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13. ABSTRACT ***(Maximum 200 Words)***

The SERDP efforts in FY92 emphasize assessing the state of the global atmosphere and ocean environments; the effectiveness of clean-up technologies for hazardous waste materials; the approaches to minimize, treat, and dispose of hazardous waste; methods for assessing hazards in existing and restored sites; and applications of demonstrated energy sources for use by the DoD facilities infrastructure.

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STRATEGIC INVESTMENT PLAN
FISCAL YEAR 1992

STRATEGIC ENVIRONMENTAL RESEARCH AND DEVELOPMENT PROGRAM

SERDP

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FOREWORD

The Strategic Environmental Research And Development Program (SERDP) is mandated in 10 U.S.C. §§2091-2904. SERDP addresses environmental matters of concern to the Department of Defense (DoD) and the Department of Energy (DOE). It is conducted as a tri-agency program with participation from the DoD, DOE and Environmental Protection Agency (EPA).

This report, on Phase II of the Strategic Environmental Research and Development Program, is submitted in compliance with Senate Report 102-395, accompanying H.R. 5620, Supplemental Appropriations, Transfers, and Rescissions Bill, 1992.

It includes project descriptions and funding and is divided into three subject areas; 1) Remote Sensing; 2) Installation Restoration and Waste Management; 3) and Energy. The individual research projects were reviewed and selected by the SERDP Council to fit an overall funding target of $24.6 million. The approved projects are submitted on behalf of the SERDP Council with membership of: the Assistant Secretary of Defense, Production and Logistics; the Director of Defense Research and Engineering; the Vice Chairman of the Joint Chiefs of Staff; the Assistant Secretary of the Air Force, Space; the Assistant Secretary of Energy for Defense Programs; the Assistant Secretary of Energy for Environmental Restoration and Waste Management; the Director of the DOE Office of Energy Research; and the Administrator of the EPA.

ACRONYMS

A	Army
AF	Air Force
ARPA	Advanced Research Projects Agency
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWA	Clean Water Act
DDR&E	Director, Defense Research and Engineering
DOE	Department of Energy
DoD	Department of Defense
DNA	Defense Nuclear Agency
DSPO	Defense Support Projects Office
EPA	Environmental Protection Agency
IR	Installation Restoration
N	Navy
R&D	Research and Development
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
SERDP	Strategic Environmental Research and Development Program
SITE	Superfund Innovative Technology Evaluation
TTAWG	Technology Thrust Area Working Group
USGCRP	U.S. Global Change Research Program

EXECUTIVE SUMMARY

The SERDP efforts in FY 92 emphasize assessing the state of the global atmospheric and ocean environments; the effectiveness of clean-up technologies for hazardous waste materials; the approaches to minimize, treat, and dispose of hazardous waste; methods for assessing hazards in existing and restored sites; and applications of demonstrated energy sources for use by the DoD facilities infrastructure..

Remote Sensing

Remote Sensing projects focus on characterizing the global environment, using advanced technologies for detection, analysis, and evaluation. Advanced surveillance methods are being applied to oceanographic and land characterization. Archival data (both classified and unclassified from national assets) and new data will contribute to environmental modeling and analysis. Several projects focus on the arctic region as it is a sensitive warning signal for global warming and climate change. Temperature data on permafrost and data on arctic ice draft will yield crucial knowledge about this very important region.

Regulatory compliance is also an important area addressed by SERDP. A project on the effects of acoustic devices on marine mammals will broaden our knowledge of the consequences of mans intervention in the sea, suggest new possibilities for the design and construction of acoustic devices, and provide a data base of information that can ease and speed the regulatory process that provides permits and authorization for use of sound in the ocean. Data from assessing atmospheric pollution from USAF operations will allow for better compliance of clean air requirements as well as leading to improved procedures to control the combustion process and thus to minimizing pollutant emissions.

Installation Restoration and Waste Management

Site cleanup and waste management will be addressed by demonstrating the most promising technologies, evaluating their effectiveness, and providing specific selection and design criteria to potential users. Reduction in costs and time for restoration are being sought as well. Pollution prevention efforts focus on waste reduction, materials substitution, and process modifications. For remaining waste problems, such as hazardous organic and inorganic chemicals, efforts are directed toward characterization methods for soil and groundwater, as well as means to restore them to environmentally acceptable levels. Compliance with the Clean Air Act, the Clean Water Act and other environmental regulations is an overall issue being addressed by many of the projects.

Energy

Demonstrations on alternative sources of energy and energy conservation means are directed at potential savings of $200 million a year in military installations. These include the use of photovoltaics, geothermal heat pumps, solar thermal dish/Stirling engine generation systems, and wind turbines.

Funding Summary $(000)

Remote Sensing	3,440
Installation Restoration and Waste Management	17,860
Energy	3,300
TOTAL	24,600

REMOTE SENSING

Technology Projects	Phase II	
	Page Number	FY 92 ($000)
Multispectral Research and Development for Environmental Analysis and Mapping	2	400
Deep Permafrost Borehole Sites in Alaska	4	450
Analysis of Submarine Acquired Ice Draft Data	6	250
ARMY TOTAL		**1,100**
Numerical Sensitivity Studies for the Design of an Ocean Observing System	8	200
Instrumentation Development-Drifting Buoys	10	700
Marine Mammal Studies	12	300
Regional Time Series Surveys	15	300
Analysis of Submarine Acquired Ice Draft Data	6	100
DoD Global Change Research Program	16	100
NAVY TOTAL		**1,700**
Remote Sensing and In-Situ and Laboratory Measures for Assessment of Atmospheric Pollution from USAF Operations	17	320
Atmospheric Radiance Algorithms for Global Remote Sensing	19	320
AIR FORCE TOTAL		**640**
TOTAL		**3,440**

PROJECT: MULTISPECTRAL RESEARCH AND DEVELOPMENT FOR ENVIRONMENTAL ANALYSIS AND MAPPING

OBJECTIVE: The objective of this program is to develop technology to support environmental analyses using airborne and spaced-based multispectral systems. The proposed program will 1) expand current MSI databases to include environmental parameters for specific environmentally critical areas such as the Chesapeake Bay, various coastal wetlands, etc; and (2) develop a system to analyze imagery for temporal environmental monitoring and spatial mapping. The system will be capable of processing satellite and aircraft multispectral imagery with significantly improved classification performance.

APPROACH: Software developed at the U.S. Army Topographic Engineering Center (USATEC) will be examined for use in analysis of environmentally sensitive habitats specifically land cover mapping (LCM) and change detection (CD) for environmental analysis. Capabilities for classification will be improved by implementing suitable spectral/spatial (S^2) classifiers. Rather than analyzing the military aspects of the terrain as is currently done, the software would be used to analyze environmental aspects. Environmental factors to be considered include various types of wetland ecotones, terrestrial and aquatic habitats and other areas to be defined over time. The resulting capability would have three goals: (1) database creation; (2) data analysis; (3) product generation. A multispectral database will be created drawing from existing database at USATEC and other Government organizations. The subsequent data analysis would be Geographic Information System (GIS) dependent and be designed to allow the most flexible analysis possible without compromising ease of use. The system will use enhanced semi-automated multispectral software (identified in a prior TEC effort) adapted for environmental analysis. A layered approach to LCM and CD will also be considered, whereby each scene element has multiple class levels accessible in a GIS-type environment that allows a user to conduct Boolean analyses about the environment. This effort includes: (1) developing remote sensing system analysis techniques for collecting the data, including modifying software to model MSI for use in the analysis; (2) demonstrating the capabilities of the system to support environmental impact assessments; (3) identifying multispectral imaging parameters which define spectral and spatial resolution requirements to support environmental change detection as well as sensor requirements to be used in the design of environmental data gathering satellites and aircraft.

BENEFITS: This program could assist counternarcotics efforts as well as global change research efforts being conducted by NASA under the Mission-to-Planet-Earth program. Current programs are not adequately resourced to support development of multispectral imagery (MSI) technology for environmental analyses incorporating spaced-based remote sensing systems. This effort could provide a centralized, MSI-derived environmental data base on a continuous basis, as well as software for environmental change detection. The enhanced multispectral exploitation software/hardware system will increase the classification and positioning accuracy of land cover mapping. Accuracy will play an increasingly important role in evaluating the success of various environmental statutes; e.g. the Chesapeake Bay Act, and the reauthorized Clean Air Act. Additionally, multispectral data will provide the basis

for optimizing the design of satellites and aircraft which collect spectral and spatial information needed to detect environmental hazards and change.

PARTNERS AND RELATED ACTIVITIES: U.S. Army Corps of Engineers, Environmental Protection Agency (EPA), and the U.S. Fish and Wildlife Service will be involved because of their interest in the enforcement of environmental policy. NASA and the U.S. Geological Survey (USGS) have developed the Land Analysis System (LAS) software for the SUN/UNIX and VAX/VMS environments that have supported USATEC's prior multispectral activities. TEC has recently complete a study of enhanced semi-automated multispectral techniques. Related activities include the evaluation of the Persian Gulf oil spill and wetlands loss in Northern Virginia.

MILESTONES:

FY93 Identify study area where MSI data could provide needed data for analysis. Review literature on previous work. Conduct feasibility study of spectral remote sensing of wetlands to assess cumulative impacts of dams and pollution.

FY94 Examine available image analysis hardware/software systems/workstations and procure best system. Begin filed spectral measurements of selected site to correlate remotely acquired signatures with *in situ* measurements measuring such parameters as seasonal wetland signatures.

FUNDING ($K): FY92 400

ACTIVITY: U.S. Army Topographic Engineering Center, (ATTN: CETEC-GL-T), Fort Belvoir, VA 22060-5546, 703-355-2802.

PROJECT: DEEP PERMAFROST BOREHOLE SITES IN ALASKA

OBJECTIVE: Establish 3 deep borehole field sites in Alaska as part of an international program to monitor the effects of global climate change in the circumpolar permafrost regions. The U.S. has no dedicated sites to systematically observe permafrost thaw/thermal degradation due to a feared general warming. After drilling of the 200m holes and installation of energy flux and temperature instrumentation, these permafrost sites will yield deep ground temperature data reflecting changes in the surface climate that have occurred over the last 100 years. These data can be used to interpret global climate model predictions and allow cryospheric temperature and energy flux models to be calibrated with field data. After the one-time initial cost of the field site installation, monitoring and analysis will be carried out by RDT&E funds in the USACRREL program.

APPROACH: Permafrost (20% of the world land area) contains in its present thermal regime a history of climate change from past centuries; this can be recovered by analyzing deep borehole temperatures. USACRREL, US Geological Survey, Geophysical Institute of Alaska, Geological Survey of Canada, Permafrost Institute (Russia), and Lanzhou Institute of Geocryology (China) have had discussions to combine resources for the development of a circumpolar network of monitoring sites. These countries contain most of the world's permafrost. Agreement was reached on the field sites and the overall circumpolar monitoring program necessary to give a clear picture of the relation of permafrost to global climate change. General Circulation Models do not adequately incorporate atmospheric/cryospheric energy fluxes for the huge permafrost regions. It is proposed to establish three field sites representing permafrost zones in Alaska, with additional sites in the other countries. Each site will require drilling and logging a 200m deep borehole, with minimal surface disturbance, instrumented for surface and ground temperatures, moisture and energy flows. Within the context of global change and the permafrost regions, the sites will be monitored for many years after site installation.

BENEFITS:

1) Establishment of U.S. portion of circumpolar network of permafrost monitoring sites.

2) International cooperation on quantitative interpretation of climate changes over past 100 years in permafrost zones, with simultaneous northern-hemisphere circumpolar measurements in several countries.

3) Early warning of permafrost thawing/thermal degradation which can jeopardize all systems now built on permafrost. These include strategic DoD facilities such as airfields, radar sites and structures of all kinds, as well as vital national interests exemplified by facilities such as the Trans-Alaska Pipeline.

MILESTONES:

		FY
Task 1.	Drill and instrument first Alaska site: Poker/Caribou Creeks	92
Task 2.	Establish second Alaska field site	92/93
Task 3.	Establish third Alaska field site	92/93
Task 4.	Coordinate international sites and instruments	92/93

FUNDING ($K): FY92 450

ACTIVITY: Dr. V. J. Lunardini, CECRL-EA, (603) 646-4326, U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, NH 03755-1290.

PROJECT: ANALYSIS OF SUBMARINE ACQUIRED ARCTIC ICE DRAFT DATA

OBJECTIVE: The objective is to screen and analyze 30 years of existing submarine sonar profiles of ice draft collected in the Arctic basin to establish a climatology of ice thickness distributions to assist in the study of global climate change.

APPROACH: Since 1958, submarines have been transiting the Arctic basin on military missions and collecting profiles of ice draft primarily for operational purposes. The vast majority of these profiles have never been analyzed in an organized fashion because they are considered sensitive to national security. Recently, much of the data from non-sensitive areas of the Arctic have been declassified. The sonar ice draft data are, without question, the only existing source of consistent historical ice thickness information. Analysis of this past information is essential to establishing an ice thickness climatology in the Arctic to begin a long term climate monitoring program. A baseline data set not available previously can provide a guide for future monitoring programs (airborne, submarine, and satellite). This effort will contribute to Defense needs and global climate change research goals.

Data from 40+ Arctic submarine missions will initially be screened to determine the unclassified portions of missions with data of sufficient quality to warrant analysis. Selected data will be analyzed to produce statistics suitable for the establishment of a climatological ice thickness data set. This program will be conducted jointly by the Army and the Navy.

BENEFITS: Current projections of global warming suggest a highly sensitive signal in the polar regions, probably best manifested in changes in sea ice cover. This program will benefit research in these climate mechanisms by establishing baseline measurements against which climatic signals may be detected and provide verification data for Arctic sea ice forecasting models. The resultant improvement in ice forecasting will enhance DoD warfare missions executed in polar regions. Finally, this funding will make effective use of valuable data set which is an unexploited national resource.

PARTNERS & RELATED ACTIVITIES: Partnership with the Army Cold Region Environmental Laboratory (CRREL) and the Naval Research Laboratory (NRL) will be established. Related research is sponsored by DoD, DOC, NASA, and NSF under the U.S. Global Change Research Program.

MILESTONES:

FY92 - Task 1
Army: Screen and process selected profiles, minimizing and quantifying possible errors.
Navy: Analyze data systematically and reduce data to ice thickness distributions

- Task 2
Army: Generate relevant statistics, mean thickness, probability density functions, and pressure ridge distributions.

FY93 - Task 3

Army: Establish regional and seasonal ice thickness data set compatible for future Navy-funded ice monitoring programs.

Navy: Generate climatic data base of submarine derived ice thickness for comparison to other data sets and model outputs.

FUNDING ($K): FY92 350 (250 - Army, 100 - Navy)

ACTIVITY: Army: Mr. S. F. Ackley, CECRL-RS, (603) 646-4258, U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, NH 03755-1290; Navy: Mr. K. Ferer, (601) 688-4760, Naval Research Laboratory, John C. Stennis Space Center, MS 39590.

PROJECT: NUMERICAL SENSITIVITY STUDIES FOR THE DESIGN OF AN OCEAN OBSERVING SYSTEM

OBJECTIVE: Develop a knowledge base needed for the design of ocean observing networks. Establish guidelines that can be employed on a regional basis to assure that ocean variability (time and space) is correctly represented in an optimal ocean monitoring system.

APPROACH: A substantial effort is being directed toward the development of ocean measurement capabilities. Data resulting from a multitude of measurement types, which include in-situ, drifting buoy and satellite sensors must be assimilated into predictive models of the ocean for nowcasting and forecasting. The best mix or combination of observations including their density and distribution must be established in order to develop efficient cost-effective networks.

This project will conduct sensitivity studies of ocean models to input data in terms of the accuracy and completeness of available data. We will generate simulated ocean data sets for use in the studies and conduct comparisons of results using error fields generated in these simulations then test the results against research quality data sets acquired through the field measurement programs such as SYNOP and REX. Guidelines and criteria will be established for the optimization of observations (i.e., What are the most effective sampling strategies? What are the prime considerations for an optimal observing network? And how should these observations be assimilated into models?).

BENEFITS: This effort will result in cost effective observing networks that are essential to monitoring ocean change. The models used to develop the information base for network design will also be available for the design of optimal observing systems. In addition, this research will provide a capability for large scale ocean simulations which are needed for Naval Warfare Systems design.

Our attempts to define or describe the ocean on the basis of available observations alone has produced limited realizations of ocean phenomenology and ocean variables. We will likely always be confined by, the cost of ocean observations, and it is, therefore, imperative that we employ available resources as efficiently as possible. A systematic assessment of the sensitivity of numerical models to input data and the methods employed in the assimilation of these data into the models is clearly needed. Various types of models, e.g., feature models and dynamic models, will be used in concert with improved numerical representations, such as, empirical orthogonal functions (EOFS) to enhance our ability to specify 3-D fields of these ocean variables.

