U.S. ARMY

Submission of Proposals

Thank you for your interest in the 1992 Army SBIR new initiatives. The Army has identified 177 topics in this DoD solicitation. A listing of participating Army research and development (R&D) organizations appears on the following pages. The remaining pages provide a brief description of each topic, grouped by organization, along with an index of topic subject areas/keywords. You are urged to propose solutions to the problems stated in the topic and not to propose a study of the problem. Your innovative ideas are what we seek. We want your concepts and your thinking on possible solutions, measured in output.

This year, we have added our judgements as to the potential commercial market applications which selected topics may have. Our intent is to undertake R&D projects which can be anticipated to have benefits for both the military and commercial sectors. An example is a MANTECH topic solicited by the U.S. Army Harry Diamond Laboratories on soldering. Successful efforts in this topic will be transitioned directly into MANTECH programs in Phase III. Similarly, two topics sponsored by the U.S. Army Electronics Technology and Devices Laboratory (ETDL), "High Energy Density Polymer Capacitors" and "Microwave/Millimeter-Wave Drop In Circulators and Switches", are offered to challenge you to identify innovative military and commercial applications to these technologies. Successful companies in these ETDL topics will be licensed by the Federal Government under a Patent License Agreement to make these devices commercially available.

All proposals which do not exceed 25 pages in length will be considered equally. You are encouraged to minimize the number of pages in your proposal.

The Army is introducing new procedures to maintain continuity between Phases I and II. Specific instructions for the preparation of Phase II proposals will be sent to Phase I awardees by the responsible Army contracting offices at the time of award. Those Phase II applicants who wish to maintain project continuity must submit their completed proposals no later than 45 days prior to the expiration of the Phase I contract. Successful Phase II applicants may then be issued a contract modification covering a four-month interim period of performance while the Phase II contract is being negotiated. This modification can be expected to become effective at the completion of Phase I contract, or as soon thereafter as possible. Funding for this interim period is intended to cover the start-up costs of the Phase II effort, and will not exceed a proration of the total Phase II effort as determined by the Army SBIR Program Manager.

J. Patrick Forry
Army SBIR Program Manager

Commander
U.S. Army Laboratory Command
ATTN: AMSLC-TP-TS (Mr. J. Forry)
2800 Powder Mill Road
Adelphi, MD 20783-1145
(301) 394-4602

ARMY SMALL BUSINESS INNOVATION RESEARCH PROGRAM

Submitting Proposals on Army Topics

Phase I proposal (5 copies including 1 red-printed form) should be addressed to:

Point of Contact

ARMAMENT RESEARCH, DEVELOPMENT AND ENGINEERING CENTER (ARDEC)

Topic Nos. A92-001 through A92-005 — J. Greenfield (201) 724-6048

Commander
U.S. Army Armament RD&E Center
ATTN: SMCAR-ASC (SBIR Program)
Bldg. 1, SBIR Program
Picatinny Arsenal, NJ 07806-5000

AVIATION SYSTEMS COMMAND (AVSCOM)

Topic Nos. A92-006 through A92-024 — R. Warhover (314) 263-1074

Commander
U.S. Army Aviation Systems Command
ATTN: AMSAV-PDLZ (SBIR Program)
4300 Goodfellow Blvd., Bldg. 102
St. Louis, MO 63120-1798

BELVOIR RESEARCH, DEVELOPMENT AND ENGINEERING CENTER (BRDEC)

Topic Nos. A92-025 through A92-027 — C. Jacobs (703) 704-2253

Mail address:
Commander
U.S. Army Belvoir RD&E Center
ATTN: AMSTR-PBP (SBIR Program)
Bldg 314, Procurement Receptionist
Ft. Belvoir, VA 22060-5606

Handcarry address:
U.S. Army Belvoir RD&E Center
ATTN: STRBE-D (C. Jacobs)
Bldg. 312, Rm. 115
Ft. Belvoir, VA 22060-5606

COMMUNICATION ELECTRONICS COMMAND (CECOM)

Topic Nos. A92-028 through A92-038

J. Crisci
(908) 544-2665

- Electronic Warfare/Reconnaissance Surveillance & Target Acquisition Directorate (EW/RSTA)
- Command, Control & Communications (C3) Systems Directorate (C3Systems)
- Avionics Research and Development Activity (AVRADA)
- Space Systems Directorate (SS)
- Software Engineering Directorate (SE)
- Advanced Systems Directorate (AS)

Commander
US Army Communications-Electronics Command
ATTN: AMSEL-AC-BID (SBIR Program)
CECOM Office Building
Wayside Road and Tinton Avenue (Intersection)
Fort Monmouth, NJ 07703-5099

Topic Nos. A92-039 through A92-041

Director
USACECOM Signals Warfare Directorate
ATTN: AMSEL-RD-SW-DTI (SBIR Program)
Building 260, Linda Monroe
Vint Hill Farms Station
Warrenton, VA 22186-5100

Topic Nos. A92-042 through A92-044

Director
USACECOM Night Vision & Electro-Optics Directorate
ATTN: AMSEL-RD-NV-RM-PB (SBIR Program)
Building 305, Linda Kline
Ft. Belvoir, VA 22060-5677

CHEMICAL RESEARCH DEVELOPMENT AND ENGINEERING CENTER (CRDEC)

Topic Nos. A92-045 through A92-050

R. Hinkle
(410) 671-2031

Commander
U.S. Army Chemical Research, Development and Engineering Center
Procurement Directorate
ATTN: SMCCR-PCA (Mr. Baker)
Building 4455, SBIR Program
Edgewood Site
Aberdeen Proving Ground, MD 21010-5423

MISSILE COMMAND (MICOM)

Topic Nos. A92-051 through A92-064

O. Thomas, Jr.
(205) 842-9227

Commander
U.S. Army Missile Command
ATTN: AMSMI-RD-PC-HB, Mr. Frederick Glover, III (SBIR Program)
Redstone Arsenal, AL 35898-5275

NATICK RESEARCH, DEVELOPMENT AND ENGINEERING CENTER (NATICK)

Topic Nos. A92-065 through A92-075 — R. Rosenkrans

Commander — (508) 651-5296
U.S. Army Natick RD&E Center
ATTN: STRNC-P (SBIR Program)
Natick, MA 01760-5011

TANK-AUTOMOTIVE COMMAND (TACOM)

Topic Nos. A92-076 through A92-090 — A. Sandel

Commander — (313) 574-7545
U.S. Army Tank-Automotive Command
ATTN: AMSTA-IRSA (SBIR Program)
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Warren, MI 48397-5000

TEST AND EVALUATION COMMAND (TECOM) — R. Cozby

Topic Nos. A92-091 through A92-092 — (410) 278-7883

Commander
U.S. Army Dugway Proving Ground
ATTN: STEDP-MT-AT-I, P. Pederson (SBIR Program)
Dugway, UT 84022-5000

Topic No. A92-093

Commander
U.S. Army Jefferson Proving Ground
ATTN: STEJP-TD-D, A. Tilley (SBIR Program)
Madison, IN 47250-5100

Topic No. A92-094

Commander
U.S. Army White Sands Missile Range
Directorate of Contracting
ATTN: STEWS-PR (SBIR Program)
Bldg. 126
White Sands Missile Range, NM 88002-5201

Topic No. A92-095

Commander
U.S. Army Yuma Proving Ground
Directorate of Contracting
ATTN: STEYP-CR (SBIR Program)
Bldg. 2100, Rm 11
Yuma, AZ 85365-9102

PROJECT MANAGEMENT FOR TRAINING DEVICES (PM TRADE)

Topic Nos. A92-096 through A92-098 — A. Piper

Naval Training Systems Center — (407) 380-4287
Attn: Code 631 (SBIR Program)
12350 Research Parkway
Orlando, FL 32826

LABORATORY COMMAND

Army Research Office (ARO) — W. Sander
Topic Nos. A92-099 through A92-103 — (919) 549-0641

Commander
U.S. Army Research Office
ATTN: SLCRO-RT (ARO SBIR Program)
P.O. Box 12211
4300 S. Miami Blvd.
Research Triangle Park, NC 27709-2211

Atmospheric Science Laboratory (ASL) — O. Johnson
Topic No. A92-104 — (505) 678-3608

Commander/Director
U.S. Army Vulnerability Assessment Laboratory
ATTN: SLCVA-RMA (SBIR Program)
White Sands Missile Range, NM 88002

Ballistics Research Laboratory (BRL) — R. Dimmick
Topic Nos. A92-105 through A92-106 — (410) 278-6955

Director
U.S. Army Chemical Research, Development and Engineering Center
Procurement Directorate
ATTN: SMCCR-PCB (BRL SBIR Program)
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Edgewood Site
Aberdeen Proving Ground, MD 21010-5423

Electronics Technology & Devices Laboratory (ETDL) — R. Stern
Topic Nos. A92-107 through A92-118 — (908) 544-4666

Director
U.S. Army Electronics Technology and Devices Laboratory
ATTN: SLCET-DT (SBIR Program)
Ft. Monmouth, NJ 07703-5302

Harry Diamond Laboratories (HDL) — D. Hudson
Topic Nos. A92-119 through A92-129 — (301) 394-4808

Director
U.S. Army Harry Diamond Laboratories (HDL)
ATTN: SLCHD-SD-P, D. Hudson (SBIR Program)
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Adelphi, MD 20783-1197

Materials Technology Laboratory (MTL) — R. Morrissey
Topic Nos. A92-130 through A92-137 — (617) 923-5522

Director
U.S. Army Materials Technology Laboratory
ATTN: SLCMT-TMP (SBIR Program)
405 Arsenal Street
Bldg. 131, Rm 144
Watertown, MA 02172-2719

Vulnerability Assessment Laboratory (VAL) — R. Flores
Topic Nos. A92-138 through A92-139 — (505) 678-1468

Commander
U.S. Army Vulnerability Assessment Laboratory
VAL Acquisition Branch
ATTN: SLCVA-RMA (SBIR Program)
Building 1647
White Sands Missile Range, NM 88002-5513

ARMY CORPS OF ENGINEERS

U.S. Army Construction Engineering Research Laboratory (CERL) — D. Moody
Topic Nos. A92-140 through A92-143 — (217) 373-7290

