $ 16,601 | Contract | $ 5,764 |

Breakdown of Program Areas

1. CHEMICAL WARFARE PROGRAM

| | | | | |
|---|---|---|---|---|
| a. Defensive Equipment Program | CFY | $13,089 | | |
| | PY | (21) | | |
| | | | In-House | $8,282 |
| TOTAL | | $13,068 | Contract | $4,786 |
| (1) Chemical Research | CFY | $ 1,277 | | |
| | PY | | | |
| | | | In-House | $ 585 |
| TOTAL | | $ 1,277 | Contract | $ 692 |

| | | | | | |
|---|---|---|---|---|---|
| (2) | Exploratory Development | CFY | $ 3,304 | | |
| | | PY | 1 | | |
| | | | | In-House | $ 1,978 |
| | TOTAL | | $ 3,305 | Contract | $ 1,327 |
| (3) | Advanced Development | CFY | $ 2,559 | | |
| | | PY | (29) | | |
| | | | | In-House | $ 1,963 |
| | TOTAL | | $ 2,530 | Contract | $ 567 |
| (4) | Engineering Development | CFY | $ 5,949 | | |
| | | PY | 7 | | |
| | | | | In-House | $ 3,756 |
| | TOTAL | | $ 5,956 | Contract | $ 2,200 |
| b. | Offensive Equipment Program | CFY | $ -0- | | |
| | | PY | 3,455 | | |
| | | | | In-House | $ 2,555 |
| | TOTAL | | $ 3,455 | Contract | $ 900 |
| (1) | Chemical Research | CFY | $ -0- | | |
| | | PY | -0- | | |
| | | | | In-House | $ -0- |
| | TOTAL | | $ -0- | Contract | $ -0- |
| (2) | Exploratory Development | CFY | $ -0- | | |
| | | PY | -0- | | |
| | | | | In-House | $ -0- |
| | TOTAL | | $ -0- | Contract | $ -0- |
| (3) | Advanced Development | CFY | $ -0- | | |
| | | PY | $ -0- | | |
| | | | | In-House | $ -0- |
| | TOTAL | | $ -0- | Contract | $ -0- |
| (4) | Engineering Development | CFY | $ -0- | | |
| | | PY | 3,455 | | |
| | | | | In-House | $ 2,555 |
| | TOTAL | | $ 3,455 | Contract | $ 900 |

2. BIOLOGICAL RESEARCH PROGRAM

| | | | | |
|---|---|---|---|---|
| a. Defensive Equipment Program | CFY | $ 78 | | |
| | PY | -0- | | |
| | | | In-House | $ |
| TOTAL | | $ 78 | Contract | $ 78 |
| (1) Biological Research | CFY | $ 78 | | |
| | PY | -0- | | |
| | | | In-House | $ |
| TOTAL | | $ 78 | Contract | $ 78 |

3. ORDNANCE PROGRAM

| | | | | |
|---|---|---|---|---|
| | CFY | $ | | |
| | PY | | | |
| | | | In-House | $ |
| TOTAL | | $ | Contract | $ |

EXPLANATION OF OBLIGATIONS

Chemical Warfare Program
Defensive Equipment Program
Chemical Research

This program supported basic research into mechanisms of enhanced chemical decomposition of threat agent simulants and into the characterization of structured requirements for biochemical catalytic decomposition of chemical agents. Development of a collective protection system against chemical and biological agents, and new and different systems for scrubbing air streams were conducted. In addition to filtration and active filtration systems, it was necessary to explore the usefulness of systems in which incoming air is scrubbed by electrical discharge. Improvement of understanding chemical reactions in impregnated absorbents and of photolysis mechanisms in humid air is required in order to develop improved Nuclear, Biological, and Chemical (NBC) protective systems for Navy/Marine Corps in service. Study of gas-surface interactions and selective detection of biological molecules using digital time of flight mass spectrometry was conducted. Attempts to develop and optimize new ionization techniques in mass spectometry which may permit sensitive and selective analysis of saxi-toxins and blue-green algal toxins were made.