PARTNERS AND RELATED ACTIVITIES: NRL and INO, working closely with the University of Washington have conducted numerical experiments for the assimilation of tomographic data into the DART model of the Gulf Stream. Efforts of this type would be continued to include other data types. A number of ONR funded PI's have been conducting specific studies relative to the sensitivity of models to data assimilation. These include the

use of Kalman filters at MIT, Oregon State University and UCLA. Harvard University has been testing the sensitivity of QG and PE models to IES data. The INO has recently completed a data assimilation study of tomographic and altimetric data into a model of the Gulf of Mexico. This project would focus on the coordination of these related studies toward a common objective that would eventually lead to the design of observing networks.

MILESTONES:

FY92 Select models for sensitivity studies.
FY92 Begin studies for simulated acoustic tomography data.
FY93 Conduct observing system simulations for Atlantic data (AMODE).
FY93 Compare design results with experimental tomographic data.

FUNDING ($K): FY92 200

ACTIVITY: Mr. Robert Peloquin, Office of Naval Research, (703) 696 6462.

PROJECT: INSTRUMENTATION DEVELOPMENT-DRIFTING BUOYS

OBJECTIVE: Develop and deploy arrays of drifting oceanographic buoys to enhance ocean circulation and coupled ocean/atmosphere models for monitoring, assessment, and prediction of environmental change. Better definition of the ocean/acoustic/ meteorological structure of the ocean and air-sea interface using drifting buoys equipped with a variety of sensors will provide meaningful insights into global climate change while enabling significant improvements in one to thirty day forecasts in the Northern hemisphere.

APPROACH: Additional sensors will be developed to expand existing data collection efforts using satellite-reporting drifting buoys. Funding sought under this program will be used to enhance ongoing developmental work in oceanographic buoys to measure such parameters as sub-surface temperature structure, ambient noise, surface wind and wave conditions, barometric pressure, optical parameters, and air temperature.

A network of buoys will be deployed in conjunction with existing Navy programs and civilian global change research programs such as WOCE (World Ocean Circulation Experiment). The goal is to obtain a global coverage at 5 degree resolution for a periods of five years. Instruments deployed with funding requested here will contribute to that array as well as a number of process oriented upper ocean studies. The buoys will be deployed from patrol aircraft (P-3) and ships. The aircraft will be outfitted with wind, temperature, and pressure recording and transmission systems which will transmit data via satellite consistent with procedures for World Meteorological Organization/World Weather Watch data collection from commercial aircraft.

Data will be collected by satellite and communicated immediately to the Fleet Numerical Oceanography Center (FLENUMOCEANCEN) at Monterey, CA and to the Naval Oceanographic Office (NAVOCEANO) at the Stennis Space Center, MS. It will also go to the WOCE buoy data center for application of precise navigation and sensor calibration. From there, buoy data, and oceanographic and meteorological products derived from them, will be distributed worldwide to other centers via the Global Telecommunications Network (GTS).

Data will be monitored and quality controlled and the final data set will be archived for transfer to the United States and international oceanographic research community.

BENEFITS: This program will significantly benefit both oceanographic and atmospheric science programs, not only by the DoD, but by the national and international science community. Observations over the ocean are sparse at best and far too infrequent to initialize oceanographic, acoustic, and atmospheric models for detection of submesoscale features.

The improvement in forecast skills by these models will have a profound impact on the Navy's ability to support the Fleet and Fleet Marine Force in naval warfare missions worldwide. Modern warfare in a changing political climate dictates that short and long term

forecasts of environmental effects on platforms, weapons, and systems be timely and accurate. Emergence of stealth aircraft technology and proliferation of modern diesel-electric submarines (which are inherently stealthy) in the third world underscore the need for accurate environmental forecasts. Understanding the mechanisms of mesoscale and sub-mesoscale features in the air/sea environment is key to such support. The benefit of this program to climate change research is no less significant. Modeling of energy transfer at the air-sea interface is key to executing coupled eddy-resolving models and basin-scale circulation models, both of which are being pursued by the civilian research community.

PARTNERS AND RELATED ACTIVITIES: The Navy's oceanographic buoy program is conducted in close cooperation with several interagency and intergovernmental programs under the sponsorship of NOAA, WMO, IOC, IGOSS, IODE, etc. Examples include WOCE and TOGA. Implicit in these efforts is the Navy's partnership with NOAA's National Ocean Service.

MILESTONES:

		FY
-	Integrate new sensors on oceanographic buoys	92
-	Deploy buoys via aircraft over Northern Hemisphere in Atlantic and Pacific	92-93
-	Investigate interaction of air-sea parameters for models	92-93

FUNDING ($K): FY92 700

ACTIVITY: U.S. Navy, Office of Naval Research, Dr. David Evans (703) 606-4112, Naval Research Laboratory, Mr Ken Ferer, (601) 688-4760.

PROJECT: MARINE MAMMAL STUDIES

OBJECTIVE: Develop an understanding and data-base on the effects of low-frequency sound on marine mammals.

BACKGROUND: The Heard Island Feasibility Test (FY90-92) examined the feasibility of using the travel time of acoustic signals over long ocean paths to estimate the average temperature of the ocean. The Test put 57 Hz sound in the water in the south Indian Ocean during 26-31 January 1991; 18 sites were listening including the east and west coasts of the U.S. using U.S. Navy hydrophone facilities. The central acoustic questions of the feasibility test were the transmission loss over global acoustic paths, and the fidelity of the received signal. There is also a critical marine-mammal question: can these kinds of sounds be made in a way that does not harm the marine mammals, and how can the regulatory process be satisfied? For a potential ten-year global program, as proposed by ARPA, technology is needed such as new sound sources that are reliable and affordable, and the knowledge of the effects of low-frequency sounds on marine mammals must be enhanced to allow signals and methodologies to be designed that will have acceptable impacts.

This SERDP proposal addresses the marine mammal issue, motivated by the Heard Island Feasibility Test; however, any use of underwater sound to explore the ocean and its contents must be examined in light of the increasing regulatory environment and an increasing awareness of possible effects of such sounds on marine mammals and endangered species.

APPROACH: This SERDP effort concentrates on marine-mammal responses to low-frequency acoustic signals.

A marine mammal research program is being developed at ONR in cooperation with the National Marine Fisheries Service and the Minerals Management Service; the program is under the review of a joint panel from the Ocean Studies Board and the Committee on Hearing and Bioacoustics of the National Academy of Sciences. This program will specifically address the response of marine mammals to low-frequency coded signals, of the kinds used for Heard Island. The frequency range being explored is 50-1500 Hz so as to cover the likely kinds of systems that will be used for ocean studies. The program consists of laboratory studies with captive animals, field studies on "animals of opportunity" using attached "smart tags" and tracking by active and passive acoustics, and species behavioral studies at representative candidate sites for follow-ons to the Heard Island Feasibility Test.

This effort is coupled to but distinct from the marine mammal monitoring program embedded within the ARPA program for a Heard Island follow-on. In that program, the marine mammals efforts will consist of surveys of animal number densities at the surface at the one or two sites being proposed for testing of new, deep, loud, low-frequency sound sources. In this program, the effort will look specifically at the response of the animals to the low-frequency sound, using tags attached to the animals and by watching the animals underwater using active and passive acoustic tracking. The work will not be restricted to the candidate

sites for a global, long-range extension to the Heard Island program. The ARPA effort is incidental to the Heard Island acoustics program and may or may not be required to have incidental-take authorizations. This effort is specifically marine-mammal research and will be conducted under marine-mammal research permits from the regulatory agencies.

BENEFITS: Global ocean warming is an early and important indicator of global change from greenhouse gases. Some direct effects of ocean warming are increased sea level, changes in ocean circulation patterns, effects on weather, ability to absorb carbon dioxide from the atmosphere, and modification of the growth environment for ocean animal and plant life. In addition, the flywheel effect on warming of the planetary system is potentially substantial due to the great heat capacity of the oceans.

The baseline data from an acoustic, global ocean-monitoring program will provide constraints on numerical models of global change and ocean warming. The emerging science of global acoustics will allow broad-ocean exploration and relates strongly to current Navy efforts. This program will involve the very best of the academic researchers working closely with personnel of the Navy labs and associated industries.

Marine mammal studies are lagging severely behind our need to know more about them. The effects of low-frequency sound study will address what is arguably the most important open question regarding marine mammals and the intervention of man in the ocean.

Other efforts using low-frequency sound in the ocean, such as tracking of deep autonomous drifting floats, will also benefit from the enhanced understanding of the effects of such sounds on marine mammals.

The primary benefits will be the knowledge base that will allow the design and construction of acoustic devices based on known levels of possible harm to the marine mammals (these levels are not currently known), and an information base that will ease and speed the regulatory process that provides permits and authorizations for the use of sound in the ocean.

PARTNERS & RELATED ACTIVITIES: The principal partners in the agencies are the NOAA National Marine Fisheries Service and the Department of the Interior's Minerals Management Service. There are lesser interactions with ARPA and their efforts toward a follow-on to the Heard Island Feasibility Test, NSF and DOE, and other Navy components.

MILESTONES:

Develop advanced whale tags that have the capability to operate in deep sound channels, to detect ensonification of the whales, and to determine some physiological response of the animals. FY92

Initiate laboratory studies of the effects of low-frequency sound on marine mammals. FY92

Test the new whale tags.	FY92
Begin field efforts with the new tags.	FY93
Begin coordination with the ARPA efforts on marine mammal surveys.	FY93

FUNDING ($K): FY92 300

ACTIVITY: Dr Melbourne Briscoe, Office of Naval Research, ONR Code 124, Arlington, VA; 703-696-5084.

PROJECT: REGIONAL TIME SERIES SURVEYS

OBJECTIVE: Provide coastal environmental boundary condition data and analysis with associated documentation/statistics necessary to support ocean environmental model testing and validation. Capitalize on DOI funded state-of-the-art technology employed to obtain the above data.

APPROACH: This program leverages a major DOI Mineral Management Service (MMS) program called Louisiana - Texas Shelf Circulation Study (LATEX), exploits capabilities uniquely developed by Navy (ONR), and is designed to understand fundamental coastal dynamics issues important to civil and military operations, e.g. Anti-Submarine Warfare and Environmental Quality, et al. LATEX is a long term field effort that can be leveraged over many years. This effort will utilize moorings, bottom mounted sensors, and drifter technologies to gain time series data and analysis on a spatial scale appropriate to mutual agency objectives.

BENEFITS: Significantly increase understanding and utility of new coastal environmental data bases and forecast models. These data would provide a new baseline time series coastal data base and provide initial conditions to support operational forecasting and environmental quality projections. This program would also serve as a test bed for DoD, MMS, EPA and NOAA model development and verification. Development of state of the art measurement systems will increase the U.S. personnel and technology infrastructure. Unclassified technology developed here would immediately be made available to the civil user community.

With this modest one-time investment, a long term data set and analyses fine-tuned to military and civil needs will be realized.

PARTNERS AND RELATED ACTIVITIES: This effort will be closely coordinated with DOI (MMS), EPA and NOAA to effectively leverage the total investment. Known technologies would be applied, but new methods under development by DOI, NOAA, and other agencies would be incorporated.

MILESTONES:

- Establish ties with the DOI LATEX managers; select academic, industrial, and federal laboratory performers. FY 92

- Develop and deploy instrumentation suites; commence field work. FY 92/93

FUNDING ($K): FY92 300

ACTIVITY: Dr. Richard Spinrad, (703) 696-4120, Office of Naval Research, Arlington, VA 22217-5000.

PROJECT: DoD GLOBAL CHANGE RESEARCH PROGRAM

OBJECTIVE: Support DoD participation in the U.S. Global Change Research Program (USGCRP).

APPROACH: In FY 1992, DoD joined ten other Federal Agencies sponsoring "Focused" global change research. The DoD Focused program concurrently satisfies DoD mission requirements and USGCRP goals. DoD does NOT engage in USGCRP Budget Options and no new money is involved. SERDP funding will pay the Defense share of distributed agency contributions to support the Committee on Earth and Environmental Sciences (CEES) Subcommittee on Global Change (SGCR) activities for FY 1992/1993.

BENEFITS: In 1990, OSD recognized that potential global change issues could impact DoD missions and directed active participation in Federal Committees addressing this problem. Additionally, limited 'Focused' research in global change was encouraged. Consequently, DoD was represented in the CEES Global Change Committee, identified a modest DoD research program, and effectively leveraged the ongoing billion dollar plus federal research effort. As an indirect issue, the USGCRP is perceived in academia as a major intellectual challenge and attracts the best and brightest U.S. science minds. Participation by DoD allows a new access to this unique resource. Finally, committee representation allows the Department to act positively rather than react to issues potentially adverse to national security interests.

PARTNERS AND RELATED ACTIVITIES: Representatives from the Army and Air Force routinely support the Chief of Naval Research in his role as the DoD representative to the CEES Subcommittee. An integrated DoD program is presented to the ten other Federal Agencies participating in the USGCRP.

MILESTONES:

Continue DoD representation to the CEES Subcommittee on Global Change Research	FY92/93
Provide the required distributed agency contribution to the CEES Subcommittee on Global Change Research	FY92/93

FUNDING ($K): FY 92 100

ACTIVITY: Commander Scott Sandgathe, Office of Naval Research - Code 11D, Arlington, VA 22271, (703) 696 4102.

PROJECT: REMOTE SENSING AND IN SITU AND LABORATORY MEASURES FOR ASSESSMENT OF ATMOSPHERIC POLLUTION FROM USAF OPERATIONS

OBJECTIVE: The goal of the research is to measure concentrations of pollutant species relevant to USAF operations, with emphasis on missile and aircraft engine emissions. In order to carry out this objective, laboratory, remote sensing, and in-situ programs are needed.

APPROACH: The approach combines a state-of-the-art mass spectrometry technique for measuring species concentrations and several established techniques in UV remote sensing. In the laboratory program, we shall measure rate constants for reactions important in the ion chemistry of the lower atmosphere, paying particular attention to reactions relevant to determining pollutant concentrations in the troposphere and stratosphere. We shall combine these measures with results from remote ultraviolet (UV) and in situ measurements to establish the chemical identities, abundances, and lifetimes of pollutant species. The species studied will be those relevant to such USAF operations as missile launches and flights of subsonic and supersonic vehicles in the atmosphere. The initial rate constant measurements will be made in an existing variable temperature selected ion flow drift tube. Use of this type of apparatus has provided most of the previous measurements of the chemical kinetics important in atmospheric ion chemistry. The chemistry in question, however, poses new challenges to laboratory measurements. It will be necessary to develop such techniques as a supersonic expansion ion source and improved sources of reactant neutral species at low temperature. For measurements at high temperatures, a new apparatus is just coming on line which will be able to reach temperatures higher than any previous device for studying ion chemistry. The laboratory kinetics measurement will then be combined with UV measurements and in situ ion composition measurements to derive the pollutant concentrations. Both currently used and developmental propellants can be examined, with particular attention given to chlorine species that are known to catalyze ozone destruction.

UV remote sensing techniques will be used in exploratory measurements of the emission and absorption from species in the plume and exhaust of missile engines. This work, which is an extension of our previous measurements of missile plume intensities, will concentrate on spectral as well as spatial characteristics of the pollutants released.

BENEFITS: Missiles and jet aircraft generate pollutant species in their flight through the troposphere and stratosphere. In order to assess the environmental impact of such species, it is necessary to know the concentrations and the lifetimes of the foreign species and the chemistry which they undergo in the atmosphere. The research will make it possible to form a coherent picture of the extent and type of pollution to be encountered in missile testing and launch. The same techniques can then be used to assess similar pollution from high performance aircraft operating at high velocity in the troposphere and stratosphere. The results of the measurements are expected to lead to improved procedures for monitoring and controlling the combustion processes and thus to minimizing pollutant emissions.

PARTNERS AND RELATED ACTIVITIES: Current organizations making in-situ ion concentration measurements are Georgia Institute of Technology and Max Planck Institute for Nuclear Physics, Heidelberg, FRG. Each of these groups has unique capabilities, and the choice of group to perform the initial phase of the study would depend on the environment to be studied. We have previously collaborated with these groups in order to combine our laboratory work with the field studies and to derive trace neutral concentrations. Several DoD facilities will be involved since the measurements will be made in conjunction with launches and flights made for other purposes.

MILESTONES:

JUN 92 Complete improvements on laboratory ion chemistry apparatus.

JUL 92 First rate measurements with new ion source and new gas inlets.

FEB 93 First in situ and remote measurements at Edwards AFB.

SEP 93 Final report and recommendations for future work.

FUNDING ($K): FY 92 320

ACTIVITY: PL/GP, Dr. A.A. Viggiano, DSN 478-4028, Hanscom AFB.

PROJECT: ATMOSPHERIC RADIANCE ALGORITHMS FOR GLOBAL REMOTE SENSING

BACKGROUND: The current unique PL/GP atmospheric transmittance-radiance codes (LOWTRAN, MODTRAN, FASCODE plus high-altitude codes like ARC/AARC and SHARC) have been designed to provide predictive capabilities for electro-optical design, target contrast, remote sensing and surveillance. The OSD/DoD Atmospheric Transmission Plan (signed in 1978 and 1982, reapproved as sufficient in 1988) assigns responsibility for developing and maintaining atmospheric radiance and transmittance algorithms for the tri-Services to the Air Force.