Commander
U.S. Army Construction Engineering Research Laboratory
ATTN: CECER-CT (SBIR Program)
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2902 Newmark Drive
Champaign, IL 61821-1076

U.S. Army Cold Region Research & Engineering Laboratory (CRREL) — C. Martinson
Topic Nos. A92-144 through A92-145 — (603) 646-4244

Commander
U.S. Army Cold Region Research & Engineering Laboratory
ATTN: CRRL-LM (SBIR Program)
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Hanover, NH 03755-1290

U.S. Army Topographic Engineering Center (TEC) — C. McKenna
Topic Nos. A92-146 through A92-149 — (703) 355-2630

Commander
U.S. Army Topographic Engineering Center
ATTN: CETEC-ZC-A (SBIR Program)
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Ft. Belvoir, VA 22060-5546

U.S. Army Engineer Waterways Experiment Station (WES) — P. Stewart
Topic Nos. A92-150 through A92-152 — (601) 634-4113

Commander
U.S. Army Engineer Waterways Experiment Station
ATTN: CEWES-CT (SBIR Program)
3909 Halls Ferry Road
Vicksburg, MS 39180-6199

ARMY RESEARCH INSTITUTE (ARI)

Topic Nos. A92-153 through A92-155 — M. Drillings
Commander — (703) 274-5572
U.S. Army Research Institute for Behavioral and Social Sciences
ATTN: PERI-BR (SBIR Program)
5001 Eisenhower Avenue
Alexandria, VA 22333-5600

ARMY MEDICAL RESEARCH ACQUISITION ACTIVITY (MEDICAL)

Topic Nos. A92-156 through A92-168

Commander
U.S. Army Medical Research Acquisition Activity
ATTN: SGRD-RMA-RC, SBIR Program
Ft. Detrick, Bldg. 820
Frederick, MD 21702-5014

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(301) 619-7216

STRATEGIC DEFENSE COMMAND (SDC)

Topic Nos. A92-169 through A92-176

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U.S. Army Strategic Defense Command
ATTN: CSSD-H-CM-CB (SBIR Program)
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106 Wynn Drive
Huntsville, AL 35807-3801

E. Roy
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U.S. ARMY TRAINING AND DOCTRINE COMMAND (TRADOC)

Topic Nos. A92-177

Director
TRADOC Contracting Agency
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Maj. Elliott
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ARMY SBIR PROGRAM
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A92-045/A92-050	CRDEC	R. HINKLE	410-671-2031
A92-051/A92-064	MICOM	O. THOMAS, JR.	205-842-9227
A92-065/A92-075	NATICK	R. ROSENKRANS	508-651-5296
A92-076/A92-090	TACOM	A. SANDEL	313-574-7545
A92-091/A92-095	TECOM	R. COZBY	410-278-7883
A92-096/A92-098	PM TRADE	A. PIPER	407-380-4287
A92-099/A92-103	ARO	W. SANDER	919-549-0641
A92-104	ASL	O. JOHNSON	505-678-3608
A92-105/A92-106	BRL	R. DIMMICK	410-278-6955
A92-107/A92-118	ETDL	R. STERN	908-544-4666
A92-119/A92-129	HDL	D. HUDSON	301-394-4808
A92-130/A92-137	MTL	R. MORRISSEY	617-923-5522
A92-138/A92-139	VAL	R. FLORES	505-678-1468
A92-140/A92-143	CERL	D. MOODY	217-373-7290
A92-144/A92-145	CRREL	C. MARTINSON	603-646-4244
A92-146/A92-149	TEC	C. MCKENNA	703-355-2630
A92-150/A92-152	WES	P. STEWART	601-634-4113
A92-153/A92-155	ARI	M. DRILLINGS	703-274-5572
A92-156/A92-168	MEDICAL	A. WOLF	301-619-7216
A92-169/A92-176	SDC	E. ROY	205-955-4393
A92-177	TRADOC	MAJ. ELLIOTT	804-727-3638

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ARMAMENTS RESEARCH, DEVELOPMENT AND ENGINEERING CENTER (ARDEC)

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BELVOIR RESEARCH, DEVELOPMENT AND ENGINEERING CENTER (BRDEC)

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PROGRAM MANAGER, TRAINING DEVICES (PM TRADE)

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ARMY RESEARCH OFFICE (ARO)

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BALLISTICS RESEARCH LABORATORY (BRL)

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ELECTRONICS TECHNOLOGY AND DEVICES LABORATORY (ETDL)

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HARRY DIAMOND LABORATORY (HDL)

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MATERIALS TECHNOLOGY LABORATORY (MTL)

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A92-137Nanocrystalline Tungsten

VULNERABILITY ASSESSMENT LABORATORY (VAL)

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CONSTRUCTION ENGINEERING RESEARCH LABORATORY (CERL)

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COLD REGIONS RESEARCH AND ENGINEERING LABORATORY (CRREL)

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TOPOGRAPHIC ENGINEERING CENTER (TEC)

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ARMY RESEARCH INSTITUTE FOR BEHAVIORAL AND SOCIAL SCIENCES (ARI)

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MEDICAL RESEARCH ACQUISITION ACTIVITY (MEDICAL)

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TRAINING AND DOCTRINE COMMAND (TRADOC)

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DEPARTMENT OF THE ARMY

FY 1992 TOPIC DESCRIPTIONS

ARMAMENTS RESEARCH, DEVELOPMENT AND ENGINEERING CENTER (ARDEC)

TOPIC: A92-001TITLE: Packaging Hazard Classification and Insensitive Munitions Improvement Program

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate design modifications to existing lightweight, square rim metal containers in order to reduce the hazard classification and pass Insensitive Munitions (IM) fast cook-off test requirements by means of preventing fragments during an ammunition fire.

DESCRIPTION: The current lightweight square rim metal container is used for tank ammunition, rockets, mines, and propelling charges. The container design has been optimized for cost, weight, cube, and performance in rough handling tests (vibration, drop, etc.). By eliminating combustible material previously found in wooden boxes, it represents a safer storage configuration; however, this is not realized in hazard classification or IM testing. Hazard classification and fast cook-off IM testing subjects packaged munitions to a large fuel fire. The preferred reaction of the munition in these tests is burning only when subjected to fire tests, the present metal container design acts as a pressure vessel, allowing a rapid build-up of pressure culminating in a release of dangerous fragments. Preliminary analysis and testing by the Ballistic Research Laboratory (BRL) determined that considerate venting is necessary to prevent pressurization of the container during fire tests. A final report on their analysis is available at DTIC.

Phase I: Using new materials and designs, investigate selective weakening of the containers pressure vessel structure or the addition of venting devices to allow the escape of combustion products, (hot, high pressure gas) from the container before catastrophic failure of the container and the launch of item or container fragments. Modeling and stress analysis shall be used to predict the success of modifications.

Phase II: Develop a full-up prototype of the lightweight square rim container with modifications incorporated to improve the performance of munitions in fire tests. The prototype design should be tested in hazard classification, IM fire and packaging simulated rough handling testing. Modified container designs shall not adversely affect container performance in simulated rough handling tests. Modifications shall be optimized for producibility and cost. Detailed design specifications shall be developed.

TOPIC: A92-002TITLE: Formulations with Enhanced Energetic Output

CATEGORY: Exploratory Development

OBJECTIVE: Develop explosive/propellant formulations with enhanced performance characteristics over present military formulations.

DESCRIPTION: 1,3,3 - Trinitroazetidine (TNAZ) is a new, insensitive energetic material. TNAZ has energetic output comparable to HMX and impact sensitivity similar to Comp. B. The material has a melting point of 101 degrees Centigrade, and, hence, is steam-castable using existing technology. It is thermally stable and compatible with a wide variety of materials. Particle size is easily modified to provide small-size (e.g. 5 micron) material. TNAZ can be pressed to 98% theoretical maximum density without binder. TNAZ lends itself to both press-loaded and melt-cast high explosive (HE) formulations.

Formulations incorporating TNAZ as primary HE fill or as a component HE fill are needed in support of the Department of the Army programs for enhanced energetic output-lower sensitivity explosives for use in improved lethality anti-armor munitions, mines, and demolition applications. TNAZ also is of interest as a component in enhanced-performance LOVA gun propellants.

Phase I - Formulations using TNAZ as main or component energetic fill for high explosive or propellant applications will be investigated. Energetic output of candidate formulations will be screened using computational methods. Promising candidates should be prepared on a laboratory scale, and thermal stability and small-scale sensitivity investigated.

Phase II - Processing parameters of promising candidates will be optimized during this phase of the program. The proposed formulations will be scaled-up to provide sufficient material for large-scale performance and sensitivity testing.

TOPIC: A92-003TITLE: Advanced Materials/Coatings for Gun Barrels

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate medium caliber barrel technology which will provide extended erosion and wear life with high performance ammunition.

DESCRIPTION: The development of an effective and practical high performance gun system depends on the ability of the gun barrel to withstand the erosive conditions associated with the projectile launcher in the barrel. For the high performance barrels, major requirements include high muzzle velocity, improved accuracy, long burst length, reduced weight, extended erosion life and the use of high performance ammunition. Exploitation of ceramic materials, refractory metals and alloys, composites, advanced coatings and state of the art processing technologies are some of the approaches to provide solutions and achieve the performance objectives. Overall program thrusts include the application of new technologies to increase the effectiveness and lethality of weapon systems with a decrease in weight of components, cost and logistic operability and maintenance.

Phase I - Investigate advanced materials and coatings for potential application for gun barrels. Develop and evaluate new materials and coatings through wear and erosion tests to choose and pre-qualify appropriate material system for gun barrels. Conduct sub-scale prototype testing to down select material system.

Phase II - Develop prototype gun barrel/liner with advanced materials and coatings and demonstrate erosion and fatigue performance through test firing. Develop design concepts and design specification for gun barrels with the use of advanced materials/coatings.

TOPIC: A92-004TITLE: Low Intensity Conflict Munitions

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate non-lethal munitions against a variety of threats.

DESCRIPTION: The feasibility of developing effective munitions tailored to low intensity conflicts and exhibiting low collateral damage has been demonstrated recently in laboratory tests. In addition, the munitions demonstrated less than lethal incapacation techniques.