Exploratory Development

Funds supported development of filter materials to replace charcoals, sensor technologies that will allow for detection and identification of chemical agents in ship compartments and developments of non-corrosive, effective decontamination solutions for chemical and biological (CB) agents. Efforts were directed towards activated peroxides, ultraviolet radiation and hypochlorite generation from seawater. Funds also supported development of mark filter materials, chemical agents antidotes, such as varapamil and identification of enzymes to be used in filtration and decontamination systems for degradation of CB agents.

Funds supported an examination of the processes that govern behavior under chemical warfare and include an examination of problems in simulating chemical warfare conditions for training purposes, the effects of extreme stress performance conditions on task

behavior; and the development of training procedures to increase personnel performance under chemical warfare conditions.

Developed pharmacological methods for improving the prevention and treatment of chemical nerve agents poisoning of combat forces.

Examined the effects of chemical warfare antidote pretreatment drugs and therapeutic drugs while primate model is stressed by exercise.

Evaluated the performance effects of acute and chronic exposure to chemical agents and CB defense drugs.

Develops biomedical specifications for a new generation of Nuclear, Biological and Chemical (NBC) Defense Clothing that will be less performance impairing.

Advanced Development

Funds supported advanced development for defense of Navy and Marine Corps afloat and ashore against chemical and biological (CB) agents. This program includes defense of ships, aircraft ground crew protection, overseas shore bases, and interfaces among these. Developments are funded in areas of detection, collective protection, personnel protection, and decontamination.

Engineering Development

Funds supported mission accomplishment in a hostile Nuclear, Biological and Chemical (NBC) environment by developing equipment and procedures which provide effective NBC Defense. This program develops protective clothing that minimizes degradation of personnel performance due to heat stress. It is also developing citadel areas for collective protection designed for new ships or backfit in selected compartments plus citadel equipment for ashore facilities. Two basic types of detectors are being developed: long-range, early-warning; and point-detectors which locate and identify local/surface contamination. Decontamination processes, substances and equipment will be provided to remove contaminants or detoxify personnel and material. Combinations of the products from these four areas provide systems for NBC Defense.

Offensive Equipment Program

Engineering Development

Prior year funds were utilized in-house for design, development, effectiveness studies, and operational and environmental testing support for the BIGEYE Weapons System.

Biological Research Program

Defensive Equipment Program

Biological Research

Funds supported basic research investigating the immunological effects of the natural steroid dehydroepiandrosterone (DHEA) and its action as an antiviral.

ANNEX C

DEPARTMENT OF THE AIR FORCE

ANNUAL REPORT ON

CHEMICAL WARFARE AND CHEMICAL/BIOLOGICAL DEFENSE RESEARCH PROGRAM OBLIGATIONS

FOR THE PERIOD OCTOBER 1, 1987 THROUGH SEPTEMBER 30, 1988

RCS: DD-USDRE(A) 1065

EXPLANATION OF OBLIGATIONS

Chemical Warfare Program

Defensive Equipment Program

Basic Research

Basic research in chemical defense is performed by the Army for the Air Force.

Exploratory Development

This program provides the technical base on which to develop chemical protective equipment and procedures to allow Air Force mission accomplishment in a chemical warfare environment.

Advanced Development

A feasibility study showed that a backpack cooling device using freon 114 could be miniaturized. A field study was conducted with an integrated combat turn crew that showed multiman intermittent cooling did not interfere with flight operations and will be well accepted by flight-line personnel. There may be some gain in sorties generated as well. A front-end analysis study on the benefit of a detector network concluded that there could be significant increase in sorties generated and casualties reduced if that network contains both area and point detectors. A mask fit field study using rapid runway repair personnel concluded that initial mask fitting and training techniques need to be improved. A study was conducted to identify the effect of thermal burden on personnel wearing the chemical defense ensemble. Materials from flight-line equipment expected to be exposed to large doses were tested with chemical warfare agents. A specification for the development of a LIDAR chemical agent area detector was drafted. A microsensor was used to detect chemical warfare agent vapors. The microsensor is a candidate for a cockpit detector.