OBJECTIVE: Extend the GPO radiative transfer codes (MODTRAN, FASCODE, ARC, SHARC) to specifically address remote sensing issues occasioned by environmental changes; work will include:

1) Upgrade existing radiative transfer codes to incorporate both anthropogenic species and improved particulate descriptions.
2) Design practical generic inversion algorithms based on moderate to high spectral resolution including nonequilibrium (non-LTE effects).
3) Develop improved parameterizations of radiative and trace constituent effects to insure more effective response of AF codes.

APPROACH: With the release of FASCOD3 (March 1992), the GP family of codes have a demonstrated ability to include CFC (fluorocarbon) signatures. FASCOD3P, coupled with the CIRRIS-1A data, has demonstrated the importance of the CFCs in the 10-12 micron window. These new measurements clearly indicate that CFC signatures are now comparable in magnitude (all a factor of 10 over background) to HNO3, a prime radiance contaminant included in the codes since 1978. Such contamination is particularly important for paths near the tropopause, typical for lines-of-sight for Theater Missile Defense scenarios. Using GP codes as a foundation:

1) Add IR CFC cross-section signatures to MODTRAN.

2) Design generalized inversion algorithm for remote sensing and data analysis compatible with moderate spectral resolution data.

3) Provide current and projected concentration profiles for CFCs and other pollutant species.

4) Improve CO_2 spectroscopy at 15 and 4.3 microns to clarify role in temperature inversions

5) Investigate the effects of altered radiative fluxes brought about by changes in trace constituent profiles.

6) Determine implications of upper atmospheric non-LTE radiative effects on remote sensing

and retrieval algorithms. Specifically, determine the contribution of altered radiative fluxes to Greenhouse warming.

BENEFITS: All these efforts are recognized as important components for maintaining state-of-the-art atmospheric radiance modeling capability. They will augment the DoD electro-optical modeling requirements for all the Services, upgrading target contrast discrimination both spatially and spectrally, particularly in the middle and upper atmosphere where new theater opportunities have emerged. In addition, the improvements will provide DoD and other environmentally concerned associates (DOE, NOAA, NASA, etc.) with efficient tools for predictions, interpretation and validation of potential environmental change effects. By supporting both military sensor systems and global change, as well as the potential relationship between the two, the radiative transfer codes upgrade provides critically needed support called for under the DOE/NRL SERDP I proposal: "Joint DoD and DOE Atmospheric Remote Sensing and Assessment Program for Global Climate Change." These codes are already being used for simulation studies by both NRL and DOE. Finally, the upgraded codes will provide needed analysis tools for CIRRIS, MSX, and potential TMD measurement scenarios.

PARTNERS & RELATED ACTIVITIES: Because of their long history of cooperative involvement, the PL/GP radiance-transmittance codes are currently used by most atmospheric research arms of the military, government (USA and others), universities, and corporations. Commercial versions of the codes are also sold under the Technology Transfer Act. PL/GP has established a Cooperative Research and Development Agreement (CRDA) specifically for its radiance-transmittance codes which have provided rapid access to the civilian scientific community. In addition, patents have been pursued for two codes, one awarded and the other filed. Particular continued involvement is expected from the DOE ARM (Atmospheric Radiance Measurement) Program, and the Naval Research Lab. Additional Canadian DREV and University of Wisconsin involvement on inversion algorithm development, particularly as coordinated with lidar returns, is expected. Other important partners include the CIRRIS, MSX, and TMD teams.

MILESTONES:

FY92 Provide current and projected profiles of anthropogenic modulation of constituents (CFCs, CO_2, HNO_3, etc.) plus improved aerosol volcanic/high alt) profiles (all preliminary).

FY93 Include fluorocarbon (etc.) x-sections (IR), developing appropriate spectral band models, etc.

FY93 Design, test, and validate banc model inversion codes based on current high-resolution algorithms.

FY93 Improve CO_2 line shape spectroscopy at 4.3 and 15 microns.

FY93 Determine influence of non-LTE radiative effects on remote algorithms.

FUNDING ($K): FY 92 320

ACTIVITY: PL/GPOS, G.P. Anderson, DSN 478-2335. R. Picard, DSN 478-2222.

INSTALLATION RESTORATION AND WASTE MANAGEMENT

Technology Projects	Phase II	
	Page Number	FY 92 ($000)
Innovative Treatment of Contaminated Groundwater at McClellan Air Force Base (AFB), Davis, California	24	1,100
Environmentally Safe Disposal of Explosive Wastes	26	1,700
Rapid Screening Reversible Sensor for Environmental Screening and Monitoring	29	500
DOE TOTAL		**3,300**
Development, Evaluation and Application of Biomarkers for Munition Exposure Monitoring	32	180
Develop Mathematical Models for Subsurface Flow and Contaminate Transport	36	720
Elimination of DU in KE Penetrators	38	450
Elimination of Chlorinated Solvent Use in Red Phosphorus (RP) Munitions Manufacture	40	230
Alternate Processes for Liquid Propellant Manufacture	42	450
Cadmium Plating Alternatives	45	270
Environmentally Acceptable Metal Cleaning	46	230
Investigation of Aqueous Cleaning System to Replace CFC Vapor Degreaser	47	120
Replacement for Chlorinated Solvents in Rocket Motor Primers & Tackifiers	48	250
ARMY TOTAL		**2,900**

Congressional Interest Program

Technology Projects	Phase II	
	Page Number	FY 92 ($000)
Oil Spill Transport Prediction System	49	300
Naval Ship Systems Radiological Control Detection	51	500
Laboratory and Field Marine Bioindicator Systems	53	600
Shipboard Secondary and Tertiary Bilge Waste Treatment System	55	300
Navy Shipboard Hazardous Materials Reduction	57	300
Navy Non-Ozone Depleting Technology Clearinghouse	59	200
Ordnance Use/Disposal Risk Evaluation/Modeling	60	100
NAVY TOTAL		**2,300**
CFC, Hazardous and Toxic Materials Elimination	61	450
Aerospace Systems Guidance and Control CFC Elimination Program	62	500
Radio Frequency Thermal Heating of Soil to Remove Volatile Organic Compounds	64	860
Manufacturing Technology for Large Aircraft Robotic Paint Stripping (LARPS)	66	650
Chemical Tank Rejuvenation	67	250
Advanced Mixing Technology for Low NOx	69	350
Fiber Optic Monitoring System Development	71	300
AIR FORCE TOTAL		**3,360**
e-Scrub - The Application of DNA Pulsed Power to Electron Scrubbing of Flue Gas to Remove Unwanted By-Products (DNA) #	72	6,000
DNA TOTAL		**6,000**
DoD TOTAL		**8,560**
TOTAL		**17,860**

PROJECT: INNOVATIVE TREATMENT OF CONTAMINATED GROUNDWATER AT MCCLELLAN AIR FORCE BASE (AFB), DAVIS, CALIFORNIA

OBJECTIVES: A combination of two innovative technologies is proposed to demonstrate the remediation of contaminated groundwater at the McClellan AFB site. The proposed demonstration will combine the groundwater withdrawal technology of horizontal wells with the treatment technology of pulsed ultraviolet (UV) to remediate the contaminated groundwater.

APPROACH: The Davis site is a radio-tracking station located in Davis, California, approximately 12 miles from Sacramento. The groundwater beneath the facility consists of multiple saturated layers, the first three of which are contaminated with low levels (50 to 500 ppb) of trichloroethane and tetrachloroethane. The contaminated units exhibit bidirectional groundwater flow based on local irrigation uses. This seasonal shift of flow direction impedes the migration of contamination from the site. These features underscore the suitability of the Davis site for this integrated technology demonstration.

The demonstration is planned to proceed in two steps to minimize cost and to optimize effectiveness. The first step will be a test of the treatment method using an existing reactor at the Davis site. The data from this test will provide implementation and design data for the full-scale treatment and withdrawal system. The second step will be installation of the horizontal well and the full-scale treatment of the contaminated groundwater. The Department of Energy (DOE) Office of Technology Development (OTD), will assist McClellan AFB with Strategic Environmental Research and Development Program (SERDP) funding to transfer the horizontal well technology from the DOE Savannah River Site to McClellan and cooperate in conducting the overall project.

BENEFITS: The withdrawal technology proposed for this demonstration is the use of horizontal withdrawal wells to remove contaminated groundwater from beneath the facility. The use of horizontal wells is favorable for the Davis site, given the plume geometry. Their use will also act as a technology transfer to the Air Force.

The pulsed UV treatment uses deep band UV light to effectively destroy chlorinated solvents and the daughter products of those solvents by destroying the chlorine bonds. This technology has shown substantial success in laboratory tests where pulsed UV treatment has achieved order-of-magnitude reductions of contaminants in groundwater in both batch and flow-through tests. Another version of this technology has been field tested at the Lawrence Livermore National Laboratory on a broad range of organic contaminants in high concentrations. This demonstration will focus on low concentrations of solvents in groundwater using a more cost-effective, pulsed UV method.

PARTNERS AND RELATED ACTIVITIES: The DOE-OTD will cooperate with the Air Force in conducting the remediation demonstration. The horizontal well technology developed by DOE has been licensed to several private firms, and it is expected that the

drilling will be accomplished with private industry involvement.

The information from this demonstration is to be used in support of future Department of Energy and Department of Defense remediation efforts.

MILESTONES:

FY92	Pilot treatment demonstration completed.
FY93	Design and initiate procurement of horizontal well/pulsed UV treatment system.
FY93	Complete field demonstration.
FY94	Complete project report on demonstration and transfer system to full scale remediation.

FUNDING ($K): FY 92 1,100

ACTIVITY: Mr. Jerry Hyde, EM-551, Trevion II, U.S. Department of Energy, 1000 Independence Avenue, S.W., Washington, D.C. 20585-0002, Telephone: FTS 233-7914, Commercial: (301) 903-7914, Telefax: FTS 233-7234, Commercial: (301) 903-7914.

Mr. J. Steele, Savannah River Laboratory, ISRL 773A, A208, Aiken, South Carolina, 29802, Telephone: FTS 239-1830, Telefax: FTS 239-1660. Mr. Paul Carpenter, U.S. Air Force, Engineering and Services Center, Environics Division (AFCESA/RAVW), Tyndall AFB, Florida 32403, Telephone: DSN 523-6022, Commercial: (904) 283-6022, Telefax: DSN 523-6499, Commercial: (904) 283-6499.

PROJECT: ENVIRONMENTALLY SAFE DISPOSAL OF EXPLOSIVE WASTES

OBJECTIVE: The purpose of this program is to develop and qualify environmentally safe processes for disposal of explosive wastes in the DOE Nuclear Weapons Complex (NWC). Arms control treaties and stockpile improvements are increasing explosive waste disposal requirements in the NWC and governmental regulations are precluding present means of disposal. In the program proposed here, candidate technologies for disposal of explosives will be investigated and recommendations will be made for promoting technologies by pilot plant operation.

APPROACH: This program is the first phase in the ultimate goal of developing a zero-waste system for high-explosives.

The Pantex plant operations will be seriously impacted by a lack of environmentally acceptable processes for the disposal of high explosives (HE) and related wastes from process streams. In the past, the U.S. has used open-pit burning for dry HE treatment and "ponding" for HE contaminated waste streams. Open-pit burning of HE, however, is being banned in several states and this ban may eventually extend to Texas, where Pantex is located. Also, states have begun to ban "ponding." The DOE has no alternative process for minimizing or destroying their HE waste in an environmentally acceptable manner.

Three distinct HE waste streams are generated at the Pantex Plant:

- large solid pieces generated from reject parts, mechanical property specimens, and stockpile-life test parts;
- contaminated rags, clothing, test equipment, etc.; and
- liquid waste from machining fluids, vacuum pump oil, formulation solvents, cleaning fluids, etc.

The DOE has two very important HE concerns that must be addressed immediately. An environmentally safe process for recycling HE from site returns and a total recycling capability for insensitive high explosives and for disposal of non-recyclable HE. The former task is near term, but the technology is being developed for the long term use as well. Most of the site returns for the next several years contain conventional plastic-bonded high-explosives (CPBX). The CPBX's have never been recycled in the U.S. Recycled CPBX, however, may have use in the DoD and possibly industry.

A single process probably will not be adequate for HE site return treatment. It probably will take a combination of three to five different technologies. Several must be investigated because none is mature. Some of these include:

- recycling the CPBX;

- nonconventional machining to remove the CPBX from the pit--either water jet, oil jet, supercritical carbon dioxide, or solvent extraction;

- either closed loop incineration, plasma arc, or microwave treatment to destroy bulk explosives;

- treatment of slurries to destroy HE--supercritical water oxidation, subcritical media destruction, ultraviolet-light hydrogen-peroxide oxidation, pyrolysis, or molten salt oxidation;

- off-gas treatment using pyrolysis or pulsed plasma processing; and

- waste-water purification via filtration through activated charcoal, wier clarification, in combination with biodegradation.

Experts in each technology will evaluate emerging technologies. A peer-select panel will select the most promising technologies. Laboratory experiments in the selected technologies will be performed to validate parameters and establish requirements for the design and construction of pilot/demonstration process systems.

BENEFITS: The main benefit of this program is to provide alternative technologies for environmentally qualified and safe processes for disposal of high explosives waste in the DOE Nuclear Weapon Complex instead of open-pit outdoor burning. All of the technologies that DOE develops for its HE, either main charge or components containing internal HE, will be of use to DoD.

PARTNERS AND RELATED ACTIVITIES: In view of the mutual interest of the DoD and the DOE in the disposal of HE, we propose an equal cost sharing for this proposal. DOE proposes to use $1.8 million of DSRP funding for this activity, with the remaining $1.7 million funding from DoD.

MILESTONES:

FY92	Report recommending state-of-the-art HE disposal and recycling technologies for further development and establishing parameters to be validated.
FY93	Complete the laboratory experimental investigation of the selected technologies for follow-on demonstrations directed toward production.

FUNDING ($K): FY 1992 1,700

ACTIVITY: Howard R. Canter, Deputy Assistant Secretary for Complex Reconfiguration, U.S. Department of Energy, Washington, DC, FAX FTS 896-2180.

Jack Swearengen, Supervisor, Technology Application, Sandia National Laboratories, Livermore, CA 94550, FTS 234-3022.

James R. Humphrey, High Explosive Chemist, Lawrence Livermore National Laboratory P.O. Box 808, Livermore, CA 94550, Telephone: FTS 543-1844, FAX FTS 543-2164.

PROJECT: RAPID SCREENING REVERSIBLE SENSOR FOR ENVIRONMENTAL SCREENING AND MONITORING

OBJECTIVE: To develop a reversible volatile organic compound (VOC) sensor for environmental screening and monitoring. The VOC sensor outlined in this proposal would have several distinct technical advantages over existing technologies. Performance specifications include the following:

- Water and heat stable chemical sensor. Extends sensing potential to include hazardous environments. Extends sensing potential to include water sampling as well as vapor.

- Chemical sensor amenable to both remote and direct sampling configurations. Fiber optic configurations permit detection over great distances.

- Broad range of VOC's detectable. The sensing element is amenable to selective membrane configurations to impart selectivity capabilities if necessary.

- Potential for very low detection limits. Estimates of low part per million to upper part per billion detection capabilities expected for most VOC's.

- Simple sensor designs. Low cost devices. Estimates for various device configurations range from $500 per unit to as low as $30 per unit. Since the devices would be reusable in the field, the long term cost savings would be significant.

- Sensor would provide both instantaneous field detection data and a reusable field device.

Specific DOE sites targeted for immediate sensor applications to include the following:

- Waste Isolation Pilot Plant - drum screening and monitoring.

- Vapor Vacuum Extraction Sites - site monitoring at INEL's RWMC facility and at the Savanna River site.

- RWMC (INEL) - drum storage, soil, and groundwater monitoring.

- Test Reactor Area) (INEL) - trichloroethylene groundwater monitoring.

APPROACH: It is proposed to combine 3M Corporation's patented vapochromic double complex salt reagents with fiber optic technologies in the rapid development of a low cost, reusable field sensor. The sensor will be configured to detect a broad range of VOC's, however, it will be calibrated for usage in field applications for the detection of selected

analytes, e.g., carbon tetrachloride or trichloroethylene. Sensor development will be divided into five parts:

- synthesize several proprietary 3M vapochromic sensing elements.
- full matrix laboratory evaluation of sensing elements.
- sensor engineering design and construction of sensor prototype.
- full matrix lab testing of prototype for a pre-determined analyte need.
- field testing of prototype.

The criteria for success will be the successful demonstration of sensor detection capabilities at one of the Arid Soils VOC's-Integrated Demonstration sites.

Preliminary laboratory work has demonstrated a high probability for success in the development of a sensitive and reversible VOC sensor for environmental screening and monitoring. The sensor will be stable to water and heat, provide instantaneous detection, and most importantly will be reusable in the field. It is of simple design but will provide rapid screening capabilities for pre-identified contaminants. The sensor will be configured to detect a broad range of VOC's, however, it will be calibrated for usage in field applications for the detection of carbon tetrachloride, trichloroethylene, or other selected analytes. Proprietary colorimetric inorganic reagents recently developed by 3M Corporation will be utilized in the development of the sensor. Successful engineering of 3M's vapochromic reagents with fiber optic technologies in the development of a first generation sensor prototype design has been demonstrated at the INEL. From this work, high probability is given for the rapid development of a low cost, reusable field sensor directly applicable to environmental characterization and monitoring.