There has been growing interest in non-lethal weapons and many technologies are available to be exploited in this arena. Targets of interest include fire control components, sensors, electronic systems, thermal sights, TVs, missile seekers, missile guidance and personnel.

Phase I - Develop design methodology and formulate concepts for specific non-lethal munitions. Develop functional specifications. Develop preliminary deployment scenarios.

Phase II - Develop laboratory prototypes and conduct tests to evaluate performance against various threat options. Develop preliminary plans on suitable delivery vehicles and weaponization.

TOPIC: A92-005TITLE: Nondestructive Inspection from Fused Data

CATEGORY: Advanced Development

OBJECTIVE: Develop a system for automated inspection of manufactured munition items in which data from a number of types of nondestructive inspection sensors in fused and analyzed for defect detection.

DESCRIPTION: This solicitation is for the development of one or more automated inspection systems in which data from diverse nondestructive inspection sensors, such as ultrasound, acoustic emission, eddy current and x-ray is fused and analyzed. Generally nondestructive inspection of manufactured munition items such as gun tubes, recoil mechanisms, propellants, projectiles, safe and arming devices, etc. is performed based on only one type of sensor. When a defect can not be characterized by data coming from one type of sensor, it may be detectable from fused data from different types of sensors. Analysis of fused data is a complex and a new field. Recent advances in artificial neural networks, computer technology, parallel processing and sensor technology open many possibilities which should be considered in the proposal. The proposal must address a particular type of defect he is familiar with to which he will apply his work.

Phase I: The contractor will address a particular type of defect, predetermined in his proposal, appropriate for inspection using fused NDE data. He will design an automated inspection system in which the fused data would be analyzed. He will provide convincing evidence that the designed system has a very good possibility of properly determining the defect. He will find potential source of venture capital for developing the "SBIR Phase III" market.

Phase II: The contractor will build and deliver a prototype system, test it, document its operational characteristics, validate its worth, and design a production version.

AVIATION SYSTEMS COMMAND (AVSCOM)

TOPIC: A92-006TITLE: Low Observable Rotor Blade De-Ice System

CATEGORY: Exploratory Development

OBJECTIVE: To develop and test various concepts for low observable de-ice systems

DESCRIPTION: Army emphasis on low observable technology for the Comanche program and all future rotorcraft programs necessitates the effective integration of radar cross section (RCS) and infrared (IR) requirements with operational requirements. Rotor blade design is a difficult challenge because of the severe environment the blades must withstand. There is a need for a de-icing system that is compatible with a rain erosion coating (REC) and also with RCS and IR signature reduction concepts. The de-ice systems to be developed and evaluated must consider a variety of design factors including performance, weight, power and cost. Successful designs will result in enhanced all-weather capability for developmental and future low observable rotorcraft.

Phase I: Using the Blackhawk UH-60A as a design baseline, analyze several candidate main rotor blade de-ice systems which are potentially compatible with signature reduction features. RCS designs under consideration should provide a nominal 10 db broadband reduction from a metallized blade RCS level and should include magnetic radar absorbing material (RAM), lossy syntactic and Jaumann concepts. IR reduction designs should consider use of standard IR paints; the proposed de-ice systems should not increase the IR signature of the baseline blade under operational conditions encountered during cold icy weather. A tradeoff analysis of the candidates should be performed which considers: effect on RCS/IR during all modes of de-ice operation, compatibility with REC materials, de-ice system weight, power requirements, de-icing performance, system cost (manufacturing, maintenance). The best candidate de-ice system should be selected for subsequent detailed design, fabrication and test.

Phase II: A full scale section of a rotor blade incorporating RCS/IR features and the proposed de-ice system will be designed and fabricated. The section should be designed so that the following tests can be performed: RCS and IR measurements during all modes of operation of the de-ice system; de-ice performance demonstrations under simulated rotor blade icing conditions.

TOPIC: A92-007TITLE: Control System for Model Scale Semi-Autonomous Rotorcraft Research Vehicle

CATEGORY: Exploratory Development

OBJECTIVE: To design an adaptive control system for use on the Free Flight Rotorcraft Research Vehicle (FFRRV) being developed jointly by the US Army and NASA Langley. FFRRV will test widely varying rotorcraft configurations. Preplanned flight maneuvers will be executed semi-autonomously to assess the flight envelope boundaries, performance, and agility metrics.

DESCRIPTION: Dynamic stability, maneuverability, and agility are not presently addressed in helicopter wind tunnel testing for both economic and technical reasons, and the investigation of these dynamic issues must therefore be conducted on free-flight vehicles of some type, whether full scale or model scale. Unfortunately, the cost of conducting full-scale flight tests has become so high, on the order of $100K per flight hour, that it can only be considered for the most important elements of research and development where any other method of test is wholly inadequate, and considerable work is now underway to replace or supplement flight testing with simulation and analysis to the maximum extent possible.
The free flight testing effort will encompass a suite of widely varying rotorcraft configurations (plants). One goal of the project is to study the effects of varying the parameters which characterize the plant. A traditional approach to developing this control system would require modeling every perturbation of the plant and developing a new control system for the altered plant prior to flight. The manual effort involved in this modeling and redesign must be minimized or performed automatically by the control system maximize the utility of the free flight testing system. This controls problem is difficult and well suited to exploit recent advances in intelligent control theory. The goal of this SBIR is to develop a highly capable, modular, and yet compact flight control system for the FFRRV. The following are some attributes and characteristics the system should process: (1) Selectable control authority ranging from simple hand-held radio control to a fully programmable autonomous autopilot with a 3-axis stability and control augmentation system. (2) Modular hardware and software elements to allow rapid system alteration, maintenance and repair. (3) Dedicated sensor suite for the control system independent of the research data system. (4) Possible flight scenario's will dictate the trade off in implementing the stability and control augmentation between the airborne and ground based computer system. (5) The vehicle space constraints and unique missions of an unmanned air vehicle reduce the available selection of commercial control hardware and sensors while increasing the sensory requirements. (6) The hardware and software modules must not be the items that restrict the vehicles possible flight envelope.

Phase I: The expected results would be a control system design, including selection of (1) sensors, (2) telemetry systems, and (3) computer hardware and (4) a detailed methodology for developing the software which would incorporate the hardware into a working system capable of exploiting FFRRV's flight envelope.

Phase II: The effort of Phase I can logically extend into Phase II development that would include flight testing the system on model helicopters and on the FFRRV.

TOPIC: A92-008TITLE: Innovative Blade Design Concepts for Highly Maneuverable Rotor

CATEGORY: Exploratory Development

OBJECTIVE: To develop innovative blade design concepts using smart material/structures to substantially enhance the maneuver capability of the rotor.

DESCRIPTION: Future military rotorcraft will require significant increases in maneuverability and handling qualities with low detectability for air-to-air combat and nap of the earth operations. The conventional techniques to improve the maneuver capability of the rotor system are based on more blade area or increasing the effective rotor hinge offset. By doing so, however, the payload capability could drop and hub stresses increase dangerously.

Phase I: Identify and compare advanced and innovative blade design concepts using smart material/structures to enhance the rotor maneuvering capability without performance and weight penalties. Then, select a few practical concepts which are representative of current future technology and conduct a tradeoff study of these concepts considering both benefits and disadvantages in terms of attributes such as rotor performance, weight, and complexity.

Phase II: Preliminary evaluation of those concepts warranting further investigation shall be performed to verify benefits and disadvantages. The fabrication and experimental testing of the most promising concept with a 10-ft. diameter scale model will be required to validate the theoretical predictions. In support of this effort, government experience, expertise and facilities can be available in each stage. In particular, wind tunnel facilities at NASA Ames and any required supporting hardware may be available upon request.

TOPIC: A92-009TITLE: High-Speed Lightweight Over-Running Clutch for Rotorcraft

CATEGORY: Exploratory Development

OBJECTIVE: To develop a high-speed lightweight over-running clutch for rotorcraft primary drive systems.

DESCRIPTION: Current helicopters use over-running clutches as critical elements of their speed reducing main transmission systems. Due to clutch mechanism limitations, clutches are located in lower-speed but higher-torque stages of transmissions. To achieve greater weight reductions in rotorcraft drive system design it is desirable to locate the over-running clutch mechanism on the high-speed low-torque engine output shaft. Additionally, due to clutch element dynamic interactions, clutches have significant reliability and flight safety concerns.

Phase I: Design an aircraft quality lightweight over-running clutch for operation at speeds from 0 to 30,000 rpm and power levels from 0 to 5,000 hp. The clutch should be designed to operate maintenance free for at least 5,000 hours of service life and should have a relatively high stiffness to prevent torsional oscillation in the drive train.

Phase II: Fabricate and test the clutch designed in Phase I. The test hardware should be full-scale and tested through engagement/disengagement cycles over speed and power ranges up to 30,000 rpm and 5,000 hp respectively.

TOPIC: A92-010TITLE: Active/Passive Clearance Control for Small Turbine Engines

CATEGORY: Exploratory Development

OBJECTIVE: Develop an active or passive clearance control concept which could be utilized in the compressors or turbine sections of small turboshaft engine systems.

DESCRIPTION: In order to achieve the stringent performance requirements being set for our next generation's propulsion systems, significant improvements in component efficiencies will be required. One of the techniques to improve the efficiency of rotating components is to reduce the clearance between the airfoils and the shroud. Because of operational constraints (i.e., engine speed ranges), tight clearances cannot be maintained under all operating conditions using conventional shroud configurations. Innovative clearance control concepts are required in order to achieve optimized performance throughout the operating range. Active/passive clearance control concepts are currently being exploited in the large engine industry but little has been done in the small engine arena. This is primarily because of the anticipated weight penalties associated with these systems. This program will focus on development of clearance control concepts which could potentially be exploited in small (10 lbs/sec flow class) turbine engine systems.

Phase I: The Phase I activity will focus on development, definition, and preliminary design of potential active or passive clearance control concepts for the compressor or turbine section of turbine engine systems. The program will assess and summarize the relative pros and cons of the concepts defined.

Phase II: The Phase II activity will focus on demonstrating through rig testing the clearance control capability of the concept selected in the Phase I program as having the best potential systems effectiveness.