Engineering Development

The Aircrew/Eye Respiratory Protection (AERP) program will provide a chemical defense mask for all aircrew positions in the Air Force. During FY88 it was determined that two masks would be required: the Tactical Aircrew Eye/Respiratory System (TAERS) for all fighter/attack aircraft, and the Pilot Integrated Hood/Mask (PIHM) system for all others. The TAERS has completed all ground testing associated

with a safe-to-fly decision and nine flight tests in F-16 have been satisfactorily completed. The PIHM has started ground test activities and will make first flight in FY 89. The Transportable Collective Protection System (TCPS) completed all design reviews and entered Development Test and Evaluation (DT&E). Aircrew Ensemble development efforts are continuing. The Gentex ensemble (a woven Nomex-activated charcoal blend) failed chemical protection testing, and the Winfield ensemble (a multi-layer system of Nomex and a von Bluecher material) was too stiff. The last remaining candidate is made by Celanese and is continuing in DT&E. The USAF is monitoring the Army efforts to develop an avionics decontamination capability. FY 89 work is focused on the fabrication of a device for "Proof-of-Principal" testing and verification of a reprocurement package. Fixed Site Detection and Warning system (FSDWS) efforts focused on an operational demonstration of the Chemical Hazard Assessment System (CHAS) with available detectors. This demonstration was successful and preparation of contractual documentation is continuing. The performance of the Survivable Collective Protection System-Medical (SCPS-M) was evaluated as well as the internal medical operations in a five week Operational Test and Evaluation (OT&E) held at Ramstein AB in Jan-Feb 88. The SCPS-M passed the OT&E. Development test and Evaluation was completed in February, also. An acquisition Strategy Panel meeting was held on 24 May for PACAF production of SCPS-M. The Osan (Korea) Hospital Contamination Control Area (CCA) program completed development testing, and functional and physical configuration audits. The CCA equipment was installed in the Osan Hospital.

OBLIGATION REPORT OF RESEARCH, DEVELOPMENT,
TEST AND EVALUATION FUNDS FOR THE PERIOD
1 OCTOBER 1987 THROUGH 30 SEPTEMBER 1988
REPORTING SERVICE: DEPARTMENT OF THE AIR FORCE
DATE OF REPORT: 30 SEPTEMBER 1988
RCS: DD-DDR&E(A) 1065

## DESCRIPTION OF RDT&E, EFFORT FOR THE CHEMICAL WARFARE PROGRAM

During FY88, the Department of the Air Force Obligated $31,705,000 for general research investigations, development and test of chemical warfare defensive equipment.

FUNDS OBLIGATED
($000)

| | | | |
|---|---|---|---|
| Current Fiscal Year (CFY) | $ 25,290 | | |
| Prior Year (PY) | 6,415 | | |
| TOTAL | $ 31,705 | In-House | $ 2,990 |
| | | Contract | $ 28,715 |

Breakdown of Program Areas

1. CHEMICAL WARFARE PROGRAM

| | | | | |
|---|---|---|---|---|
| a. Defensive Equipment Program | CFY | $ 25,290 | In-House | $ 2,990 |
| | PY | 6,415 | Contract | $ 28,715 |
| Total | | $ 31,705 | | |
| (1) Basic Research | None. | | | |

| | | | | |
|---|---|---|---|---|
| (2) Exploratory Development | CFY | $ 4,444 | In-House | $ 897 |
| | PY | $ 166 | Contract | $ 3,713 |
| TOTAL | | $ 4,610 | | |
| (3) Advanced Development | CFY | $ 2,334 | In-House | $ 130 |
| | PY | $ 0 | Contract | $ 2,204 |
| TOTAL | | $ 2,334 | | |
| (4) Engineering Development | CFY | $ 18,512 | In-House | $ 1,963 |
| | PY | $ 6,249 | Contract | $ 22,798 |
| TOTAL | | $ 24,761 | | |

b. Offensive Equipment Program — None.

2. BIOLOGICAL DEFENSE RESEARCH PROGRAM — None.