BENEFITS: Successful development of this sensor technology would provide significant added capabilities to the area of remotely operated sensors capable of continuous and accurate monitoring of VOC's. Moreover, availability of sensitive, easy-to-operate field devices would enable real time analyses and reduce costs associated with collection and transport of samples to analytical laboratories.

PARTNERS AND RELATED ACTIVITIES: Successful development of this sensor technology would be enhanced through a collaboration with 3M Corporation. Future and immediate plans for this technology development include collaboration with 3M Corporation. Significant manpower and materials commitment has already been verbally communicated to the INEL by 3M management concerning a joint venture in sensor development.

As expected from disclosure in 3M Corporation's patent US4,826,774, rapid and reversible detection of numerous VOC's has been demonstrated using the INEL sensor device. Examples of VOC's readily detected through vapor sampling include: carbon tetrachloride,

trichloroethylene, trichloroethanes, chloroform, methylene chloride, toluene, octanes, cyclohexane, ethanol, and acetone. This list is by no means comprehensive but exemplifies the potential to readily detect VOC vapors of a wide range of chemical compound classes.

MILESTONES:

FY92	Synthesis of vapochromic sensor material patented by 3M Corporation.
FY92	Laboratory evaluation of vapochromic sensor material.
FY92	Sensor engineering design and configuration.
FY92	Laboratory testing of sensor device.
FY93	Field testing and evaluation of sensor device.
FY93-94	Vapochromic sensor material development, alternative sensor designs and configurations, field testing.

FUNDING ($K): FY92 500

ACTIVITY: Dr. W. K. Reagen, INEL, (208) 526-7793.
G. D. Lancaster, INEL (208) 526-1903, Fax (INEL): (208) 526-1390.

PROJECT: DEVELOPMENT, EVALUATION AND APPLICATION OF BIOMARKERS FOR MUNITION EXPOSURE MONITORING

OBJECTIVES: More than thirty nitroaromatic compounds are produced as by-products during the manufacture of 2,4,6-trinitrotoluene (TNT). In addition to TNT itself, manufacturing wastes consist of a diverse mixture of nitrated toluene and benzene isomers, together with products of their reduction and photolysis. Contamination of aquatic and terrestrial environments by TNT and its congeners is known to occur in conjunction with plant discharges, spills, and the open burning of production wastes. Many, and perhaps most, of the major waste stream components have been shown to be toxic and/or mutagenic in a variety of test systems. As a producer and user of TNT, it is mandated that the U.S. Army assume responsibility for protecting human health and the environment from undue risks associated with TNT manufacturing practices and environmental contamination which has resulted from them. Research addressing improved and more sensitive methods and models for munitions related biological exposure and effects is necessary both for environmental monitoring purposes and the interpretation of biological response data. Toward that end, it is the objective of this research to establish a cost effective and workable experimental biological system which responds to the presence of TNT and associated munitions and to utilize this system for the development of exposure probes and to evaluate the applicability of those probes to munitions bioeffects monitoring.

BACKGROUND: Establishment of a Multipurpose Eukaryotic System for Probe Evaluation and the Study of Munitions — The use of animals as experimental and developmental systems for the study of xenobiotics is costly in terms of manpower, materials, and facilities. Likewise, the use of primary eukaryotic cells in culture requires animals or a source of their tissues and is labor intensive by virtue of the finite life span of such cells and the need for their repeated preparation. Continuous eukaryotic cell lines would appear to provide a workable solution to the problem, although most of them are either incapable of or possess a limited capacity for metabolic activation of chemicals. However, inducible phase I enzyme activity like that associated with cytochrome P-450 has been demonstrated in a few continuous cell lines following their immortalization, and both phase I and phase II conjugating enzymes have been demonstrated in several others. On such line, continuous rat hepatoma H4IIE cells, applied to munition bioeffects could provide the Army a cost effective system in developing biomarkers for its pollutants.

APPROACH: H4IIE cells are available commercially from the American Type Culture Collection, and testing of the stock has indicated that it possesses AHH activity after induction. Following the procurement of this cell line, it will be maintained and propagated at 37°C in a humidified 5% carbon dioxide atmosphere by means of standard tissue culture techniques. Growth medium is that recommended by the supplier or Q-minimal essential medium without ribonucleosides and deoxyribonucleosides but with L-glutamine and supplemented with 10% each of fetal calf and calf serum and antibiotics. As an initial step in the work, it is proposed that the cytotoxicity of TNT, all major associated nitroaromatics, and the principal compounds (amines) that can be formed from them in the environment be determined in the cell system. A recent advance in cytotoxicity testing, neutral red uptake

assays, provides a convenient means of miniaturizing and automating such analyses. The responsiveness and efficacy of the system for chemicals alone or in mixtures can be determined rapidly and inexpensively. Additionally, such studies can be conducted with and without pre-induction of the H4IIE cytochrome P-450 by potent planar hydrocarbon inducers at non-toxic levels to assess the effects of metabolic activation on munitions cytotoxicity. In itself, cytotoxicity can be considered as a biomarker, and a cell culture system that is responsive to the various TNT munitions or products of environmental reduction would be applicable to chemically contaminated soil/water samples in a context of clean-up and monitoring activities. Such a system would likely provide a less expensive alternative to current screening systems.

BACKGROUND: Probes for Biomonitoring — The development of molecular and biochemical probes for pollution biomonitoring is currently an active area of investigation. It is thought that such probes will be economical to apply, potentially applicable to biological specimens regardless of species of origin, and may signal changes in biological systems prior to observable macrobiotic effects. Thus studies are in progress to establish probes for susceptibility based on markers of responsiveness such as genetically determined target receptors and metabolic deficiencies, exposure based on the accumulation of chemicals and their bioreactive intermediates in biological fluids and macromolecules, and effects based on the induction of xenobiotic metabolizing systems and cellular damage and repair processes. As a long term goal in a context of xenobiotic insult, ideal probes would encompass all three areas: susceptibility, exposure, and effects.

For the most part, less complex systems such as induced xenobiotic metabolizing enzymes and adducted chemicals in macromolecules are being examined as exposure monitors; although they are not ideal in that they may not detect direct biological damage (genetic or otherwise), they can be inferred to do so in the light of the potential of chemicals formed or bound to cause adverse effects. Within such limits, interest exists today in the P-450 monooxygenase enzymes and antioxidant defense enzymes as inducible signal systems for xenobiotic chemical insult. The former systems have been the subject of considerable interest and much experimental effort; the latter have received far less attention but, by the nature of nitroaromatic metabolism itself, could be even more appropriate for munitions pollutants. Conversely, a more complex and advanced approach based on genetic damage due to chemical insult has been recently proposed. In this approach, changes in selected genetic regions as markers of exposure are measured following their amplification in the laboratory by molecular methods. This approach has the advantage of measuring direct damage due to chemical exposure and may be applicable to sentinel species.

APPROACH: Cytochrome P-450 Probes—Cytochrome P-450 activity has been associated with the metabolism of nitroaromatic compounds and aromatic amines, as well as with the reduction of nitro groups. However, induction of the system(s) by nitroaromatics is both less clear and less well studied. Following their exposure to selected TNT associated nitroaromatic munitions, H4IIE cells will be screened for the induction of P-450 IAl enzyme activities (aryl hydrocarbon hydroxylase and ethoxyresorufin hydroxylase). Should induction occur with these compounds, non-radioactive labeled molecular probes based on P-450 gene

sequences will be developed and applied to the cell mRNA populations. Enzymatic activities versus molecular probes will be compared for their utility in biomonitoring. Should cytochrome P-450 probes appear to be appropriate for munitions based on *in vitro* studies, they could then be applied to exposed rats or rat sentinels at contaminated sites for validation.

BACKGROUND: Antioxidant Probes — The potential for cellular damage due to free radicals in biological systems is considerable. The metabolism of many xenobiotic compounds and particularly the nitroaromatics is known to generate oxygen free radicals, the most important being superoxide anion. To combat potential damage from superoxide anion when it is generated, subcellular defense systems have been evolved which include water soluble reductants (glutathione, ascorbate, urate), fat soluble vitamins (tocopherol, carotene), and enzymes (superoxide dismutase, catalase, and glutathione peroxidase). Superoxide dismutase (SOD) catalyzes the breakdown of superoxide anion to oxygen and hydrogen peroxide, itself a reactive intermediate. Peroxide is then removed by reaction with cellular catalase forming water and oxygen and with glutathione peroxidase in the presence of glutathione (GSH) forming oxidized glutathione (GSSG) and water. Because oxyradical generating compounds are likely a more diverse group than cytochrome P-450 inducers and because the generation of oxyradicals is closely related to quantifiable end points such as antioxidant enzyme activities, it has been suggested that these defenses may have considerable potential in serving a biomarkers for exposure to a wide range of pollutants.

APPROACH: To evaluate this concept, H4IIE cells will be exposed to key TNT related nitroaromatics *in vitro* and levels of SOD, catalase, and glutathione peroxidase will be determined and correlated with exposure. Should significant increases of any of the enzymes be noted, non-radioactive molecular probes for the corresponding enzyme gene will be developed and used to analyze cell mRNA populations for increases following exposure. Depending on the results of cell culture exposure studies and degrees of molecular homology, enzymatic activities and nucleic acid probes will be evaluated as exposure monitors in rats or other species in the laboratory and/or in sentinels during validation studies.

BACKGROUND: Probes for Genetic Damage — Many of the munitions are mutagenic as well as toxic. A methodology has recently been developed and is currently being refined by which base changes, including point mutations, in short defined nucleic acid sequences can be determined. Essentially, sections of redundant genes (ribosomal RNA, transfer RNA, mitochondrial DNA) or selectable genes (hypoxanthine-guanine phosphoribosyl transferase, HGPRT) of known sequence in eukaryotic systems exposed to mutagens are amplified to high copy by polymerase chain reactions and purified. The sequences are then subjected to gel electrophoresis through denaturing gradients in which different base changes characteristically impede migration. Melting maps applied to the resulting electrophoretic profiles define points in the sequence at which mutation has occurred. The method has been used to assess the mutational spectra for chemical substances in lymphocytes selected on the bases of mutated HGPRT genes. For redundant cellular genes, it could be applicable to determining mutational frequency as well as spectrum.

APPROACH: The literature for defined sequences in selectable and redundant rat genes will

be searched and candidate sequences identified. H4IIE cells will be exposed to known mutagenic TNT munitions. The selected sequences will be analyzed for the frequency of mutation and mutational spectra as appropriate. Mutations will be correlated with concentrations and times of exposure. Following establishment of the technology in vitro, it will be applied to experimental animals and extended to caged sentinels or reworked for application to natural species.

BENEFITS: This research will develop methodologies using biomarkers that will greatly enhance specificity and sensitivity in the detection of the presence of environmental contaminants. This will result in a greatly improved level of certainty and predictability in the assessment of the hazard of military contaminants.

PARTNERS AND RELATED ACTIVITIES: None. This research will be performed at the USABRDL laboratory facilities.

MILESTONES:

FY92 - Establish cell culture/munitions exposure in NR Uptake Assay. Complete cytotoxicity measurements for key munitions components in TNT wastewater. Screen for antioxidant enzymes SOD, catalase, and GSH peroxidase following munitions exposure. Screen for P-450 induction after munitions exposure. Measure superoxide formation from munitions.

FY93 - Establish dose responses and antioxidant enzyme or P-450 induction. Develop nucleic acid probes based on enhanced P-450 or antioxidant enzymes. Establish mRNA isolation procedures. Identify rat genes for genetic studies. Complete superoxide measurements for munitions.

FY94 - Apply molecular probes to cells following munitions exposure. Establish technology for polymerase chain reactions and gradient gel electrophoresis. Evaluate munitions mutagenicity in the cell system.

FY95 - Validate probes in munitions exposed experimental animals. Identify candidate sentinel species based on molecular homology or field application. Establish mutational frequencies and spectra in munitions treated cells. Apply probes to sentinel species for validation.

FUNDING ($K): FY92 180

ACTIVITY: Dr. Wayne R. Mitchell, US Army BRDL, DSN 343-2538; 663-2538 for Munition Exposure Monitoring.

PROJECT: DEVELOP MATHEMATICAL MODELS FOR SUBSURFACE FLOW AND CONTAMINANT TRANSPORT

OBJECTIVE: The objective is to refine and develop three-dimensional groundwater flow and contaminant transport modeling tools that will be coupled with digital characterization models. The contaminant transport and flow models must be general enough to allow simulation of the wide range of physical and biogeochemical processes which affect flow and contaminant transport/fate. The integrated models will assist in evaluating remediation alternatives, groundwater contamination, and cleanup optimization at DoD and DOE sites.

APPROACH: The contaminant transport code will consist of the 3D, time-varying mass transport (i.e., advection, diffusion, and mass sources/sinks) equation in the vadose and saturated zones. The model will be limited to dissolved organics and single-phase, single-component transport. The model will be written in modular fashion so it could be easily expanded to include trace metals and multicomponent transport. The code will be general enough to include all known phase transfer processes, such as sorption and volatilization, biogeochemical transformations, hydrolysis, oxidation-reduction reactions, biodegradation and biotransformation. The groundwater flow code will numerically integrate the three-dimensional, time-varying equations of mass and momentum in a coupled saturated-unsaturated zone framework. Spatial variability will be considered explicitly through incorporation of numerical algorithms depicting 3D subsurface hydraulic and soil type variation. The initial code will be developed for single-phase and rudimentary multiphase flow. More sophisticated multiphase flow simulation will be incorporated in later efforts. The model will be written in a specific modular fashion to allow for ease of update, and for coupling with a companion contaminant transport model in a comprehensive multi-dimensional groundwater modeling system. The flow and transport models will be coupled with digital characterization models and visualization/user interface tools developed under additional Environmental Quality research work units. Partnering with ongoing DoD, DOE, and EPA research will further extend the validity of the research products.

BENEFITS: Although a number of models exist that are capable, in some circumstances, of predicting groundwater movement, these models are often difficult to use, site-specific, or antiquated. The Army's ability to effectively predict the fate of contaminants within groundwater, and to appropriately manage the treatment of surface and groundwater resources, is directly linked to the accurate and efficient estimation of groundwater and contaminant movement. The proposed technology advancement will provide the ARMY and DoD with tools to more effectively predict the migration of organic contaminants in vadose and saturated zones. The ability to accurately model such migration behavior will allow evaluation of management and treatment strategies proposed for use at contaminated sites. This capability will reduce the costs and time required for remedial alternative evaluations. The products of this research will provide the DoD with tools/models for the evaluation of remediation alternatives for many of its current contaminant concerns. The research also represents the foundation for future development of an integrated groundwater modeling system of enhanced sophistication.

PARTNERS AND RELATED ACTIVITIES: Partners include DOE, EPA, and States.

MILESTONES:

FY92 Review and select existing approaches of coupled unsaturated/saturated single phase-single component groundwater flow and contaminant transport models. Initiate modification/development as appropriate.

FY92 Develop knowledge-based system to support model selection in concert with Environmental Quality research.

FY93 Develop mesh generation and visualization routines.

FY93 Complete the initial version of the groundwater flow and contaminant transport models, implementing results from companion Environmental Quality research.

FY93 Complete the coupling of the groundwater flow and transport models.

FY93 Complete the initial verification and documentation of the groundwater contaminant transport model.

FUNDING ($K): FY92 720

RESEARCH ACTIVITY: US Army Engineer Waterways Experiment Station, CEWES-HV-C (Dr. Jeffery P. Holland) 3909 Halls Ferry Rd. Vicksburg, MS.

PROJECT: ELIMINATION OF DU IN KE PENETRATORS

OBJECTIVES: To substitute non-radioactive tungsten alloys in place of radioactive depleted uranium (DU) in all major Army armament systems. The goal is to eliminate the environmental concerns that presently exist for maintaining a radioactive material (i.e., depleted uranium) in the Army material inventory.

APPROACH: New advances in material processing by rapid solidification technology will be implemented for the development of a new generation of tungsten alloys exhibiting ballistic performances matching those of radioactive depleted uranium alloys now being used by the Army in various armament systems. Presently, depleted uranium alloys are the materials of choice as kinetic energy penetrator cores because of their more effective terminal ballistic performance against a broad spectrum of target configurations. The most recent tungsten alloys developed under DoD/ARPA/DOE sponsorships still lack efficient terminal ballistic capabilities. These alloys have been fabricated using a traditional liquid phase sintering technology. This conventional processing technology is severely constrained in its ability to fabricate appropriate high density tungsten alloy in microstructures that exhibit beneficial ballistic penetration mechanisms. New processing technologies and manufacturing capabilities are therefore required to develop a new class of high density tungsten alloys that can re-establish the preeminence of these alloys for anti-armor kinetic energy penetrators.

A multi-disciplinary approach will be undertaken to accomplish the objectives of the program. Fundamental studies will be conducted at universities to clarify target-penetrator interactions so as to establish the beneficial microstructure that needs to be designed into tungsten heavy alloys for them to perform as efficiently as depleted uranium.