TOPIC: A92-011TITLE: A Head-Coupled Visual and Aural Sensor System for Teleoperated Rotorcraft Research Vehicle

CATEGORY: Exploratory Development

OBJECTIVE: To allow the ground-based human pilot of a remotely operated rotorcraft research vehicle to project their sensory, motor and cognitive skills to a remote location, thereby giving them the sensation of being present at that location in the cockpit of the flight vehicle. The faithful reproduction of sensory information, and the degree to which the command and control infrastructure is rendered transparent to the operator determines the fidelity of the telepresence experience.

DESCRIPTION: The proposed effort is to be part of the Free Flight Rotorcraft Vehicle (FFRRV) program being conducted jointly by the US Army and NASA Langley. The FFRRV program is developing the technology to perform dynamic agility, stability, control, and acoustic research using instrumented, free flight, reduced-scale powered rotorcraft models having Mach-scaled wind-tunnel model rotor systems. The free-flight rotorcraft program is in part an outgrowth of the fixed-wing drop model program which has become an essential part of the development of all high-performance military aircraft; the significant difference between the rotary-wing and fixed-wing programs is that the helicopter models must be powered and are therefore subject to all of the dynamic handling quality issues of full-scale helicopters, but amplified by the smaller scale of the research vehicle. Development of a telepresence capability can provide the model helicopter research pilot with considerably enhanced

sensory environment, necessary for nap of the earth flight and when coupled with a computerized control system which can emulate full-scale aircraft control laws and handling qualities at model scale. Although the telepresence research is to be conducted on helicopter models, the technology is wholly transferrable to the fixed-wing activities at Plum Tree, and to the unmanned air vehicle, flight test, and robotics communities at large.

Although there have been a number of studies aimed at providing remotely controlled systems some measure of telepresence capability the technology is immature and there are few precedents on which to rely for guidance. Moreover, the technique has never before been attempted at this scale for research flight vehicles having the level of performance expected from the FFRRV, and there are several unknowns in solving the telepresence problem. For example, the required tracking rates and damping characteristics for vision systems needed for flight operations are not well defined, nor has the significance of inertial and aural piloting cues been examined. Several novel means of providing simulated vibration and g-force cues are also being formulated for integration with the aircraft sensor suite to provide aircraft state information to the pilot through the cockpit environment.

This technology offers not only enhanced research capabilities for model flight research conducted at Langley, but also has exciting implications for full scale flight testing, hazardous environment operations for all forms of automotive vehicles, combat, reconnaissance and surveillance activities, and robotic applications.

Phase I: The expected results of the Phase I would be the complete design of the: (1) Camera and aural sensor pointing system, (2) Pilot's helmet tracking system, (3) Helmet mounted stereo display capable of displaying computer generated graphic overlays, (4) Helmet mounted stereo audio system, (5) Telemetry and control system.

Phase II: This design must be sensitive to the volume, and weight restrictions of the free flight research vehicle. Phase II would be the manufacture and test of the complete system incorporated into FFRRV.

TOPIC: A92-012TITLE: Novel Inlet Protection Systems for Auxiliary Power Units

CATEGORY: Exploratory Development

OBJECTIVE: Develop and assess novel inlet protection systems for auxiliary power units and secondary power units (APU/SPU). The emphasis of this program is to develop an inlet protection system with the highest efficiency for the lowest cost and size.

DESCRIPTION: The small gas turbine engines (under 3 lbs/sec flow class) currently used as helicopter APUs/SPUs are extremely susceptible to performance degradation due to sand ingestion. Currently, only vortex tube type inlet particle separators have been used to protect production APUs. Vortex tube type separators are very efficient at removing sand but the size and cost of this type of separator can make them difficult and expensive to retrofit existing APUs. New concepts for high efficiency inlet protection systems need to be developed for current and future APUs/SPUs. The desired levels of sand removal efficiency for C-Spec (200 micron median particle size), AC-Coarse (30 micron), and AC Fine (8 micron) test sands are 99%, 95%, and 89% with a pressure drop less than 3%. It is preferable that the new concepts be completely self cleaning although barrier filters (and other concepts that could require frequent maintenance) could also be considered as part of a desert kit to enhance the inlet protection system performance in severe sand environment.

Phase I: Develop and assess inlet protection system concepts applicable to small gas turbine engine APUs/SPUs. Conduct a trade-off analysis between efficiency, pressure loss, cost, and size for the concepts under consideration. Develop a preliminary design for the most promising concept.

Phase II: Design and fabricate a prototype for the most promising inlet protection concept. Conduct testing to determine the C-Spec, AC-Coarse, and AC-Fine sand removal efficiency and to determine the airworthiness of the prototype.

TOPIC: A92-013TITLE: Reconfigurable Flight Controls

CATEGORY: Exploratory Development

OBJECTIVE: To explore the feasibility of developing a system to identify critical failures in a helicopter fly-by-wire flight control system caused by battle inflicted damage, and reconfigure the control system to give an acceptable range of handling qualities which would, as a minimum, allow the pilot to safely return to base.

DESCRIPTION: Since the early 1980's the Air Force has conducted studies, simulations, and flight test evaluations of battle-damage tolerant flight control systems on F-15 aircraft. Once the aircraft sustains a hit during combat operations, the flight control system of the damaged aircraft reconfigured itself to give the pilot the best available flying qualities. Flight control computers through on-board sensors, assess the battle damage and perform a self-repair on the flight control system. The pilot quickly obtains control of his aircraft with flying qualities sufficient to complete his mission or at least exit the theater of operations.

Phase I: Identify and evaluate the merits of potential helicopter flight control system concepts which identify battle inflicted damage and can reconfigure to allow, as a minimum, the pilot to safely return to base.

Phase II: Conduct Conceptual design studies of the best concepts, conduct trade studies, and perform further investigations to determine definite technical requirements, as well as technical areas which need further development in order to bring these concepts to reality.

TOPIC: A92-014TITLE: Novel Turbine Concepts for Unconventional Engines

CATEGORY: Exploratory Development

OBJECTIVE: Develop an efficient small turbine able to operate at high pressure and temperature in wave rotor engines or hybrid gas turbine/wave rotor engines.

DESCRIPTION: Proposed wave rotor engines and hybrid gas turbine/wave rotor engines promise significant improvements in efficiency and specific power, especially for small size engines. While cycle parameters and wave processes for these engines are actively being studied, not much attention has been focused on the turbines required for these applications. The turbines will have to operate at high pressure and temperature, and because of their small size, will be susceptible to high tip clearance leakage losses. In addition, depending upon the porting arrangements of the wave rotor portion of the engines, the turbines may also be required to accommodate multiple gas sources at different pressures, temperatures and flow rates. New ideas and concepts are sought which will allow the turbines to meet the demanding requirements of this novel class of engines.

Phase I: Generate conceptual turbine design for a specific wave rotor or hybrid gas turbine/wave rotor engine. Perform turbine analysis, including estimation of performance parameters. Develop plans for transition to a laboratory demonstration in Phase II.

Phase II: Demonstrate the concept in a laboratory test. Obtain sufficient data to validate the predicted performance parameters.

TOPIC: A92-015TITLE: Helmet Mounted Display Flight Symbology and Stabilization Concepts

CATEGORY: Exploratory Development

OBJECTIVE: To evaluate innovative helmet mounted display flight symbology and stabilization concepts.

DESCRIPTION: Future methods of presenting and stabilizing flight symbology in wide field-of-view, visually coupled, dual optic helmet mounted displays will require significant changes to meet expected pilotage requirements. To maintain essential pilot performance during low altitude night operations under degraded weather conditions, advances in flight symbology technology need to be achieved in conjunction with advanced helmet display and sensor development. Typical screen stabilized helmet mounted display symbology in use today were developed in the late 1970s. The current technology will not provide the cueing and symbology stabilization requirements which will be necessary in future aircraft.

Phase I: Identify and evaluate new and innovative flight symbology presentation and stabilization concepts for Army aviation. A variety of design concepts should be taken into consideration. Then, using a baseline which is representative of current technology, select a limited number of candidate flight symbology presentation techniques which could provide increased pilotage effectiveness over the baseline.

Phase II: Preliminary evaluation of flight symbology concepts warranting further investigation shall be performed in both ground and in-flight simulation to verify improvement for piloted evaluations of promising configurations.

TOPIC: A92-016TITLE: Sensor Fusion for Extra Wide Field of View Helmet Mounted Display

CATEGORY: Exploratory Development

OBJECTIVE: To develop the architecture and software for merging multiple sensor image data for extra wide field of view helmet mounted display presentation.

DESCRIPTION: Current helmet mounted displays (HMD) in the RAH-66 present a modest forward hemisphere sensor scanned field of view (FOV) for pilotage use. The proposed CONDOR Advanced Visionics System (CAVS) helmet mounted display with a wider FOV, color and a virtual or synthetic display for laser eye protection offers the opportunity for further pilotage improvements. Without the availability of extremely wide FOV sensors to provide the data to fill or nearly fill the typical human eyesight FOV, a need exists to explore the effect of merging perhaps twin sensors scanning adjacent fields of regard. The blending of the sensor data for extra wide FOV with some stereoscopic overlap to complement human eye capability is at least an interim means to explore HMD capability that may be possible with next generation sensor fusion technology. The architecture and software necessary to interface current state-of-the-art sensors, graphics generator, and HMD hardware is a development required in order to investigate the pilotage implications of extra wide FOV in helmet mounted displays.

Phase I: Develop the architecture and software for merging infrared or Forward Looking infrared or video sensor image data from appropriate twin sensors whose adjacent fields of regard, with partial stereoscopic overlap, cover a total azimuth of 120 degrees and provides HMD binocular stereo image of the outside world with extra wide FOV for enhanced pilotage in day/night, adverse weather and battlefield obscurant conditions.

Phase II: Develop sensor/HMD interface component hardware which implements the architecture and software elements from phase I.

TOPIC: A92-017TITLE: Metal Matrix Composite Tubes for High Temperature Shear and Multiaxial Testing

CATEGORY: Exploratory Development

OBJECTIVE: Fabricate continuous fiber metal matrix composite tubes for shear and multiaxial fatigue and deformation evaluation.