BENEFITS: A new tungsten alloy capable of displacing depleted uranium as the material of choice in armament systems will have a major impact on the environmental, logistic and life cycle burden the Army presently carries to maintain an effective warfighting capability. Conservative estimates for this yearly cost of doing business is $2M to $5M and growing as new DU items enter the inventory. Furthermore with tungsten there will no longer be environmental and disposal problems that presently exist in handling the present radioactive depleted uranium materials. In addition, a revitalization of the U.S. industrial base would occur with the introduction of tungsten as a major armament material. The potential for enhanced foreign military sales by our industrial base would become a major factor in not only lowering the unit cost burden of our ammunition supply but also providing for a reliable surge capability in times of national concern. The return on investment is therefore expected to be attractive and rapidly achieved.

PARTNERS AND RELATED ACTIVITIES: The U.S. Army has conducted various studies to assess the long term strategy for kinetic energy penetrator systems. In association with ARPA and DOE agencies joint research activities are being pursued to enhance the ballistic performance of these systems either through innovative system designs or material selections. Industry has been supportive of these efforts only when provided with federal funding since there is a limited commercial application for heavy metals. As such, Cooperative R&D

Agreements (CRDA's) are non-existent since the private sector sees little commercial utilization of high strength tungsten alloys aside from foreign military sales.

MILESTONES:

1. Develop unique precursor tungsten alloy powders. FY 91

2. Utilizing advanced powder consolidation system fabricate experimental lots of heavy alloys. FY 92

3. Assess ballistic performance of "designer" alloys. FY 93

FUNDING ($K): FY 92 450

ACTIVITY: USA ARDEC, Dr. Shelton Cytron, Picatinny Arsenal, NJ 07806-5000.

PROJECT: ELIMINATION OF CHLORINATED SOLVENT USE IN RED PHOSPHORUS (RP) MUNITIONS MANUFACTURE

OBJECTIVE: Pine Bluff Arsenal (PBA) has requirements to manufacture L8A3 RP Smoke Grenades at least through FY97. The RP-rubber smoke composition employed, requires the use of methylene chloride in the manufacturing process and herein lies a major problem.

The recently enacted "Clean Air Act of 1990" requires the total elimination of the release of methylene chloride vapors to the atmosphere by the year 2000. This date may be advanced to 1995 in line with President Bush's initiative to stop production and use of ozone-depleting halogenated hydrocarbons. There is significant evidence that methylene chloride is one of the substances that poses a threat to the ozone layer. This would preclude the manufacture of the L8A3 grenade by the current process.

Furthermore, methylene chloride is regarded as a possible occupational carcinogen. For this reason the state of Arkansas, EPA and OSHA have directed that replacement solvents be identified. OSHA has proposed to reduce the 8-hour average human exposure limits from 500ppm to 25ppm. Compliance with this proposed regulation and other anticipated regulations and emission limits is becoming increasingly difficult and costly.

The objectives of this study will be to: (a) evaluate candidate replacement solvents, (b) develop a new RP/Butyl Rubber smoke mix process based on solvent selection, (c) conduct initial testing to verify that performance of L8A3 grenade with the new solvent is equivalent to or better than L8A3 grenades with methylene chloride, and (d) develop an implementation plan to include specification of required equipment/facility modifications for manufacture of L8A3 grenades with the new process.

APPROACH: Six candidate solvents have been identified by a literature search. These solvents will be evaluated by manufacturing L8A3 RP smoke compositions on a bench scale level. In addition to considering the solvents' properties, the effect on manufacture, performance, stability, and storage life must be evaluated. After bench scale screening tests, a small lot of L8A3 grenades will be manufactured. Initial performance testing will be conducted. Results of this study to include an implementation plan will be documented in a Scientific and Technical Report. The implementation plan will be executed if elimination of methylene chloride is mandated by either the Clean Air Act of OSHA as anticipated.

BENEFITS: An implementation plan to eliminate the use of methylene chloride, a possible occupational carcinogen and ozone-depleting chemical, will be developed for the L8A3 grenade manufacturing process at PBA. This will assure lack of interruption in the L8A3 procurement cycle due to adverse environmental impacts, and minimize manufacturing cost escalation as a result of new or tightened environmental regulations associated with the continued use of methylene chloride.

PARTNERS AND RELATED ACTIVITIES: PBA is the sole manufacturing facility in the United States for production of the L8A3 grenade. This study will be accomplished in its

entirety at PBA.

MILESTONES:

	Months After Funding Received	
	Start	Complete
Review candidate solvents		1
Prepare bench scale batches of RP composition using candidate solvents, evaluate manufacturing procedures/problems	1	4
Develop new process	3	5
Load into grenades	5	6
Conduct initial performance testing	6	7
Prepare Scientific and Technical Report	6	9

FUNDING ($K): FY92 230

ACTIVITY: USA, ARDEC, Picatinny Arsenal, NJ 07806-5000.

PROJECT: ALTERNATE PROCESSES FOR LIQUID PROPELLANT MANUFACTURE

OBJECTIVE: The liquid propellant being developed for use with the AFAS consists of 80.8% Hydroxyl Ammonium Nitrate (HAN), 19.2% Triethanol Ammonium Nitrate and 20.0% water. HAN is produced as 2.8-3.5 molar product contaminated with residual nitric acid via an electrolytic process which requires the use of a liquid mercury cathode. The nitric acid is currently removed by passing this acid HAN over weak-base ion-exchange resins. There are environmental, safety and process issues associated with the use of resins for this purpose. Mercury is present in both metallic and ionic forms. Metallic mercury is removed from the HAN via mercury traps. There is no method for removing ionic mercury from the product. The objectives of this program are to:

1. Identify techniques to reduce the level of ionic mercury in HAN to below detectable levels.

2. Demonstrate the feasibility of Electrochemically Facilitated Separation for the removal of nitric acid from 2.8-3.5 molar HAN without the use of resins.

APPROACH:

Mercury Removal

Perform a literature search to identify promising techniques such as resins with affinity for mercury. Select and test the performance of the best candidates in terms of product quality, environmental/safety implications, and process economics. Issue findings in a Final Report. Develop demonstrated technology to support full-scale production of HAN, if feasible.

Electrochemically Facilitated Separation

Outline the objectives of the testing. These should include:

- Improvement of current efficiency (from 25% to more than 50%) through use of more selective anode side membranes.
- Improvement of HAN recovery through use of more selective cathode side membranes.
- Demonstration of membrane stability.
- Demonstration of electrode stability i.e., prove that there is no product contamination.
- Identification of optimal operating conditions; current, temperature and flowrates.
- Demonstration of control over a continuous process.
- Design a laboratory-scale cell from suitable materials.
- Define process to recycle the recovered weak nitric acid.
- Define economics of a production scale module.
- Perform preliminary hazards analysis to document improvements.
- Evaluate product quality, environmental/safety implications and process economics.

Issue Final Report on findings.

- Develop demonstrated technology in support of full-scale production of HAN, if feasible.

BENEFITS:

Environmental

Mercury Removal Resins

- Mercury content of product will be reduced; possibly to below detectable limits. This will minimize the significant expense associated with handling, storage and disposal of mercury contaminated liquid propellant.

Electrochemically Facilitated Separation

- Does not require addition of chemical regenerant.
- Permits recovery/recycle of nitric acid.
- Eliminates disposal of solid resin which may be contaminated with mercury.
- Minimizes volume of waste significantly.

Safety:

Electrochemically Facilitated Separation

- Continuous operation minimizes amount of material present during operation.
- Eliminates safety issues associated with drying-out of the resin bed.

Process:

Electrochemically Facilitated Separation

- Improves HAN recovery to 95% (over current 85%).
- Operates continuously; minimizes sizing.

PARTNERS AND RELATED ACTIVITIES: ARDEC, in conjunction with BRL, PBMA and Olin Corporation are in the process of demonstrating the performance of HAN pilot plant. SAChem produces commercially available HAN by a proprietary process (on a small scale). Thiokol Corporation blends HAN with other ingredients to produce liquid propellant.

MILESTONES:

	Months after contract award	
	Start	Complete
Literature search	0	1
Procurement/modification equipment/resin	1	
Pilot studies	4	11
Final Report	9	12

FUNDING ($K): FY92 450

ACTIVITY: USA, ARDEC, Picatinny Arsenal, NJ 07806-5000.

PROJECT: CADMIUM PLATING ALTERNATIVES

OBJECTIVE: Currently, 80% of the environmental releases of Cd may be directly related to electroplating waste. More than 50% of these discharges may be directly related to wastes generated by DoD Plating activities. Objective is to develop, evaluate and implement alternatives to Cd plate.

APPROACH: Select viable candidates, perform laboratory corrosion, adhesion, SCC, coefficient of friction, breakaway torques and compare results with Cd plate. Determine effects of co-mingling with Cd and galvanic coupling with steel and aluminum alloys.

BENEFITS: In addition to these environmental problems, Cd plating is a health hazard to workers operating electroplating baths. This project meets the DA goal of a 50% reduction in hazardous waste generation by 1995.

MILESTONES:

Sep 93	Laboratory testing of additional alternatives-Ion beam assisted deposition (Zn-Ni, AI-Zn).
Jul 94	Outdoor exposure tests.
Jul 95	Field tests.

FUNDING ($K): FY92 270

ACTIVITY: MTL, TACOM, OCR. Mr. Milton Levv- SLCMT-EMM, 617-923-5331.

PROJECT: ENVIRONMENTALLY ACCEPTABLE METAL CLEANING

OBJECTIVE: This program addresses Army Environmental Management, specifically:

3. Pollution Prevention Pillar.
II. Eliminate the need to purchase ozone-depleting substances by the end of 1995.
3. Solvents.
a. Non-ozone-depleting solvents for aircraft/weapons/shipboard/shoreside applications.

APPROACH: The first year of Phase II will continue exploratory research (6.2) of potential cleaning replacements for ozone-depleting chemicals for different materials and their configurations. The second year of Phase II will implement (6.3a) previous findings and produce alternate cleaning procedures for DoD material that will be distributed to depots and other maintenance facilities.

BENEFIT: The Clean Air Act Amendments of 1990, DODD 6059 and AMC Reg 70-68 require abolishing the use of halon and other ozone-depleting agents. The range of applicability includes all military ground vehicles.

MILESTONES: Phase II of the SBIR contract is currently unfunded. Clean Air Act Amendments of 1990 resulting in phaseout of CFCs and other ozone-depleting chemicals take effect in 1995. The end item will be a "cookbook" to environmentally acceptable cleaning processes for different materials and configurations. This "cookbook" will be delivered two years from the date of contract award.

FUNDING ($K): FY92 230

ACTIVITY: TACOM, Thomas M. Landy, AMSTA-UDM, (313) 574-8757 and Creare, Inc. (Hanover, NH).

PROJECT: INVESTIGATION OF AQUEOUS CLEANING SYSTEM TO REPLACE CFC VAPOR DEGREASER

OBJECTIVE: The manufacture of ammunition metal parts requires that specific components be degreased prior to subsequent industrial operations. Specifically, prior to painting large caliber projectile subassemblies, they are first vapor degreased using a CFC 113 based solvent to remove light water soluble cutting oils and hand oils. Increasing regulatory restrictions and the cost of CFC based solvents necessitate the implementation of alternative cleaning systems. DoD Directive 6050.9 and AMC-R 70-68 require that alternatives to CFCs be sought. The objective of this project is to adapt an aqueous based cleaning system for use in the large caliber projectile paint line.

APPROACH: Specifications for LAAPs cleaning system will be prepared and off-the-shelf equipment will be customized for the paint line.

BENEFIT: Substitution of CFC solvents will result in compliance with DoD and Army policy and the elimination of a portion of the Army's contribution to the concentration of stratospheric chlorine. Also eliminated will be the expense of the increasingly costly solvent and the generation of a listed hazardous waste. Continued reliance on CFC based solvents will adversely impact production when the production and importation of CFC based cleaning solvents is banned in 1995.

MILESTONES:

	Completion Dates
Select and validate cleaning agent and specify equipment	FY93
Prove-out equipment technology and install at LAAP	FY94

FUNDING ($K): FY92 120

ACTIVITY: ARDEC, Mr. Mark Napolitano.

PROJECT: REPLACEMENT OF CHLORINATED SOLVENTS IN ROCKET MOTOR PRIMERS AND TACKIFIERS

OBJECTIVE: Stickiness ("tack") is imparted to rubber to facilitate motor manufacturing: chlorinated solvent wipes are commonly employed for this purpose. Also state-of-the-art primers and adhesives are up to 90% alcohol. Process and material advances in paint and coatings science offer the potential for quick transfer to rocket motor manufacture.

APPROACH: An extensive literature, market and industry search will identify potential products which are either 100% non-volatile, water based or containing environmentally sound solvents. Major aerospace suppliers, such as Lord and Hysol, are developing adhesives and tackifiers of this type, and the commercial coatings industry offers many water-based, corrosion inhibiting primers. In the initial laboratory phase, the corrosion control of steel primers will be evaluated, and the bond strength of adhesives and tackifiers will be screened with two typical elastomers on steel panels. From the screening study, the bond integrity of tow candidate will be tested in a typical propellant, insulation, substrate system at temperatures simulating the typical motor operating range (-65, 77 and +145°F). The best candidate system will be validated in a process sensitivity and accelerated aging program. The data and conclusions will be presented to the propulsion industry at the JANNAF Propulsion Meeting.

BENEFITS: Since essentially all solid propellant rocket motors employ primers, adhesives and tackifiers, the results of this program will be broadly applicable. Approximately 1,000 gallons of such solvents will be saved annually at this site and other small to medium rocket motor manufacturing operations, with savings up to 10,000 gallons annually at large operations (e.g., TITAN, Shuttle, Peacekeeper, Minuteman, Trident, Poseidon).

PARTNERS AND RELATED ACTIVITIES: Thiokol, Inc.

MILESTONES:

Screen 5-7 candidate for adhesion.	FY92
Downselect to 2 candidate and verify bond system compatibility and adhesion.	FY92
Complete 1 year aging of candidate mtls.	FY93

FUNDING ($K): FY 92 250

ACTIVITY: U.S. ARMY Missile Command, RSA, Diane Bowers, (205) 876-0887.

PROJECT: OIL SPILL TRANSPORT PREDICTION SYSTEM

OBJECTIVE: This project is designed to provide a first generation dynamic oil spill forecast capability. The Oil Spill Prediction System (OSPS) will combine existing and planned, state-of-the-art, ocean forecast systems with the best available oil spill model. The output of OSPS, applicable to both military and civilian needs, will provide real-time and near-real-time predictions of the transport, dispersion, and weathering of oil released in the oceanic environment.

APPROACH: The technical approach will include the design of an overall OSPS architecture to combine present state-of-the-art, real-time, modeling know-how with the best available oil spill forecast, science and technology. This will involve the assessment of all recent developments that have been attained at research institutions. The system will provide a capability to predict oil movement in open ocean, in coastal and semi-enclosed sea regions and in regions characterized by strong boundary currents. The tools for making operational predictions at regional centers and remote shore sites, as well as onboard ships will be developed. This oil spill prediction capability will be fully integrated with operational forecasting models using existing Cray YMP computers. The model(s) will be UNIX based and will therefore be operable on a wide range of computers. Some computers now being employed include: the HP-835, the SUN series systems and the Navy Tactical Environmental Support System (TESS(3)).

Existing dynamic models will be adapted to optimize the upper levels to provide appropriate response to wind forcing. In addition, a capability to assimilate in-situ and satellite data will be provided to assure real-time model updating. New or improved models will also be assessed for their applicability to the ocean regions discussed. Model(s) selected will be evaluated using available data sets and structured (prototyped) for operation on DoD operational systems.

BENEFITS: This program will benefit all federal agencies including the US Coast Guard. It will provide a unique capability for tracking and predicting oil movement in the event of accidental spills in peacetime. During conflicts, amphibious, and special warfare areas would receive direct support in the event of operational interference resulting from accidental or intentional oil release. The models developed through this effort will be designed to run on existing Navy mainframe operational supercomputers and on remote-site UNIX based transportable computers being used throughout the DoD Services (i.e.,SUN systems, HP-835, etc). In addition, the models will run on Navy Regional Oceanographic Center and shipboard computers. Oil spill prediction products would be available through any or all of these sources, i.e., central or remote sites. DoD has acknowledged Navy responsibility for ocean and atmospheric predictions. Cray YMP supercomputers are being implemented at central sites, namely, the Fleet Numerical Oceanographic Center and the Naval Oceanographic Office to greatly improve DoD environmental prediction capability. Powerful small computers are being installed at Navy regional centers and on board ships for environmental prediction. Communication links being implemented by the Navy will provide an ability to send numerically generated data fields directly to these remote computers. In addition, the remote

computers will have a capability to receive satellite generated images (IR, SAR and SSM/I) of the sea surface. The small computers (with communications capability) could be set up rapidly when needed by DoD activities or Joint Force Commanders at remote sites. All of the elements needed for real time ocean/atmospheric predictions will, as a result, be in place. This system will provide DoD and the US a unique global nowcast and forecast capability. An oil spill prediction model can and should be included within this prediction system. The model would provide a means for estimating: film breakup due to wave action, the loss of volatile components to the atmosphere, the dissipation of oil slicks due to wind action, and the prediction of oil impingement on beaches. It would also enable the identification and/or prediction of the oil film fringe location for the distribution of oil consuming microbes. DoD operates a large number of small craft and ships any one of which could be involved in oil spills. The location of an oil spill nowcast/ forecast capability within DoD will also directly support other US Government agencies responsible for civilian oil spills and oil spill cleanup. These include the National Oceanographic and Atmospheric Administration (NOAA), the US Coast Guard and the Environmental Protection Agency (EPA). The Minerals Management Service (MMS) would also benefit since they have a need for environmental statistics in connection with their offshore leasing programs.