DESCRIPTION: The evaluation of metal matrix composites has been limited to uniaxial, crack growth, and modules of rupture (MOR) testing of thin rectangular cross section specimens. These specimen are typically cut from plates no larger than 12'x12' which have been fabricated, at considerable expense, in highly specialized equipment. Investigations of the shear and multiaxial fatigue and deformation behavior are almost nonexistent due to the difficulty and expense of fabricating more elaborate shapes. It is important that manufactures develop techniques for fabricating intricate (or at least more interesting) shapes if they hope to make useful components from these materials.

Phase I: Investigate current fabrication processes and develop new techniques that will reduce the cost and improve the quality of metal matrix composites. Specifically, find a way to make metal matrix composite tubes cheaper, with good fiber matrix bonding and low porosity. High temperature application requires that coefficient of thermal expansion mismatch be closely examined.

Phase II: If Phase I shows it to be practical, fabricate a quantity of metal matrix composite tubes (fiber and matrix combination to be determined in phase) for evaluation of their shear and multiaxial properties at high temperature.

TOPIC: A92-018TITLE: Rotor Blade Motion Tracking

CATEGORY: Basic Research

OBJECTIVE: Demonstrate an optical/video technique that can be used to accurately determine motion of any point on a rotor blade.

DESCRIPTION: Helicopter vibration continues to be a major problem for Army operational forces and will continue to be so until rotors can be designed using improved analyses. All current helicopters have n/rev and 1/rev vibration levels that detract from mission performance somewhere in the aircraft envelope and these vibrations are a major source of damage to aircraft mission equipment as well. The current state-of-the-art analyses capability is inadequate to design helicopters for low vibration so it is necessary to design vibration suppression devices after the aircraft's first flight.

The problem of rotor loads and vibration prediction is extremely difficult and involves detailed calculation of the aerodynamic loading on the blade, the rotor structural response, and the helicopter fuselage response. Because of the complexity of the loading and response, it is impossible to take a final quantitative measurement, such as the n/rev vibration at the pilot's seat, and work back to a single cause for this vibration. To solve this problem it is necessary to make many measurements at many locations and in this way isolate the inadequate portions of our design analyses. One of the intermediate measurements that is essential to improvement of analyses is an exact knowledge of the blade motion. Presently, these motions are inferred by structural loads measurements, but the accuracy of these estimated has never been determined. It may be possible now, with new optical/video systems and sophisticated target tracking algorithms to make these determinations.

Phase I: An optical/video system with an appropriate tracking algorithm will be used to examine rotor blade motion in hover. The primary objective will be the accurate tracking of rigid blade motions, that is, blade flapping and feathering. The resulting blade motions will be compared with input motions based on the rotor controls. A model rotor and test facilities will be provided by the Army Aeroflightdynamics Directorate, Moffett Field, California.

Phase II: The optical/video system used in Phase I will be applied to the more difficult problem of elastic blade motion in forward flight in a wind tunnel. The motions in this case will be significantly smaller and of substantially higher frequency, thus requiring improved resolution and tracking of the blade.

TOPIC: A92-019TITLE: High Bandwidth Helicopter Electric Flight Control Actuation

CATEGORY: Exploratory Development

OBJECTIVE: Develop an electric flight control actuator suitable for helicopter application.

DESCRIPTION: Until recently, electric flight control actuation has not been feasible due to the maturity of the technology. As a result of the More Electric Aircraft effort, improvements in linear stroke, torque, power, efficiency, heat rejection, weight, volume reliability, and cost have been realized in the past five years. What is required now is an electric actuator with high bandwidth response which can compete with hydraulics without sacrificing weight, redundancy, reliability, nor simplicity.

Phase I: Preliminary design a high bandwidth electric actuator suitable for a selected baseline helicopter airframe.

Phase II: Detail design, fabricate, and bench test an electric actuator which will function as a cyclic/collective actuator.

TOPIC: A92-020TITLE: Advanced Wave Rotor, Fluid-Fluid Energy Exchanger

CATEGORY: Exploratory Development

OBJECTIVE: Develop proof of principle of a wave rotor, fluid-fluid energy exchanger.

DESCRIPTION: Analytical studies have shown that, for small gas turbine engines, significant increases in efficiency and specific power can be achieved by replacing part, or all of the compression system with a wave rotor, fluid-fluid energy exchanger. Such an engine can operate at much higher pressure ratio and peak temperature than a conventional gas turbine. Since the rotor passages are alternately exposed to hot and cold flow, the mean material temperature is considerably lower than the peak cycle temperature. This allows the use of conventional, non-exotic materials. The ability of the wave rotor device to produce power in addition to increasing pressure ratio is critical, since it must drive the compression system which feeds the wave rotor. Recent advances in computational fluid dynamics (CFD) have made possible the detailed analysis of the complex flow fields and wave motions in such a device and will allow the demonstration of proof of principle to proceed with confidence.

Phase I: Generate a conceptual, preliminary design of a wave rotor, fluid-fluid energy exchanger, including all pertinent cycle and performance parameters. Perform detailed analyses of flow fields/wave motions using latest CFD codes and develop plans for transition to a laboratory demonstration in Phase II.

Phase II: Perform laboratory demonstration of a wave rotor, fluid-fluid energy exchanger.

TOPIC: A92-021TITLE: Fracture Tough Ceramic Bearing Races

CATEGORY: Exploratory Development

OBJECTIVE: Develop fracture tough ceramic or ceramic composite races for use in all ceramic rolling element bearings for aircraft gas turbine engines.

DESCRIPTION: Future gas turbine aircraft engines will require main shaft bearings capable of operating at elevated temperatures (1000 degrees F). Ceramic bearings offer the potential to operate at elevated temperatures. However, ceramic bearing races have not been developed which posses the fracture toughness needed for these applications. The increased speeds and resulting centrifugal forces increased the need for fracture toughness in outer races. Thermal expansion differences between the shaft and ceramic inner races necessitate fracture tough inner races. Silicon nitride is commonly used for ceramic rolling elements, however, novel materials or processing techniques will be required for fracture tough races.

Phase I: Explore a number of ceramic and ceramic composite materials and manufacturing methods to obtain a fracture tough material. Fabricate specimens and perform material property testing on candidate materials.

Phase II: Perform detail design of an all ceramic rolling element bearing with fracture tough races manufactured from the material selected during Phase I. Fabricate a minimum of four sets of bearings and perform rig testing to validate the concept.

TOPIC: A92-022TITLE: Expert Diagnostics for Gas Turbine Engines

CATEGORY: Exploratory Development

OBJECTIVE: Develop expert system for turboshaft engine fault location.

DESCRIPTION: In the arena of weapons diagnostics, expert systems have approached high levels of success with regard to reliability, accuracy, ease of usage, and cost effectiveness. An expert gas turbine engine diagnostic system will be developed using the T800 as a baseline. The expert system will incorporate "adaptive" features which will identify "patterned" faults which lead to various failures, catastrophic or otherwise, and hence prevent them.

Phase I: Using a baseline engine, develop system architecture/software plan. Develop approved computer model simulating T800+ expert system.

Phase II: Detail design, develop software/hardware, test via computer simulation or piggy back on T800.

TOPIC: A92-023TITLE: High Power Density Piezoelectric Actuator for Helicopter Gearbox Noise Cancellation

CATEGORY: Exploratory Development

OBJECTIVE: Develop a vibratory force actuator with a very high output force per pound of actuator weight. The intended use of this device is for active noise cancellation for large military helicopter main gearboxes.

DESCRIPTION: The primary source of structure borne noise in large military helicopters is the main rotor gearbox. Noise levels of 100 to 120 Db are typical. Active noise cancellation appears to have significant potential for noise reduction. Currently, available actuators which produce the required force are much too large and not suitably packaged for helicopter use. It is desired that a single axis actuator capable of producing canceling forces of 50 to 100 pounds at 1000 to 4000 HZ be developed. An actuator of this type could produce a 15 Db reduction in gearbox noise. In order to be weight competitive with currently used acoustical enclosures, the actuators should weigh less than 10 pounds. Advanced piezoelectric materials such as ceramics, polymers, or composites of the two are candidates for such a device. The proper combination or configuration of these

materials could allow a lightweight, high force, high frequency actuator to be developed. In addition, electroreological and magnetostrictive technology could also be applicable to such a device.

Phase I: Develop a single axis high power density actuator for active noise cancellation of helicopter main rotor transmission vibrations. The configuration of the actuator should provide minimum weight and volume and be highly durable in the helicopter environment. The actuator should produce canceling forces in a single axis. Unique or enabling technological aspects of the device shall be demonstrated by bench testing. The results of this bench testing shall be used to evaluate the concept's potential for successful development.

Phase II: The configuration demonstrated in the Phase I effort shall be further optimized and retested. A detailed design of a multi-axis flightworthy device shall be conducted. Several devices shall be fabricated. The contractor shall coordinate this effort and the potential of testing the device on an aircraft or suitable rig with a helicopter airframe manufacturer.

TOPIC: A92-024TITLE: High Efficiency, Low Weight Electric Inlet Particle Seperator (IPS) Electric Blower for a Turboshaft Engine

CATEGORY: Exploratory Development

OBJECTIVE: Develop an efficient low weight, low volume electric drive for an IPS gas turbine engine blower.

DESCRIPTION: An electric IPS blower shall be developed using the T800 turboshaft engine as a baseline. The electric blower design shall include the controller. An analysis will be done to determine optimum power quality (e.g., AC, 28 VDC, 270 VDC) for the electric blower. The system will maximize air cooled designs, low weight and volume, and high reliability and maintainability. The motor and controller shall be located in the same module to best facilitate a LRU.

Phase I: Preliminary design of the electric IPS blower using the T800 as a baseline.

Phase II: Detail design, fabricate, and bench test the IPS electric blower. Testing will simulate T800 IPS operation over full engine operating range.

BELVOIR RESEARCH, DEVELOPMENT AND ENGINEERING CENTER (BRDEC)

TOPIC: A92-025TITLE: Mine Detectors

CATEGORY: Basic Research

OBJECTIVE: To analytically or experimentally demonstrate the feasibility of mine detection concepts.

DESCRIPTION: The Army currently has only a hand held metallic mine detector in its inventory. There is a critical need for a capability to detect nonmetallic as well as metallic mines. The need is for hand held and vehicular mounted detectors.

Phase I: An analytical demonstration of the concept feasibility is required. A description of an experimental approach that would verify the analytical results is required.

Phase II: Experimental verification preferably in a natural environment is required. Objective for transition to Phase III... This phase must include extensive field data acquisition in several field environments and analysis/evaluation of mine detection performance.

Potential Commercial Market: If successful, this research could develop a device that could be used to detect underground pipes, water main breaks, and bomb detection, to name just a few.

TOPIC: A92-026TITLE: Intrusion Detection from a Moving Platform

CATEGORY: Exploratory Development

OBJECTIVE: Development of a capability to detect intrusions into a protected area with sensors mounted on a moving platform.

DESCRIPTION: A capability is required so that mobile platforms (robots) may be used to supplement, or replace, current, fixed-in-place, sensors.

Phase I: The Phase I program will categorize the environment seen by various types of sensors when mounted on a moving platform, determine the sensing techniques most applicable to proper operation in this environment, and develop or adapt sensing algorithms that are able to distinguish intruder generated phenomena from those resulting from the continuously varying operational environment.

Phase II: The Phase II program's objective is to package this capability in a manner appropriate to an operational mobile platform. This package will be mounted, and the mobile sensing platform concept validated by test.

Potential Commercial Market: This research would advance the state-of-the art in the Security Industry. Moving Security Platforms would be used for interior surveillance in office and warehouse environments.

TOPIC: A92-027TITLE: Overhead Cover - Infantry Fighting Positions (OHC-IFP)

CATEGORY: Advanced Development

OBJECTIVE: A significant deficiency identified for units that participated in Desert Shield/Storm was that the Class IV building materials for overhead protection did not reach defensive units in the desert. The objective is to type classify an OHC-IFP device. DESCRIPTION: Develop an OHC-IFP device which weighs no more than 35 pounds, has integral ability to defeat or deflect 7.62 mm ball direct fires and stabilize the walls of the fighting position. With soil added atop, it will be able to defeat fragments from near miss 155 mm high explosive and variable timed artillery munitions. It is intended to be a Common Table of Allowances, (CTA) item, whose primary users will be infantry soldiers.

Phase I: Develop design concept and demonstration model which meets Mission Need Statement Requirements.

Phase II: Finalize design and develop full-scale prototype. Conduct static load and live fire testing. Product Level III drawing package for program to be type classified.

Potential Commercial Market: This research will impact the Construction Industry, Materials Industry and Door manufactures, at least. It will enable industry to construct lightweight, low cost structures like hollow core doors.

COMMUNICATIONS ELECTRONICS COMMAND (CECOM)

TOPIC: A92-028TITLE: Method for Advanced Production Techniques for In-Line Deposition of Diamond Scratch Resistant Coatings on Optical Glass Fibers

CATEGORY: Exploratory Development

OBJECTIVE: Develop a new on-line method for deposition of true diamond or diamond like scratch resistant coatings to replace current organic in-line plastic coatings that are deposited on optical glass fiber prior to spooling on the draw-tower take-up reel and potential use of diamond film materials for Photonic-Opto Electronic Devices.

DESCRIPTION: Diamond film coatings of optical fibers will possess utility for replacing current bulky moisture permeable organic polymer coatings used in Army's Fiber Optic guided missile program. These diamond coated fibers will allow for: (a) the processing of an all inorganic lighter weight optical fiber than current organic polymer coated fibers. (b) superior dimensional and higher temperature stability than polymer coated fibers, and (c) overcoming the aging or degradation problem of current organic polymer coatings due to moisture absorption, temperature stress plastic flow and environment radiation including micro bend optical losses.

Phase I: In Phase I, a thorough investigation will be conducted of state-of-the-art techniques for processing diamond coatings on optical glass fibers that will not degrade its inherent low optical loss, provide high strength including low micro bend losses, but greatly improve its surface hardness scratch resistant characteristics and whose surface is capable of withstanding sand blast environment without mechanical degradation of its high tensile strength.

Phase II: Phage II will continue on-going research and development efforts of Phase I Program.

Potential Commercial Market: High potential for application to commercial communications systems (telephone, cable TV) which use fiber optic transmission lines.

TOPIC: A92-029TITLE: Personal Computer (PC) Digital Map Real-Time Video Interface Boards

CATEGORY: Exploratory Development

OBJECTIVE: Develop Super Videographics Adaptor (SVGA) video interface boards for use in displaying a full-color digital map with perspective views. The interface boards must be capable of translating and rotating the digital map in real-time and overlaying objects on the scene.

DESCRIPTION: The Army, both airborne and ground, are expanding the uses of a full-color digital map derived from Defense Mapping Agency (DMA) feature and elevation data bases. A low technique to generate and display digital map data in a perspective view to be hosted in a PC environment is needed. A high speed SVGA video interface which would plug directly into the 386/486 series of machines is envisioned. The board is envisioned to have multiple uses. One use would be in a aircraft environment where systems such as the COMPUSCENE IV have had wide application. A second application would be in a ground based mission planning environment. In this application, it is envisioned that a pilot would prefly his mission in real-time over a route he selected using a digital map perspective view of the terrain that he would view from the cockpit. Real-time is defined as a minimum of IO updates a second.

Phase I: Identify the data thruput requirements to handle the three- dimensional view in real-time using Defense Mapping Agency (DNA) data with a variety of feature overlays.

Phase II: Develop a prototype interface board for evaluation no later than October 1992.

Potential Commercial Market: High potential for use in commercial mapping activities.

TOPIC: A92-030TITLE: Radio Frequency (RF) Beacon Taggant

CATEGORY: Exploratory Development

OBJECTIVE: Develop a miniaturized electronic geo-position location determination and satellite transmission system for non Line-of-Sight (LOS) operation to track fixed and mobile subjects.

DESCRIPTION: Assorted counternarcotics and special operations forces (SOF) missions require precise real-time Position/Location knowledge of fixed and moving subjects such as vehicles, aircraft, personnel, precursor chemicals and controlled substances. Knowledge of the position and movement of military, law enforcement and/or criminal activities is critical for surveillance and interdiction responses. The objective of this topic is to utilize the capabilities of the Global Positioning System (GPS) and satellite communication technology to meet this requirement. Ideas for further miniaturization, conformal antennae, and power reduction is encouraged.

Phase I: Identify available small/miniature Global Positioning System (GPS) receivers and satellite transceivers (UHF,SHF,etc.). Survey available commercial and US national satellite families that could potentially be used to support geo-position information transmission. Address the integration of existing GPS receiver functions and satellite ground terminal transmitter functions into one small combined package. Concepts for remote activation and individual user identity codes, ideas for extended battery life, limited text message transmission/reception could be discussed in Phase.I.

Phase II: Integrate an existing miniaturized Global Positioning System (GPS) receiver with the transmitter portion of a small commercial/military portable satellite transceiver. The target result would be a "Walkman" sized system to support overt and limited covert position determination and relay. The antenna suite should be optimized to conform to the conflicting requirements of small size (covertness) and omni-directional coverage. A proof of principle brassboard should be a product of this phase.

Potential Commercial Market: Some potential for application to commercial applications, including drug interdiction.

TOPIC: A92-031TITLE: Assessment of Improvement of High Frequency Circuit Predictions by Passive Means

CATEGORY: Basic Research

OBJECTIVE: Develop improved HF Propagation Prediction schemes using passing satellite updating parameter information.

DESCRIPTION: To first order the shape of the ionospheric electron density profile, Ne(h) is given by the ratio of the profile's total electron content (TEC = /Ne(h) dh) to its peak density (N max) . This ratio defines the equivalent slab thickness which is an operationally useful ionospheric parameter as it allows a simple conversion between TEC and foF2, the latter being the quantity used for HF frequency management and circuit performance reliability applications. Recent studies have shown that on a global basis scale height time/space variability is significantly less than either of its constituent parameters. Hence, its modeling may be simpler and its prediction may be more accurate than that of either of its constituent parameters. If such is the case, a model of slab thickness combined with real-time observations of TEC (from various GPS satellites, for example), may accurately infer N max (and hence, foF2) over wide geographical areas.

Phase I: Assessment of predictability of slab thickness (T).

Phase II: Assessment of comparative predictability of T and its constituent parameters. Determination of viability of inference of foF2 from model and passive TEC measurements to include expected accuracy and cost estimate/benefit.

Potential Commercial Market: High potential for applications to commercial High Frequency communications.

TOPIC: A92-032TITLE: Advanced Design Tools for Evaluating Fault-Tolerant Avionics Systems

CATEGORY: Exploratory Development

OBJECTIVE: Identify/develop an integrated set of system level performance and reliability prediction tools for the development of a mission critical and flight critical avionics systems.

DESCRIPTION: As multiprocessor and parallel processing systems become responsible for critical missions, the need to accurately predict system performance and reliability early in the design process becomes imperative. This is particularly true of fault-tolerant systems where system design is complex and intricate, with little room for uncertainty in the design process. Thus, there is a need for a plausible design paradigm and supporting toolset to assist in efficiently and effectively evaluating the impact of design decisions during early design phases. Experience has shown a particular need during requirements capture and conceptual design stages, since uncovering design or reasoning errors and unexpected anomalies in system behavior early can have the greatest impact on costs and schedule times. These methods and supporting tools allow prediction of the effectiveness of an architecture in relation to the mission requirements, the reliability and performance goals, and the system workload.

Phase I: Identify/specify a set of performance and reliability prediction tools that support design standards with respect to fault-tolerant avionics systems. Tools must support top-down design, be hierarchical, and be able to parametrically evaluate important measures of interest such as: throughput, use of resources, contention for resources, worst case data latency and communication delays.

Phase II: Develop/customize the set of tools that are capable of evaluating large-scale digital fault-tolerant avionic systems. Evaluation should include ability to determine probability of system failure with respect to time, number of processors required for reliability, and sensitivity of system reliability to performance of selected fault-tolerant mechanisms and assumed failure modes. respect to time, number of processors required for reliability, and sensitivity of system reliability to performance of selected fault-tolerant mechanisms and assumed failure modes.