PARTNERS AND RELATED ACTIVITIES: This development would be conducted with close cooperation with CNO OP-45 the Naval Facilities Engineering Command and the Naval Ship Engineering Command. We plan to work closely with the NOAA Hazardous Materials Response and Assessment Division, Seattle, Washington, and the Army Corps of Engineer Research Center, Vicksburg, MS. The work will also be closely coordinated with the Minerals Management Service.

MILESTONES:

- Develop improved Ekman wind drift formulation.	FY92
- Evaluate deep/shallow water wind drift formulation.	FY92
- Integrate Navy oil slick models with NOAA models.	FY 92/93
- Develop real-time capability for assimilating remotely sensed satellite and aircraft data into the integrated models.	FY92/93

FUNDING ($K): FY 92 300

POINT OF CONTACT: Robert A. Peloquin, Office of Naval Research, Arlington, VA 22217-5000, phone (703) 696-5084.

PROJECT: NAVAL SHIP SYSTEMS RADIOLOGICAL CONTROL DETECTION

OBJECTIVE: Develop highly sensitive, accurate, user friendly, easily maintained, and cost effective systems for monitoring exposure to personnel while working with and around radiation sources on nuclear powered ships, in industrial and medical facilities, while recovering from nuclear accidents, and during environmental remediation of previously contaminated sites. The new systems will stem the spiraling servicing and calibration costs from obsolete instrumentation now in use. The new expandable technology will enable meeting continually more stringent federal accuracy and sensitivity criteria well into the future.

APPROACH: Major improvements are needed in the capabilities, calibration and repair of radiation survey meters and dosimeters. Current RADIAC instruments are 1940's vintage technology. They are single-purpose, insensitive, often contain radioactive material, and require frequent calibration. Maintenance costs continue to rise due to growing parts obsolescence and restrictions on shipping radioactive components. The first major improvement under development is the Multifunction RADIAC. It singly will replace up to 30 types of outdated radiacs, and will not be administratively hindered by containing any radioactive material. Its computer-based calibration and diagnostic system (ARCADES) will shorten by at least a factor of four the servicing/calibration time and expense, and be able to detect the smaller quantities of radiation recommended by cognizant scientific groups worldwide. The second major improvement is a new system under development for detecting and recording personnel radiation doses, the laser heated Thermoluminescent Dosimeter (LHTLD). This system will measure the low levels of radiation that a system must be able to measure to meet new NRC regulations and will provide sensitive measurements down to the levels required to meet all new and imminent health and safety requirements. It will accurately measure neutron radiation which the prevailing of the two current systems in use does not do. This is important because draft NRC regulations increase the hazard index associated with neutrons. It will replace the two older dosimetry systems currently in use with a less expensive, more reliable, simplified automated system. The automated system will save the Navy $600K per year at shipyards due to reduced manhours needed to read the dosimeters.

BENEFITS: The Multifunction RADIAC/ARCADES system will make radiation safety more affordable and readily available to all facets of nuclear Navy ships, site restoration, and the industrial and medical nuclear radiation programs. It will replace numerous single-use instruments. Benefits include high sensitivity, more rapid calibration, smaller required inventories, higher availability, easier transportability, and logistics savings. Savings of up to 75% of current RADIAC maintenance costs will start in 1996 and be fully realized by 2003. The technology created in both these programs is expected to be fully commercialized in the 1992 to 1994 time frame. There are currently no known similar research and development programs underway in the civilian sector.

PARTNERS AND RELATED ACTIVITIES: The Defense Nuclear Agency is developing an alpha radiation probe to meet ANSI and NRC requirements. The probe will interface with the

Multifunction RADIAC/ARCADE system. The Air Force is staffing a memorandum of agreement with the Navy in order to use the new systems to fulfill an established requirement under a Statement of Need (SON). They have been unable to obtain R&D funding for this type of system. A Joint Service Operational Requirement (JSOR) for the Multifunction RADIAC was issued by the Navy in April 1988. It is being staffed through the services. The laser heated TLD system will have widespread applicability throughout the other services, DOE, all other state and federal agencies with dosimetry needs, and the civilian community as a state-of-the-art dosimetry system.

MILESTONES: Milestone II, beginning of Engineering and Manufacturing Development, will occur in March 1992 for the Multifunction RADIAC System. Milestone III, production, will occur in September 1993. The laser heated TLD system began Engineering and Manufacturing Development in September 1990 and will reach Milestone III, production, in January 1994.

FUNDING ($K): FY 92 500
(Multifunction RADIAC System-100, Laser Heated TLD System-400)

RESEARCH ACTIVITY: U.S. Navy RADIAC Program (SEA 04R); Naval Sea Systems Command, Washington, DC. Phone: (703) 602-2753, AV 332-2753.

Sponsor: OPNAV 455, Phone: (703) 602-2582, AV 332-2582.

PROJECT: LABORATORY AND FIELD MARINE BIOINDICATOR SYSTEMS

OBJECTIVE: Develop sensitive laboratory and field bioindicator systems that can be used simultaneously to evaluate contamination in the marine environment associated with Naval facilities, ships and operations.

APPROACH: The Navy has been required to document the extent of contamination and confirm the effectiveness of pollution control and cleanup operations in marine waters affected by the Navy. The most reliable measurement of impact (fate & effect) on the marine environment is the measure of the biological response in marine organisms. Current methods used for sampling and analysis do not make use of the accuracy, sensitivity and selectivity that can be achieved by emerging biological techniques.

Basic research in detection and recognition of chemicals by living organisms is necessary. This includes: characterizing molecular mechanisms and physical/chemical principles of detection of odorant chemicals by olfactory neurons and consequent signal transduction; identifying proteins and characterizing ligand receptor interactions, developing binding sites for target ligands through protein modeling and monoclonal antibody technology; synthesizing macrocyclic organic molecules having the ability to strongly bind heavy metals and whose spectroscopic indicators, e.g. fluorescence, are strongly modulated by metal binding; and developing neural network classifiers for pattern recognition in biosensor arrays.

Exploratory development is needed in coupling response with measurement mechanisms using fiber optics, laser, fluorescent, spectroscopic and other techniques.

Advanced development of available bioassay procedures will be based on protocols utilizing a suite of invertebrate and vertebrate organisms known for their sensitivity to toxicants. Emphasis here will be on reliability, specificity, cost effectiveness and comparisons with standard protocol as well as selection of organisms appropriate to the receiving water matrix and reflective of receiving water conditions. Candidates include phytoplankton, amphipods, mysids, mussels, worms and fish. Protocols to be evaluated include life-cycle tests, embryo survival, larvae survival and growth and reproductive capacity. A variety of sublethal assays will be perfected including growth rate, bioaccumulation and phytoplankton measuring effects on fluorescence and bioluminescence light output. Assay and measurement developments will be supported by field measurements from a variety of platforms to confirm applicability.

BENEFITS: The limitations of existing protocols include lack of combined laboratory and field approaches, inadequate calibration of existing systems and inappropriate extrapolations to and from real-world environments will be overcome. The resultant precision in measuring the effects of the Navy's presence on the marine environment will ensure against overregulation and misdirected or wasteful expenditures without useful environmental return and further assure that operations and compliance efforts provide for the protection and preservation of the marine resource required by the environmental policies of the United States.

PARTNERS & RELATED ACTIVITIES: Cooperative work on protocol development will be conducted between the Office of Naval Research, the Naval Research Laboratory Washington and Stennis MS. EPA approval of developed methods will be pursued.

MILESTONES:

FY93 Determine the most productive direction for environmental quality related biosensor research by furthering on going efforts in diverse disciplines and collaboratively assimilating the state of the science for long term Navy approach.

FY92 Complete field testing of in-situ mussel bioindicator system and develop standard operating procedures.

FY92 Test and evaluation: EPA in-situ mysid chamber, NCCOSC field dosing apparatus, Transportable bioassay trailer, planktonic luminescence laboratory assay.

FY93 Develop standard operating procedures for bioluminescence fluorescence, and ATP assay methodology.

FY93 Simultaneous calibration of laboratory and field indicators, work with EPA on protocol acceptance.

FY93 Finalize procedures and transition to compliance applications.

FUNDING ($K): FY 92 600

ACTIVITY: Office of the Chief of Naval Research POC CDR Scott Sandgathe (703) 696 4102. Naval Command Control and Ocean Surveillance Center (NRaD), San Diego, California, 92152 POC: P. F. Seligman (619) 553-2775.

PROJECT: SHIPBOARD SECONDARY AND TERTIARY BILGE WASTE TREATMENT SYSTEM

OBJECTIVE: Develop a shipboard secondary and tertiary bilge waste treatment system which will provide an effluent which meets existing and anticipated environmental regulations for overboard discharge of oil, heavy metals and other ultratrace contaminants.

APPROACH: Navy shipboard oil/water separators are designed to separate oil from water and produce effluent which contains less than 20 parts per million oil. However, they do not meet the stringent effluent water quality requirements being imposed by the Clean Water Act and state, national and international regulations. These requirements place strict limitations on heavy metals and other EPA priority pollutants discharged into natural waters - even in ultratrace concentrations. By the year 2000, effluent quality requirements are expected to equal water quality requirements.

This project will result in shipboard equipment which will process bilge waste and provide an overboard discharge which meets existing and future requirements for all regulated constituents. The treatment system will be designed with inherent flexibility to accommodate the bilge generation levels, and thereby the bilge processing requirements, of all Navy ships.

Existing technologies for the treatment of bilge oily waste will be evaluated to provide a data base from which to select the best technology for meeting the particular and unique requirements of Navy shipboard equipment. In the absence of appropriate existing technology, state-of-the-art technologies/systems will be developed. The existing parallel-plate OWS technology on Navy ships is recognized as an excellent primary treatment stage. Therefore, emphasis will be placed on technologies and systems for secondary and tertiary treatment, as required. The most promising will be configured for affordability and shipboard use and, after preliminary testing in the laboratory, will be installed aboard a Navy surface ship for comprehensive TECHEVAL. Final system design, installation, and maintenance documentation will be prepared following a successful evaluation.

BENEFITS: The shipboard bilge waste treatment system will ensure that Navy ships meet all existing anticipated environmental requirements concerning the overboard discharge of all potential contaminants. The alternative, i.e., the inability of navy vessels to discharge "pollutant free" waste streams overboard, could potentially limit or even preclude the deployment of these vessels in territorial waters of the United States or foreign countries. Such limits on Naval operations are not acceptable.

The technology development and systems engineering necessary for the discharge of "environmentally sound" effluent from Navy ships can be transitioned for use aboard other Department of Defense ships and foreign naval vessels and by the domestic and international maritime industry as well. The overall positive effect is significant. The effects of heavy metals and other pollutants on the marine environment are virulent, destroying marine organisms and, concurrently, the economy of the affected region.

PARTNERS AND RELATED ACTIVITIES: Navy, Naval Civil Engineering Laboratory, Port Hueneme, CA. Technology developed and lessons learned in the Small Craft Bilge Treatment Systems program and in the development of a bilge waste treatment system for the Naval Weapons Station (NWS) Earl will be utilized and refined in this effort.

MILESTONES:

FY 92: Identify and select the most promising state-of-the-art technologies and systems for the secondary and tertiary treatment of shipboard bilge waste.

FY 92/93: Design and fabricate a shipboard secondary and tertiary bilge waste treatment system. Install aboard ship and evaluate.

FY 93: Complete shipboard evaluation and final design, installation and maintenance documentation.

FUNDING ($K): FY 92 300

POINT OF CONTACT: Carderock Division, Naval Surface Warfare Center, Annapolis Detachment, Code 2834, Annapolis, MD 21402-5067. POC: Mr. Craig Alig (410) 267-3526.

PROJECT: NAVY SHIPBOARD HAZARDOUS MATERIALS REDUCTION

OBJECTIVES: Utilize and expand the Naval Surface Warfare Center Shipboard Hazardous Materials Database to identify hazardous materials used Navy-wide; reduce hazardous materials through consolidation, or substitution of less hazardous materials; and control the introduction of new hazardous materials into the Navy. Incorporate information on material substitution efforts into database, and provide database access to all military services so that substitution and minimization can be effectively implemented throughout the Department of Defense.

APPROACH: The diverse types and quantities of hazardous materials (HM) required by the Navy to achieve and maintain operational effectiveness have escalated thereby increasing the generation of hazardous waste (HW) and concomitantly raising the cost associated with HM/HW handling, storage and disposal. Successful reduction of hazardous materials used by the Navy demands a clear understanding of the requirements for hazardous materials to be on Navy ships or in use at shore activities. By employing the relational analysis capabilities of the Center's database, the technical requirements for hazardous materials can be assessed as either critical for general shipboard and shore maintenance.

The Navy HM reduction efforts include collecting compositional information for products supplied under given NSN's, identifying target materials that require substitution, reviewing processes and applications, and performing risk assessments and economic analyses. Recommendations for material consolidation and substitution are made to equipment life cycle managers and inservice engineering agents for their technical evaluation and approval. Pertinent information on less hazardous substitutes and their applications will be incorporated into the database.

The success of this technology demonstration is certain because its approach is based on a completed lubricant reduction program for combat and weapon system equipment that resulted in a 64% overall reduction, (DTRC/SME-88/91).

BENEFITS: The reduction of Navy HM through an effective elimination and substitution program will reduce the costs associated with handling and storage of HM, and of its disposal as HW. Additionally, a reduction in the variety and quantities of HM will enhance the health and safety of all personnel, greatly facilitate the Navy's compliance with statutory requirements, and contribute significantly to preserving the environment. Project efforts will also be of immediate benefit to the Naval Supply Systems Command in their development and maintenance of a Navy-wide authorized HM use list. The NSWC database will serve as an information center for Navy-wide and service-wide substitution efforts.

The minimization process and substitutes for hazardous materials can be applied to the industrial sector resulting in an overall reduction in the generation of industrial hazardous waste nation-wide.

PARTNERS AND RELATED ACTIVITIES: The Hazardous Materials Afloat Working Group, under the leadership of the Naval Supply Systems Command, includes representatives from the Atlantic and Pacific Fleets, the Echelon 2 Commands, the Navy Environmental Health Center, the Naval Safety Center, and various shore communities, each committed to achieving the Navy's HM/HW reduction goals. Efforts to collect and share information pertaining to hazardous materials and hazardous waste Navy-wide are in progress. The U.S. Army and U.S. Air Force have also expressed an interest in participating in the hazardous material minimization program.

Industry efforts to identify safe and effective substitutes for chlorinated solvents, especially the widely used CFC-113, and 1,1,1-trichloroethane solvents, and the U.S. Air Force's solvent substitution program are being closely monitored. EPA reports on pollution prevention strategies including plans to reduce 17 toxic chemicals by 50% by 1995, have also been given consideration.

MILESTONES:

Sept 92	Expand shipboard HM database to include all Navy used hazardous materials. Prioritize HM for substitution, and utilize database to minimize or control highest priority HM.
Sept 92	Incorporate into database information and status on substitution efforts Navy-wide, including material and process information.
Sept 93	Provide database access to all military services to facilitate HM minimization throughout DoD.

FUNDING ($K): FY92 300

ACTIVITY: Navy: Carderock Division, Naval Surface Warfare Center, Annapolis Detachment, Code 2832, Annapolis, MD 21402-5067, (410) 267-3246.
Laboratory Contact: Mr. Craig Alig, (410) 267-3526.

PROJECT: NAVY NON-OZONE DEPLETING TECHNOLOGY CLEARINGHOUSE

OBJECTIVE: Operate and maintain a centralized information collection, management/storage, and dissemination resource for new substances and technologies to replace uses of chemicals which are being restricted under the Montreal Protocol on Substances that deplete the Ozone Layer.

APPROACH: Collect and, upon request, disseminate technical data regarding potential substances and technologies for, and experience with, replacing CFC refrigerants and solvents and Halon firefighting agents. Information on chemical/physical properties, health and environmental effects, regulatory status, technology issues, and user experience with substitute chemicals and technologies will be collected, reviewed, and incorporated in a searchable database. Users of clearinghouse services will be encouraged to submit their own data and experiences when it becomes available.

BENEFITS: There are numerous applications for CFCs and Halons. Because of the many large and small users within the U.S. and foreign militaries, it is imperative that time and effort are not duplicated and wasted developing data and relearning lessons that can be readily obtained elsewhere. Widespread availability of technical data and operational experience with CFC/Halon substitutes will ensure that past successes and failures are considered by other users attempting to eliminate their CFC/Halon use. The clearinghouse will reduce such duplication in R&D and testing and will permit more informed substitution decisions. It will also promote valuable interaction among users and suppliers, help identify common requirements/constraints which may better direct R&D efforts, and possibly facilitate the development of standards.