Potential Commercial Market: High potential for application in commercial flight control and monitoring.

TOPIC: A92-033TITLE: Impulse Radar Electronic Support Measures (ESM) Techniques

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate the means by which to detect, characterize, Direction Find (DF), and detect impulse radars.

DESCRIPTION: The emerging deployment of impulse radars and their probable military deployment over the next decade makes it imperative to develop the means to conduct successful Electronic Support Measures (ESM) against this class of radars. The current ESM receivers were not designed to deal with this class of radars. The impulse radar is characterized by a short pulse of energy (1 to 100 nanoseconds long). The techniques/equipment developed should be designed to work in the sidelobes of the impulse radar. This innovation will significantly enhance the capabilities of the next generation Guardrail Common Sensor and

future Integrated Protection System. There is also the probable upgrade (preplanned product improvement) of existing ESM/Electronic Intelligence (ELINT) systems and incorporation of the technology into ESM/ELINT systems currently under development.

Phase I: Develop a sound theoretical basis and design of an ESM receiver, (or portion of a receiver that can be added to an existing ESM receiver) which will intercept, recognize, characterize, and direction find (DF) an impulse radar in the presence of other emitters.

Phase II: Develop and demonstrate a prototype ESM receiver based upon results of Phase I. This ESM receiver will output a digital work correctly describing the intercepted impulse radar signal to an existing ESM digital processor. A suitable antenna, the ESM receiver, and the ESM digital processor will be demonstrated as a system in both lab and field tests.

Potential Commercial Market: Some possibility for commercial application.

TOPIC: A92-034TITLE: Autonomous Satellite Location Using a Hand-Held Theodolite

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a hand-held theodolite capable of locating satellites autonomously.

DESCRIPTION: The use of commercial and military satellites is increasing for communications, navigation and other purposes. Satellite terminals are getting smaller, less expensive, more mobile and simpler to operate. To complement these developments, the capability to autonomously locate satellites in the field is required. Given multiple satellites ephemerides, dates, times and ground terminal locations, the theodolite will: a) calculate antenna pointing angles, b) visually and audibly guide the operation to the proper pointing angle(s) for the entire time a satellite is in view and c) display the times a satellite will be in view.

Phase I: Develop methodology to design a hand-held theodolite and develop functional specifications (hardware and software).

Phase II: Develop a full-up, laboratory prototype theodolite with appropriate controls, displays and interfaces. Optimize hardware/software, algorithm and interface design based on laboratory test results and provide complete documentation of hardware/software, analysis and test results.

Potential Commercial Market: Limited potential for commercial application.

TOPIC: A92-035TITLE: Non-Cooperative Combat Identification

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a non-cooperative technique for positive, real-time, identification of friendly vehicles on the battlefield.

DESCRIPTION: A requirement exists to eliminate fratricide and improve combat effectiveness through positive identification of ground vehicles at ranges compatible with modern weapon systems. The objective method for vehicle identification would be covert, unexploitable, and integrated into the target acquisition function of both air and ground weapon systems. It would require minimal or no changes to the target vehicle signature (non-cooperative) and make use, where practical, of existing and/or forecasted target acquisition assets (FLIR, Laser, or Radar). Data fusion from multiple sensors is acceptable but availability/costs for integration in all types of air and ground platforms must be considered in the concept. Under this SBIR effort, the contractor would first prove feasibility of a concept through modeling, analysis, and hardware/processor design and then develop a prototype to validate the concept in a field demonstration. Offerors should emphasize their capability to fully develop their conceptual approach in Phase I and to develop, prototype, and demonstrate their system in Phase II. Offerors are not required to submit concepts in their proposal, however, a good conceptual approach could help their proposal.

Phase I: Review government requirements. Fully develop at least one conceptual approach. Coordinate with appropriate government organizations to obtain user support and to integrate this effort into other R&D programs.

Phase II: Develop, prototype, and demonstrate combat identification system. Continue extensive coordination with government organizations.

Potential Commercial Market: Some potential for commercial application in drug interdiction efforts.

TOPIC: A92-036TITLE: Continuous Wave (CW) Laser Detection Techniques

CATEGORY: Exploratory Development

OBJECTIVE: Develop and Demonstrate Techniques for detecting low power lasers at ranges as great as 5 Km.

DESCRIPTION: Until recently military systems have used pulsed type lasers with high peak power and short pulse widths. As a result, laser detection systems have often depended on the laser's fast rise and fall times and narrow pulse widths. Now CE type lasers are finding use in military systems. Techniques for detecting CW lasers must now be developed for use in military systems.

Phase I: Determine and design a technique(s) for detecting low power (2 watts average) lasers in the 400-1100rm, 1000-3000rm, and 9000-1100rm spectral bands from distances up to 5 Km.

Phase II: Fabricate and demonstrate prototype hardware models of the technique(s) designed and developed under Phase I.

Potential Commercial Market: Limited potential for commercial applications.

TOPIC: A92-037TITLE: Support for Ada Fault Tolerant Software Systems

CATEGORY: Advanced Development

OBJECTIVE: To provide the ability to continue the execution of critical software functions when failures occur in a distributed set of processors that are executing a single Ada program. This would indicate user control over the fault detection and recovery strategies and Ada runtime services that insure a predictable state when failures occur.

DESCRIPTION: Since Ada is the DoD mandated language, it must be able to be used effectively for Army distributed fault tolerant systems. By having an effective failure semantics model, the effect of various system faults on a program executing across a distributed system can be determined. It can also dictate the kind of functionality required from an Ada runtime environment during fault conditions. Enhancing and tailoring support for fault tolerant Ada software based on a failure semantics model is the basis of this project. Issues to be addressed include: fault detection, containment, and recovery; use of exception handling; and reconfiguration strategies. Examples of faults are failures in memory, communication subsystems, and permanent or intermittent failure of processors. Runtime services needed to support fault tolerant operation need to be addressed. Special attention must be paid to the runtime maintaining a consistent view if a rendezvous across a network is occurring when a fault occurs. Ways to reconfigure and to allow continued operation need to be addressed. The features of Ada 9X that could support fault tolerance need to be assessed and incorporated as appropriate.

Phase I: Capitalize and assess existing approaches to a fault model for effectively using Ada in real-time distributed systems that have a need for continued operation in the presence of faults. Formulate a strategy to tailor an Ada runtime environment that could provide the needed support and propose a solution that will answer as a minimum the issues described in this solicitation.

Phase II: Based on the results of Phase I, produce a prototype capable of being transitioned for use in the development of Army fault tolerant Ada software systems.

Potential Commercial Market: Limited potential for commercial applications.

TOPIC: A92-038TITLE: Data Distribution Technology

CATEGORY: Exploratory Development

OBJECTIVE: Develop procedures to construct sets of rules, processes and triggers for generation and update of databases.

DESCRIPTION: The Information Distribution System concept provides the framework for establishment, distribution, and maintenance of object oriented databases within the future Army tactical command and control systems. This concept requires rules that completely describe the needs for combat information at each individual database maintained within the system, processes that locally compute updated values for the data in these databases, and triggers that permit data distribution based upon deviations from the computed norm. This effort will focus on the development of a toolkit of procedures to permit construction of the sets of rules, processes and triggers needed for generation and timely update of the Army tactical command and control systems databases. These sets of rules, processes and triggers must be flexible enough to accommodate change in a responsive manner yet provide the degree of stability necessary for combat effectiveness. Each set must be complete so there is a requirement to continually check for consistency and completeness during the development process.

Phase I: This phase of the effort will be to identify candidate procedures for the toolkit to be developed and methodology to test the adequacy of these procedures. The initial application to be addressed will be the Combat Vehicle Command and Control (CVCC) System.

Phase II: This phase of the effort will be development and evaluation of a prototype set of tools for the CVC2 system.

Potential Commercial Market: High potential for application to commercial software systems.

TOPIC: A92-039TITLE: A Secure Shell Toolkit for Unix based Intelligence and Electronic Warfare (IEW) Applications

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a toolkit that provides the required functions to add a secure shell and identify approaches to insulate IEW applications from Unix. This effort addresses basic IEW system security accreditation issues and answers.

DESCRIPTION: Future IEW systems are being targeted to be hosted upon Unix based platforms. These systems must meet Defense Intelligence Agency (DIA) system security accreditation criteria. Part of IEW application development efforts is to properly isolate from accessing Unix (intentionally or unintentionally). What is needed is an innovative approach to an IEW application toolkit that aids the system developer in solving this problem when the version of Unix is not considered secure and assist when it is. This toolbox would provide software engineering approaches and solutions to the common accreditation problems encountered in building an IEW application. This effort involves identification of key IEW system accreditation issues, tools for overcoming weaknesses, and implementation guidelines for specific functions in accomplishing system security accreditation objectives. IEW systems have normally been operated at "system High" and concerned only with a collateral release function and not multi-level security. This effort will focus upon making security accreditation a part of overall IEW design rather than an afterthought. One result will be a "how to manual" for IEW system managers to guide them in IEW system building.

Phase I: Implement the proposed innovative approach for a proof of principle demonstration and testing. Provide a users guide for use of the tool kit and document lessons learned in a final report.

Phase II: Based upon the Phase I prototype, produce a robust took kit, a programmers reference manual, and a developers guide to building secure Unix applications.

Potential Commercial Market: Definite application for improved safeguarding of information contained in commercial and industrial automated data systems.

TOPIC: A92-040TITLE: Detection of Wideband Conventional and Mixed-mode Transmissions

CATEGORY: Exploratory Development

OBJECTIVE: To develop methods that will detect various classes of wideband, conventional and mixed-mode transmissions (HF/VHF/UHF) with channelized, digital architectures.

DESCRIPTION: The sophistication of emerging communications technologies requires new means of detection, direction finding, and classification when that technology involves wideband, conventional and mixed mode transmissions at the frequency ranges of high-frequency (HF) through very-high frequency (VRF). Many wideband, channelized digital receiving

architectures exist and have been designed that have limited bandwidth. In order to obviate expensive upgrades, re-design, or totally new architectures, methods of detecting wideband signals must be developed that fit within the given, channelized architectures.