PARTNERS AND RELATED ACTIVITIES: Clearinghouse activities will be coordinated with related activities and capabilities within DoD, industry, and NATO allies.

MILESTONES:

FY92: Establish clearinghouse and begin operation internally within the Navy to assure performance and effectiveness.

FY92-FY93: Open Clearinghouse availability for Department of Defense and other government use.

FY93: General availability of Clearinghouse to industry and foreign users.

FUNDING ($K): FY92 200

POINTS OF CONTACT: U.S. Navy contact is Mr. Joel Krinsky, (703) 602-7599, Naval Sea Systems Command, (SEA 56Y1), Washington, D.C. 20362. Laboratory Contact: Mr. Craig Alig, (410) 267-3526, Carderock Division, Naval Surface Weapons Center, Detachment Annapolis, Annapolis, MD 21402-5067.

PROJECT: ORDNANCE USE/DISPOSAL RISK EVALUATION/MODELING

OBJECTIVE: Establish the capability to conduct air dispersion modeling for dispersion of airborne emissions from open burning/open detonation operations. The POLU10 will be used in conjunction with air dispersion modeling for the completion of risk assessments necessary in obtaining RCRA Subpart X permits for OB/OD.

APPROACH: Initially, the POLU10 combustion products program will be expanded to include a larger number of explosives/propellants/ pyrotechnics which may be treated by open burning/open detonation (OB/OD). The data from the POLU10 program will then be used as the input data for an OB/OD air dispersion model. The OB/OD air dispersion model will be developed specifically for the unique OB/OD operation. The developed model will be used to conduct the risk assessments which will be a portion of RCRA Subpart X (40CFR284.600) Part B, permitting for OB/OD activities.

BENEFITS: The project will benefit all DoD activities currently applying for Subpart X Part B developing a uniform means/method for determining the risk assessments.

PARTNERS AND RELATED ACTIVITIES: The project will be undertaken with assistance from Army activities and EPA personnel to ensure that the model meets regulatory requirements to conduct risk assessments for Subpart X permit submissions.

MILESTONES:

- Expand POLU10. FY92
- Identify appropriate model. FY92
- Integrate POLU10/model. FY93
- Demonstrate model. FY93

FUNDING ($K): FY92 100

POINT OF CONTACT: U.S. Navy, Naval Ordnance Station, Indian Head, MD 20640-5000, POC: Pam Clements, Code OE, (301) 743-4450.

PROJECT: CFC, HAZARDOUS AND TOXIC MATERIALS ELIMINATION

OBJECTIVE: The purpose of this program is to establish an enhanced in-house testing capability, and to test and evaluate new materials and processes which eliminate the use of hazardous and toxic materials. CFCs will be phased out of existence as early as 1992 and other hazardous materials will follow suit in later years.

APPROACH: Potential substitute materials and processes will be evaluated via testing to the applicable requirements of the Air Force Logistic Command customers with the goal of qualifying the materials/processes for ALC use. The elimination of CFCs, will be investigated as will new processes and materials dealing with non-electrical metal/parts cleaning, adhesive bonding operations and painting operations. In order to gain any confidence in new materials/processes within a reasonable time period, some form of accelerated testing must be conducted in the laboratory to simulate actual service life. This is particularly true in the area of adhesive bonding and corrosive control. Part of this effort will be to develop a better accelerated ageing test(s) stemming from the results of an AFLC-funded adhesive bond durability contract. In addition, in-house material processing capability will be upgraded where necessary and practical to ensure the ability to evaluate new materials and processes as well as run the proper controls for the testing. Such upgrade efforts will mainly focus on the preparation of parts for painting and bonding.

BENEFITS: New materials and processes that are environmentally compliant will become available to the given weapon system for incorporation with little or no compromise in performance parameters such as corrosion protection and adhesion. Also, improved equipment and test procedures will allow for more realistic testing of material and process substitutions. This program will assist efforts to provide an environmentally compliant system with comparable performance.

PARTNERS AND RELATED ACTIVITIES: Efforts will be coordinated and jointly funded as appropriate. Other substitute materials testing, including the use of CFCs for cleaning, will be conducted in the Materials Directorate for ALC or SPO customers. Toxicology testing of substitute materials will be conducted by Armstrong Laboratory.

MILESTONES:

Program Start	June 1992
Program Completion	June 1994

FUNDING ($K): FY 92 450

ACTIVITY: WL/MLSE, J. Mazza, DSN 785-7483.

PROJECT: AEROSPACE SYSTEMS GUIDANCE AND CONTROL CFC ELIMINATION PROGRAM

OBJECTIVE: Aerospace systems guidance and control systems employ CFCs in literally thousands of different areas. The use of CFCs in the building of systems guidance and control system has become essential in guaranteeing extreme levels of cleanliness for high reliability components. In many areas the Air Force has mandated directly, in their drawings, to use CFCs and no other substitute. Consequently, Air Force program Offices remain highly dependent on the use of CFCs, and will be incapable of producing or maintaining highly reliable guidance systems in the future unless CFC replacement are developed. Due to the significant use of CFCs, the replacement will require detailed studies to validate the alternatives while not compromising the quality or accuracy of the guidance systems.

APPROACH: The current CFC replacement program will build on initial research. This up front work selected a basic approach for solving the problem. The initial work identified a broad list of solvents and techniques with potential applications in the cleaning process. The continuing effort has been set up as a (3) phased program involving 3 contractors. The effort is expected to be completed by 30 JUN 94. Phase I will involve the identification of alternative solvents, test coupons and cleanliness criteria. The application process for the solvents above will also be investigated. Additionally, several other cleaning techniques will be investigated. They are: High Energy (plasma) cleaning, Carbon Dioxide Snow Cleaning and Super Critical Fluid Cleaning. This initial research will set the stage for phase II of the elimination program. Phase II will take the descoped solvent and technique lists and evaluate them for final down select. Multi-material piece part compatibility, and process application will be tested. Critical assemblies will be built using CFC-free processes and life tested. They will be tested then torn down to evaluate effects of new processes. Phase III will build on the results of Phase II. Assembly layouts will be modified and deviations initiated in order to build CFC-free instruments. Any program unique equipment needed to implement CFC-free assembly will be identified and installed. Guidance instruments will be built using CFC-free processes, then tested to ensure no detrimental effects at system level.

BENEFITS: The program is essential to supporting the designed capabilities of the fielded aerospace systems. Without CFC replacements the Air Force will be unable to repair failed guidance systems and still comply with the following: DODD 6050.9, AFR 19-15, which will prohibit USAF use of CFCs, the 1990 Clean Air Act, and the Montreal Protocol.

PARTNERS IN RELATED PROGRAMS: OC-ALC/LIIRN in conjunction with Aeronautical Systems Division (ASD) for application to aircraft gyros and instruments. Space Systems Division (SSD) for satellite applications. The Navy Trident Program (SP 234) is using this research to solve similar problems on their missile guidance and control systems. Coordination with the National Center for Manufacturing Sciences at 900 Victors Way, Ann Arbor, MI 48108-1779 will offer the opportunity benefit from CFC substitute testing being accomplished by a manufacturing consortium.

MILESTONES:

10/30/92	PHASE I COMPLETE
3/31/93	PHASE II COMPLETE

FUNDING ($K): FY 92 500

ACTIVITY: HQ BMO/HVG, Capt George Rogers DSN 876-5695.

PROJECT: RADIO FREQUENCY THERMAL HEATING OF SOIL TO REMOVE VOLATILE ORGANIC COMPOUNDS (VOCs)

OBJECTIVE: Develop, demonstrate, and optimize a pilot-scale (single module) and full scale (triple module) design to thermally remove VOCs commonly found in jet fuels and solvents from various soil matrices and depths in the vadose zone above the aquifer.

APPROACH: Tests are being conducted at shallow depths to demonstrate the VOC recovery efficiency of a single RF generator and vacuum extraction system from clay and sandy soils with various moisture contents in the range of 10 to 20 percent. In FY 85, pilot scale field demonstration tests were first conducted at Volk Field WI in sandy soil at depths up to 7 feet for 99 percentile removal of low boiling type VOCs found in jet fuels and cleaning solvents. A Kelly AFB TX field demo will target removal of similar type VOCs at depths of 30 to 40 feet in clay soils of similar moisture content. By the end of FY 94, we hope to deliver a commercially available full-scale treatment system to Air Force users to achieve 99 percent removal of VOCs at shallow depths. Higher soil moisture contents and groundwater treatment to remove VOCs need further investigation.

BENEFIT: This in situ treatment method can provide tremendous savings as compared to excavation, incineration and landfill methods of contaminant removal. Heavily contaminated fuel spills can rapidly be cleaned up in a matter of weeks for volumes up to 3,000 cubic feet at low costs ranging from $40 to $75 per ton. RF technology can be used compatibly and complementary with other innovative technologies such as bioremediation and air stripping to achieve cleanup of even larger scale areas. RF technology has advantages over other technologies such as in-situ soil venting, bioventing, or biological treatment. RF cleanup on a volume-to-volume basis is faster and more efficient; bioremediation treatment can take months as compared to days for RF (12.5 days at Volk) and biological bacteria are not as effective in removing chlorinated hydrocarbons as RF. Excavation removal and incineration can cost $500 to $1000 per ton of soil treated.

PARTNERS AND RELATED ACTIVITIES: AFCEE, EPA, USATHAMA, and Army Corps of Engineers are sharing information related to this effort. The DOE Office of Technology Development is a strong advocate and is co-funding RF Technology Development to avoid duplication of efforts addressing similar VOC removal R&D. Tinker AFB and the DOE Savannah River are participating in Integrated Technology Demonstration planning activities with AFCESA. Private industry (General Electric, Westinghouse, O'Brien and Gere, etc.) is expressing strong interest in future design optimization activities on power generators and VOC vapor capture and treatment.

MILESTONES:

FY 92 Kelly AFB Site 1 Single Module Demo Plan and Site Characterization Initiated; Pilot-Scale Treatment Starts.

FY 93 Site S-1 Demo Completed, Technical Report Submitted. Full-Scale Cleanup Plan

using 3 RF Modules Initiated; Technology Transfer to Kelly AFB and Users with Clay and Sandy Soil VOC Removal Requirements. Initiate deep soil demonstration in partnership with DOE Savannah River Lab and Tinker or McClellan AFB.

FY 94 Commercial availability of shallow soil applications in sandy and clay type soils at other AF bases.

FUNDING ($K): FY 92 860

ACTIVITY: HQ AFCESA/RAVW, Paul R. Carpenter, DSN 523-6022.

PROJECT: MANUFACTURING TECHNOLOGY FOR LARGE AIRCRAFT ROBOTIC PAINT STRIPPING (LARPS)

OBJECTIVE: The prime objective of this program is to establish, for Oklahoma City Air Logistics Center (OC-ALC) implementation, an automated low-cost paint removal capability for large aircraft with minimal environmental impact. The program will establish an automated stripping process with the following characteristics: Reduced aircraft preparation, clean-up, and depaint manhours; reduced depot flow time; reduced ALC personnel exposure to the extremely hazardous work environment; lower cost; and a significant reduction of toxic/hazardous waste produced. Program requirements shall include a reduction of hazardous waste generation by 90%, and system availability of 85%, while maintaining surface quality acceptable in accordance with OC-ALC specific criteria. Program goals include reducing organic coating removal flow time by 50% over chemical stripping methods while reducing manhours by 50%.

BENEFITS: The LARPS system will cut OC-ALC paint removal costs by 57% annually according to a preliminary benefits analysis. More importantly, however, is the elimination of nearly 135,000 gallon/yr of hazardous methylene chloride based chemical strippers from aircraft paint removal operations. This accounts for 90% reduction in these potentially cancer causing chemicals. Oklahoma City Air Logistics Center currently spends $3 million per year to remove paint from C-135 series, B-52, B-1 and E-3 aircraft.

FUNDING ($K): FY92 650

ACTIVITY: WL/MTP, David See, DSN 785-3612.

PROJECT: CHEMICAL TANK REJUVENATION

OBJECTIVE: The purpose of this program is the development of the necessary automated or in-situ filtration and conditioning systems(s) to provide SA-ALC a completely installed, operational, chemical rejuvenation system. This system will reverse contamination and remove the sludge from the rust remover solutions Ferlon and Mil-C-14460, hydrochloric and nitric acid rust remover solutions, and rinse water solutions without removal of the tanks from service. The process will attempt to achieve near 100% chemical rejuvenation.

APPROACH: A needs analysis of system requirements for the rejuvenation systems at SA-ALC will be made. The needs analysis will include a recommendation of the minimum hardware/software requirements or upgrades needed to satisfy the goals specified in this effort. An assessment of the technical capability and economic feasibility of the selected rejuvenation system(s) chosen will be made. This assessment will include an analysis and comparison of similar rejuvenation methods available or already in use within DoD and industry, their advantages, disadvantages, and limitations. The system will be designed to maximize the rejuvenation of the solution while minimizing the cost. The assessment will also address fixed vs. portable vs. in-situ rejuvenation systems. The full scale system will be fabricated, installed, and validated at SA-ALC. Full scale chemical rejuvenation tests of the solutions will be conducted. A training course will be offered on the explanation and use of all aspects of the chemical rejuvenation system. Documentation of operating and maintenance procedures will be made. Level II drawings of all equipment parts which are specifically designed under this contract will be made and parts which are specifically designed under this contract will be made and a parts and source list for all parts, including off-the-shelf parts will be made.

BENEFITS: Components to be cleaned or stripped are dipped in the appropriate solution, then rinsed with water and dried. This cycle leaves contaminated residue in the hydroxide and acid tanks, as well as in the rinse tank, causing degradation of the respective liquids thus requiring frequent fluid changes. SA-ALC has 3,400 gallon and 13,1650 gallon rust remover tanks. They must be changed on a cycle ranging from every 45 to 360 days. On average, 4-6 hours are required for each change. All 16 tanks have a companion rinse water tank which must also be changed. Since 95% of all components separated from gas turbine engines are subject to rust remover cleaner, reconditioning of the old rust remover solution will result in elimination of transportation and disposal of old solution. It will also reduce the need for purchase of new rust remover solution. The project could have wide spread applications, not only to the Air Force, but also DoD and the commercial aircraft industry as well.

Savings of over $600K/yr in new cleaning solution purchase costs alone can be realized by reconditioning the old solution.

PARTNERS AND RELATED ACTIVITIES: No activities in this area, to the best of our knowledge.

MILESTONES:

Program start	Mid-FY 92
Program completion	Mid-FY 95

FUNDING ($K): FY 92 250

ACTIVITY: WL/MTP, S. Mazdiyasni, DSN 785-3612.

PROJECT: ADVANCED MIXING TECHNOLOGY FOR LOW NO_x GAS TURBINE COMBUSTORS

OBJECTIVE: Oxides of nitrogen (NO_x) emissions from aircraft at high altitudes is estimated to be 30 times more harmful to the environment than ground emissions. NO_x in the stratosphere depletes ozone and contributes to an increase in ultraviolet radiation reaching the earth's surface. The International Civil Aviation Organization (ICAO) is on the verge of reducing the commercial aircraft NO_x standard by 50%. A 90% reduction is expected by the year 2010. The Air Force is currently exempt from ICAO standards. However, Attachment 3 of Air Force Regulation 19-1, "Pollution Abatement and Environmental Quality," specifies goals for gaseous emissions for Air Force aircraft that are to ... "be periodically evaluated to insure support of national environmental objectives." Military engines operate much hotter than engines for commercial use in order to achieve higher levels of performance. NO_x emission level is a strong function of peak operating temperature. The performance trend in military propulsion is counter to the international pressure to reduce NO_x. This program will develop fuel injection and mixing concepts for combustors that reduce NO_x emissions in future Air Force engines while maintaining high performance.

APPROACH: Maintaining an optimal mixture of fuel and air everywhere within the combustor is critical in attaining very high performance levels while minimizing NO_x formation. Wide excursions in the local fuel-air ratio, typical of current gas turbine engine combustor design, must be avoided. Fuel injection and fuel/air mixing processes that take place in the primary flame zone of a combustor are key factors. This proposed program would leverage extensive resources already invested in an existing effort between the General Electric Company (GE) and the Aero Propulsion and Power Directorate (APPD) of Wright Laboratory. In the existing effort we are evaluating an advanced, dual-dome combustor design to develop technologies for maximum heat release, approaching stoichiometric combustion at the highest power settings. For maximum performance, controlling excursions in the local fuel-air ratio minimizes hot spots and pockets of inefficient combustion; for minimum NO_x production, the approach reduces regions of molecular nitrogen dissociation, pockets of atomic nitrogen oxidation, and cold spots that freeze the products of undesirable reaction paths. For both the base program and the expanded effort which includes low No_x considerations, GE will provide the design expertise while APPD provides the testing and instrumentation capability. Mixing effectiveness, specific oxides of nitrogen, and liquid and gas phase behavior will be measured non-intrusively with laser induced fluorescence, spectroscopic, and Mie scattering techniques, respectively. Resulting technology will enable designers to rationally trade between performance and low emissions, thereby addressing AFR 19-1 and enhancing the commercial competitiveness of the United States aviation engine industry.

MILESTONES:

12/93 Baseline: Measure mixing effectiveness and NO_x within dual-dome combustor.
10/94 Prototype Injector/Mixer: Design and fabricate injector/mixer for low NO_x.
9/95 Hardware Evaluation: Measure mixing effectiveness and NO_x in prototype.
3/96 Modify Design: Optimize design for high performance and low NO_x.
6/96 Evaluate Design: Measure performance and NO_x in final hardware.
9/96 Trade-off Model: Document the procedure for trading performance and low emissions in the design of modern gas turbine combustors.

FUNDING ($K): FY92 350

ACTIVITY: Thomas A. Jackson, WL/POSF, DSN 785-6462.

PROJECT: Fiber Optic Monitoring System Development

OBJECTIVE: This project will develop fieldable prototypes of fiber optic monitoring systems from laboratory breadboard systems developed through previous Air Force projects. Fiber optic monitoring will allow in situ, real-time analysis.

APPROACH: Three related but independent research and development efforts will be undertaken: Transportable Laser Spectrometer (TLS), Attenuated Total Reflection (ATR) Fiber Optic Sensor, and Fiber Optic Electrochemilumenescence (ECL) Sensor. Spectroscopic analysis has been well established within the laboratory and there have been several technological advances recently. This project provides for further development of the technology of transmitting light through optical fibers to a monitoring location and returning the resulting light. The TLS effort has two objectives; the first is to is to simplify the system for monitoring a specific contamination, e.g., benzene; the second is to provide a versatile site investigation/monitoring system that could be used for qualitative and quantitative analysis of contaminants. The ATR Fiber Optic Sensor effort will be useful for monitoring both vapor and aqueous phase contaminants. This sensor could be supported by the TLS and will be useful for monitoring complex mixtures of contaminants. The Fiber Optic ECL Sensor does not require stimulation by an external light source but still requires a spectrometer. It has the potential for being an inexpensive sensor for long-term site monitoring.

BENEFITS: Stringent groundwater monitoring requirements using traditional monitoring methods will place a tremendous burden upon Air Force resources because of costs and manning requirements. Air Force personnel will have new options and capabilities available for site investigations and monitoring. Significant cost savings will occur using fiber optic monitoring systems because of smaller, more easily installed monitoring points, reduced operation and maintenance costs, and decreased manning and technical expertise required. The knowledge furnished by improved characterization or monitoring of sites will afford better planned and conducted remedial activities.

PARTNERS IN RELATED ACTIVITIES: Research programs will be carried out at North Dakota State University, the University of Alabama in Huntsville, and by Cape Cod Research.

MILESTONES:

FY92: Base sensor and support system for intensive laboratory testing.
FY93: Small-scale field demonstrations.

FUNDING ($K): FY92 300

RESEARCH ACTIVITY: AFCESA/RAVW, Bruce Nielsen, DSN 523-6011.

PROJECT: e-SCRUB - The application of DNA pulsed power to electron scrubbing of flue gas to remove unwanted by-products

OBJECTIVE: Utilizing electron beam dry scrubbing (EBDS), the objectives of this program are to demonstrate a cost effective approach for removing NO_x and air toxins from DoD incinerators and SO_2 and NO_2 from coal fired boilers. This program will also provide technology transfer so that civilian utilities which use high sulfur content coal can continue to do so and still comply with the Clean Air Act Amendment (CAAA) of 1990. Thus, this program will avoid the devastating economic impact of the CAAA on producers of high sulfur content coal.

APPROACH: The Defense Nuclear Agency has supported pulsed power research for nuclear weapons effects simulation (NWES) for many years. This research has presented DNA with an opportunity to integrate this electron beam technology into EBDS, to provide an affordable electron beam dry scrubbing of stack gases. Over the past twenty years, EBDS has demonstrated the efficient removal of SO_2 and NO_x from the stack gas of coal-fired facilities and NO_x and air toxins from the flue gas of incinerators. The DoD is mandated by the CAAA of 1990 to reduce emissions from its incinerators of NO_x and air toxins: these pollutants contribute significantly to the smog problems in urban areas. In addition, coal-fired facilities contribute significantly to acid rain and other air pollution problems through emission of SO_2 and NO_x. This problem is common to DoD coal fired facilities, and many commercial facilities. Furthermore, civilian utilities in the eastern United States which rely on high sulfur coal mined in the Appalachian area will also be severely affected by the CAAA 1990, which mandates significant reduction of both SO_2 and NO_x emission for existing plants and new construction.

Until now conventional electron beam generators have been too expensive for cost effective application of EBDS. However, in support of NWES, the Balanced Technology Initiative (BTI) and the Strategic Defense Initiative Office (SDIO), DNA has developed the high power transformer accelerator (HPTA), electron beam generator. This can satisfy the power, size and cost requirements for an EBDS process affordable by the utilities and DoD boilers burning high sulfur coal and incinerators burning municipal solid waste (MSW)

Specifically, using the HPTA technology, DNA will develop a high power, continuously pulsed electron beam generator; the major elements and support subsystems are:

(1) Slow power condition system, which includes main power supply, command resonance charge unit and thyratron switched unit;

(2) Saturable reactor modulator, which includes saturable reactor units, pulse forming lines, output lines, and reset circuits;

(3) High Power Transformer Accelerator which includes the cells, HPTA support structure, cathode stalk and its support structure;

(4) Electron Gun (E-Gun) which include thermionic-cathode support structure, thermionic cathode, grids, grid driver, foil and foil support structure;

(5) Instrumentation Command and Control (IC^2) which includes all diagnostics, safety interlocks and operation;

(6) Auxiliaries which include oil, water, and vacuum subsystems; heat exchangers; flowing gas load which includes duct-work, dryers and blowers; and facility modifications such as prime power, conduits, storage tanks and thermal management.

In addition, DNA will derive an optimum layout of an EBDS treatment facility utilizing HPTA for the electron gun.

BENEFITS: The DoD is mandated by the CAAA 1990 to significantly reduce the emissions of air toxins and NO_x from its incinerators, especially those within high smog urban zones or those that can effect these through air motion. A cost effective EBDS (made so through the application of DNA's HPTA electron beam generator technology) would simultaneously remove both of these pollutants. Furthermore, there is now a unique opportunity to transfer defense technologies conceived for use in SDI, BIT, and NWES to the civilian economy to address severe national environmental and economic concerns. With EBDS, a critical national environmental goal mandated by the CAAA 1990 can be met without a devastating economic impact on the coal industry and the users of high sulfur coal. The Defense Nuclear Agency believes that this transfer of defense technology is a very valuable addition to the overall Strategic Environmental Research and Development Program.

In addition, the advent of low cost gun technology will allow the cost effective application of e-SCRUB up to 28 DoD coal fired facilities (in the range 10 to 45 MWe), removing ~95 percent of total SO_2 and ~70 percent of total NO_x from each plant. This represents ~47 percent reduction of the total emissions by treating just 21 percent of the total (131) DoD coal fired facilities.

Finally, the development of a compact, high power, high efficiency, continuously-pulsed power system will facilitate a wide spectrum of advanced weapon system developments such as:

(1) Electronic jamming systems
(2) Electronic mine clearing devices
(3) Directed energy weapons such as high energy lasers and high power microwave sources

PARTNERS AND RELATED ACTIVITIES: The Defense Nuclear Agency will collaborate with the Karlsruhe Nuclear Research Center (KFK), which has an active program in the EBDS program with KFK. Karlsruhe Nuclear Research Center will apply the two-step irradiation process and moving gravel bed filter developed by KFK to the high sulfur content

coal and moderate de-NO_x (70 to 80 percent removal efficiency) conditions appropriate to the East Coast of the United States. In addition they will apply the EBDS process to the high deNO_x and deSO_x, low deSO_x and high HCL levels typical of DoD incinerators burning municipal solid waste (MSP). The Defense Nuclear Agency will also collaborate with the University of West Virginia, which has an active program in the clean coal technology. They will assist in the analysis of EBDS for incinerators and utilities, along economic analysis of the by-product (fertilizer), value.

MILESTONES: During FY 92, DNA will perform an integrated test of these HPTA subsystems:

-	Average Power	0.5 MW
-	Run Time	10 Minutes
-	Beam Kinetic Energy	800 keV
-	Beam Current	6 kA
-	Load	Flowing Gas

Also during FY 92, DNA will task KFK to document EBDS under conditions simulating high sulfur east coast coal and DoD incinerators burning municipal solid waste. Both the KFK II AGATE II Test Facility and kinetic reaction computer models will be applied.

FUNDING ($K): FY 92 6,000

POINT OF CONTACT:

Office of Deputy Assistant Secretary of Defense for Environment, Room 206; 400 Army-Navy Drive; Arlington, Virginia 22202; Mr. James A. Marsh, (703) 695-8360.

Defense Nuclear Agency, 6801 Telegraph Road; Alexandria, Virginia 22310; Major Jeffrey Cukr, (703) 325-0905.

ENERGY

Technology Projects	Phase II	
	Page Number	FY 92 ($000)
Photovoltaics (PV) for Military Applications	76	800
Geothermal Heat Pumps	78	400
Solar Thermal Dish/Stirling for DoD Applications	79	800
Windfarm for Military Installations (Additional Funding)	80	1,300
DOE TOTAL		**3,300**

PROJECT: PHOTOVOLTAICS (PV) FOR MILITARY APPLICATIONS

OBJECTIVE: (1) to identify near term high value opportunities for PV at military installations and (2) educate installation-level staff about the technical, economic, and environmental benefits of the technology.

APPROACH:

(1) Work with facility-level people to identify PV-project potential within their domain;

(2) Provide technical and economic expertise and support to develop specific projects at those installations with the greatest PV potential;

(3) Support R&D activities necessary to bring critical component technologies required to allow completion of high value applications, to the marketplace;

(4) Link DoD and PV industry participants in technology transfer and commercialization; and

(5) Provide broad-based training, technical assistance, and outreach support to prioritize coordinated efforts to assure optimum results from available limited resources.

BENEFITS: Benefits include environmental compliance, enhanced energy cost-savings and enhanced energy security. Today's PV systems have proven to be highly reliable. Select applications can also be implemented at competitive costs over their total life cycles. PV's zero emissions, low O&M costs, and domestic production are attributes which enable all these benefits to be realized. In addition, greater utilization of PV systems will enhance economies of scale on the production side, promoting further cost reductions--which will in turn expand the scope for greater PV utilization both in the military and civilian sectors (a SERDP objective).

PARTNERS AND RELATED ACTIVITIES: The principal partners involved in this effort are the DoD (specifically OSD and the PV Review Committee including the Office of Naval Research, the Air Force Civil Engineering and Services Agency, and the Army Corps of Engineers Construction Engineering Research Laboratory); the DOE (specifically the Office of Solar Energy Conversion and DOE labs such as Sandia, NREL, Oak Ridge and Lawrence Livermore Laboratories); and industry (SEIA). DOE/DoD collaboration in this area is already underway, together with a number of related outreach activities.

MILESTONES: This project will be completed by the end of FY 1992.

FUNDING: FY 92 800

POINT OF CONTACT: James E. Rannels, Director, 1000 Independence Avenue, S.W., Washington, D.C. 20585. Phone: (202) 586-1720 Fax: (202) 586-8134, 896-1721-FTS.

PROJECT: GEOTHERMAL HEAT PUMPS

OBJECTIVE: Contribute to Department of Defense modernization and energy efficiency efforts by accelerating installation of geothermal heat pumps (GHPs) to reduce power consumption and maintenance costs at DoD facilities. Leverage DoD construction and retrofit funds with utility incentives and private sector shared savings contracts to save DoD $25-$50 million annually in electric power costs.

APPROACH: Install geothermal heat pump (GHP) systems in at least six DoD sites using SERDP funds to pay up to 100% of the incremental costs over traditional HVAC systems and fully fund a few residential systems. Utilize the GHP ranking analysis and site specific preliminary design developed in the first SERDP phase to determine the initial installation sites. Assist DoD in completing design work, issue RFP, and manage installation. Monitor the GHP energy use and maintenance cost savings, compare with prior consumption, and provide results to DoD in negotiating future rate concessions from utilities based on peak load reductions from GHP installations. All GHP ground heat exchangers types will be considered. To maximize the number of installed sites the SERDP funds will be leveraged with utility financial incentives, shared savings contractors, and sites with major potential to continue GHP system expansion.

BENEFITS: Chapter 10 of Military Handbook 1190 states, "The most efficient method of using electric power for heating is the water source heat pump (GHP)..." Compared to air source heat pumps, GHPs reduce annual electric power consumption by 35%, electric peak loads up to 50%, refrigerant use by over 50%, and electric power plant emissions by 30%. Lifecycle costs for GHPs are excellent, often the lowest of all HVAC alternatives. With DoD spending $1.5 billion annually for electricity, a program retrofitting less efficient facilities with GHPs could save DoD $25-$50 million annually by the year 2000.

PARTNERS AND RELATED ACTIVITIES: A number of DoD sites, including the Patuxent Naval Air Station, Maryland; Camp Shelby, Mississippi; and Fort Polk, Louisiana have installed GHP systems to reduce energy costs, the need for new transmission lines, and utility demand charges. The private sector will pay for new GHP systems as part of a shared savings program and some utilities will provide incentives for installation of GHP systems to improve utility load balance. DOE and EPA are developing advanced programs to increase GHP use. The Farmers Home Administration uses GHP systems for low income housing, as GHPs offer the lowest life cycle cost.

FUNDING ($K): FY 92 400

POINT OF CONTACT: Lew Pratsch, Geothermal Division, Conservation and Renewables, DOE, (202) 586-1512.

PROJECT: SOLAR THERMAL DISH/STIRLING FOR DoD APPLICATIONS

OBJECTIVE: Implementation of this proposal will establish the technology of using solar thermal dish/Stirling engine generation systems in the southwest for intermediate power. These plants could either be installed by a utility or an independent power producer at DoD facilities to provide power for military installations.

APPROACH: A 5 kWe dish/Stirling engine generation system is being developed by Cummins Power Generation Co. (CPGC) for remote applications. This is a joint venture proposal to field test units at user sites. The intention is to operate them under actual conditions as power units to learn their operating, maintainence and reliability characteristics for remote sites. It is proposed that an additional unit be purchased for installation and operation at a military facility to gain first-hand operational experience. A military installation would be a strong candidate for one of these plants when they are produced in production quantities, especially if the land were available at a DoD facility.

BENEFITS: This effort would result in the military being able to have independent and secure power on their installations. The power generated from these units when mass produced should be competitively priced for peaking/intermediate remote applications. The installation would not require additional power lines to the facility to meet future needs. Since land utilization for dish/Stirling systems is an important factor, utilization of existing military bases for solar thermal powerplant parks could benefit DoD and the utilities.

PARTNERS AND RELATED ACTIVITIES: DOE and CPGC have entered into a joint venture project to produce three proof of concept test articles, three design verification units and then ten manufactured units, and to test them at user sites. To fabricate a new design verification or manufactured unit and to test it at a military site would cost about $900,000.

MILESTONES: A unit could be installed by late 1993 or 1994.

FUNDING ($K): FY 92 800

POINT OF CONTACT: Gary D. Burch, (202) 586-0081.

PROJECT: WINDFARM FOR MILITARY INSTALLATIONS (Additional Funding)

OBJECTIVE: The primary objective of this project is to demonstrate the cost and operational benefits of powering grid connected U.S. military facilities in high wind areas with state-of-the-art wind turbines.

APPROACH: Commercial wind turbines (windfarm of 1 MW or greater) will be purchased, adapted for military application at a selected location with a high wind resource, installed, and operated. In addition, DoD personnel will receive O&M training and participate in the development of test plans for the installation. The project will be managed by the National Renewable Energy Laboratory (NREL) with wind resource assessment and siting support from the Pacific Northwest Laboratory (PNL). NREL and PNL will work closely with the engineering staff of the selected DoD facility to develop procurement plans based on the facility's needs. Testing will be conducted for a period of at least one year.

BENEFITS: The primary benefit to the DoD facilities will be the reduced consumption of nonrenewable fossil fuels for electrical power generation. In addition to cost savings, the use of state-of-the-art wind turbines will result in an alternate energy source that will serve to increase base security by providing a backup power source and increasing reliability while decreasing the reliance on vulnerable primary power sources. Larger scale windfarms have the potential to save hundreds of millions of dollars in reduced fuel and logistic costs over the lifetime of the wind turbines. There are several manufacturers of highly reliable wind systems now reporting greater than 95% availability with routine maintenance, and over 16,000 wind turbines currently installed in the U.S. providing about 1600 MW of bulk power to electric utilities. This project will serve to open related military applications.

PARTNERS AND RELATED ACTIVITIES: Similar work has been proposed for utility service areas in the Federal Wind Program and should be mutually beneficial. Partners in this work will include the wind energy industry, DOE National laboratories, and DoD (U.S. Army CERL).

MILESTONES: Project will be completed by the end of FY 1992.

FUNDING: FY 92 1,300

POINT OF CONTACT: Peter R. Goldman, Program Manager, Wind/Hydro/Ocean Division, (202) 586-1995.

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