Phase I: The contractor shall categorize these wideband conventional and mixed-mode communication techniques into constituent components, and propose optimal detection algorithms for each. He shall also propose algorithms suitable for implementation within a channelized receiver architecture. Performance analysis of the proposed algorithms will be evaluated through simulation and analysis.

Phase II: This phase of the research project will focus on experimental validation of the algorithms. The proposed algorithms will be tested on data collected on transmissions and signals that were studied in the first phase of the project.

Potential Commercial Market: Some potential for application where government monitoring is required to maintain discipline of commercial communications systems.

TOPIC: A92-041TITLE: Noise Reduction Techniques

CATEGORY: Exploratory Development

OBJECTIVE: Develop and laboratory test Radio Frequency (RF) noise reduction methods and techniques for communication system sensitivity improvements.

DESCRIPTION: Recent theoretical results based on the use of higher order cumulants of a random process, such as the bispectrum, indicate that, in principle, Gaussian and other types of background noise can be reduced or eliminated from communication signals. These results need to be applied to practical situations. The development involved in this project would investigate the optimum way to implement with these algorithms on digitally channelized architectures as well as perform laboratory performance testing.

Phase I: Investigate noise reduction algorithms using high order cumulants as applied to the wideband communication problem we well as the expected performance when implemented on the above mentioned system architecture. Develop a candidate architecture for implementation. Perform limited simulation of the resulting design. Document this investigation in a Phase I final report.

Phase II: On commercially available signal processing hardware, implement the algorithms(s) defined in Phase II. Laboratory test the resulting configuration. Prepare and submit a final report on this phase.

Potential Commercial Market: High potential for commercial applications in providing improved communications systems.

TOPIC: A92-042TITLE: Forward Looking Infrared (FLIR) and Millimeter Wave Algorithms to Detect and Classify Stationary Targets

CATEGORY: Exploratory Development

OBJECTIVE: To develop algorithms to detect and classify Stationary Ground Targets in the presence of clutter and at low depression angles.

DESCRIPTION: Tank based multi-sensor systems are required to detect and classify Stationary Targets. The difficulty in distinguishing targets from natural and manmade clutter limits the detection range. A considerable amount of target and clutter data at 94GHZ and Long Wave Length Infrared (LWIR) exists at the Night Vision and Electro-Optics Directorate and elsewhere that can be used in this effort.

Phase I: Gather and organize the relevant millimeter wave and Forward Looking Infrared data. Develop a comprehensive set of potentially useful algorithms to detect and/or classify stationary targets that can be tested with the acquired data.

Phase II: Implement the algorithms identified in Phase I. Test and optimize the algorithms against the data base. Determine the best algorithm set that is practical to implement. Conduct trade off studies.

Potential Commercial Market: Some potential for commercial applications in the area of search and rescue efforts. Also, can be applied for drug interdiction programs.

TOPIC: A92-043TITLE: Infrared (IR) Materials Growth and Detector Processing Technology for Monolithic Dual-Band Detectors

CATEGORY: Advanced Development

OBJECTIVE: To provide development activity for material growth and detector processing technologies for future monolithic dual-band IR arrays. Moreover, to provide breakthrough IR detector technology that will complement ongoing DOD programs for second generation thermal imaging systems.

DESCRIPTION: A critical need exists throughout DOD for high-performance, high density photovoltaic (PV) detector arrays that are responsive to selected bands (3um to 5um and 8um to l2um) of infrared (IR) radiation. This project must address and provide the approach, rationale, resolve technical barriers, materials growth and detector processing technology for future two (dual-band) spectral band arrays. The work must systematically/attack the unknowns in the growth techniques and how best to grow and process two spectral band detectors where the adverse effects of material defects are minimized.

Phase I: In Phase I, this project is to provide development activity for investigating, evaluating and developing materials growth and detector processing technologies directed at advanced two spectral region (3um to 5um and 8um to l2um) detectors. This effort must use a monolithic compatible process to fabricate arrays on GaAs/Silicon (Si) substrates containing Si circuits.

Phase II: This Phase will demonstrate the improved detector performance, improved processing stability, increased reliability and overall array producibility.

Potential Commercial Market: Some potential for applications in commercial systems where improved materials requirements justify the increased cost.

TOPIC: A92-044TITLE: Uncooled Focal Plane Technology

CATEGORY: Basic Research

OBJECTIVE: Develop Advanced Uncooled Focal Plane Technology

DESCRIPTION: Technology related to advancing Uncooled Focal Plane Arrays: a. Develop high performance thin-film ferroelectric materials. Demonstrate films with figure-of-merit at room temperature (pyroelectric cofficient divided by dielectric constant) greater than .5. b. Develop high performance bolometer material with a temperature coefficient of performance greater than 2% at room temperature and a resistance of 2-10K ohms. c. Develop a chopper for an uncooled system with no moving parts. d. Novel detection.

Phase I: Develop concept and design.

Phase II: Fabricate hardware and demonstrate performance.

Potential Commercial Market: Some potential for commercial application.

CHEMICAL RESEARCH, DEVELOPMENT AND ENGINEERING CENTER (CRDEC)

TOPIC: A92-045TITLE: Improved Filtration for Nuclear, Chemical and Biological Aerosols

CATEGORY: Exploratory Development

OBJECTIVE: To develop a technology to provide higher performance aerosol filtration for use in military nuclear, biological, chemical (NBC) filter systems. At least an order of magnitude increase in filtration efficiency is sought with no more airflow resistance than the media currently used by the military.

DESCRIPTION: (1) General - The filtration media currently used in military NBC filters provides at least 99.97 percent filtration efficiency when tested with 0.3 micron diameter aerosol. The maximum pressure drop of the current filtration media is

40 millimeters of water at an airflow velocity of 320 centimeters per minute. Other requirements of the current filter media (details are stated in MIL-C-51079D) are that the material be water repellent, resistant to mildew, resistant to tearing/cracking, resistant to combustion, and resistant to the effects of temperature and humidity. A higher performance aerosol filtration technology is being sought with a filtration efficiency of at least 99.997 percent with no increase in airflow resistance. The improved aerosol filter may be used, or a totally different approach. The technology must be applicable to aerosol filtration associated with protective masks and/or collective protection systems.

Phase I: A concept of the aerosol filtration approach shall be fabricated. Testing shall be performed on the proposed aerosol filtration concept so as to provide evidence that the performance requirements are achievable. Of particular importance are the requirements for filtration efficiency and pressure drop.

Phase II: The aerosol filtration concept shall be developed to the extent that prototypes are fabricated. The prototype design shall be demonstrated to be implementable into military NBC filtration systems. Testing shall be performed to demonstrate that the aerosol filtration performance required of military NBC filtration systems is met.

TOPIC: A92-046TITLE: Using Thermophilic Bacteria to Produce Heat-Stable Enzymes for Enhanced Biodetection

CATEGORY: Exploratory Development

OBJECTIVE: To use thermophilic bacteria for testing and production of heat-stable enzymes for use in the Bio-Chemical Detector.

DESCRIPTION: Thermophilic bacteria isolated from geothermal sites can survive at temperatures of 100 degrees Celsius and above. Enzymes have been extracted from these bacteria and are able to withstand extreme temperatures. Researchers have incorporated enzymes isolated from thermophilic bacteria in the polymerase chain reaction (PCR). The results are improved efficiency and cost effectiveness because repeated enzyme addition was not needed after each heat cycle. The reaction also shows higher accuracy and yield when using the high temperature DNA polymerase.

Phase I: Phase I of this proposal requires the isolation and characterization of enzymes from thermophilic bacteria. The enzymes should be characterized by their reaction against thermophilic and conventional bacteria. The results will be used to develop assays.

Phase II: Phase II of this proposal is the incorporation of Phase I findings into existing biosensor systems. If successful, biological sensors such as the Light Addressable Potentiometric Sensor (LAPS), which currently employ temperature-sensitive urease can be modified.

TOPIC: A92-047TITLE: Generic Biological Agent Alarm/Monitor System

CATEGORY: Exploratory Development

OBJECTIVE: To develop a monitor/alarm system which exploits physical, spectroscopic, luminescent, or electrochemical properties of biological materials to warn of a flux in their concentrations in the environment.

DESCRIPTION: The Army has a need for a generic alarm capability to warn of the presence of potentially dangerous biological materials. An alarm system could be developed which utilizes fluorescence, luminescence, scattering, electrochemical, or other properties of biological polymers to warn of a change in concentration of these materials in the environment. This could be interfaced with a separate air sampler or could sample the air directly. This system could interface with other components so as to provide a near-real time detection capability for biological materials.

Phase I: This effort would explore the feasibility of using one of the above technologies as a means to detect biological materials in aerosol form. The contractor would be required to write a feasibility report and to provide a breadboard model for evaluation by the Government.

Phase II: The Phase II effort would develop a prototype unit with emphasis on weight, size, power consumption, and performance.

TOPIC: A92-048TITLE: Lightweight Mass Spectrometer

CATEGORY: Exploratory Development

OBJECTIVE: Development of a lightweight, man-portable mass spectrometer and associated technologies. The goal is to design and build a very mobile device which can detect chemical agents and related compounds.

DESCRIPTION: Design, fabricate and evaluate a mass spectrometry based detector which can detect chemical agents and associated compounds. Targeted requirements are: weight less than 20 lbs; power 250 watts (24 VDC); size less than 1 cu ft; sensitivity less than 1 ppb. The device shall operate as a "turn-key" detector and shall not require highly skilled operators.

Phase I: Define potential design options for this mass spectrometer, describe tradeoffs for these options, and propose the best overall design solution. Assemble and modify laboratory equipment to demonstrate the design. Evaluate this design.

Phase II: Design and build a mass spectrometer based on the equipment used to demonstrate the design produced in Phase I. Evaluate the design and prepare final report and associated drawing package.

TOPIC: A92-049TITLE: Biosensor Miniaturization

CATEGORY: Exploratory Development

OBJECTIVE: Explore methods of miniaturization of biosensor technologies currently under investigation at CRDEC. Emphasis will be placed on reducing power consumption and investigating alternative sensor designs while still meeting current mission and assay requirements. Other technologies may be considered in this topic (e.g., electrochemical).

DESCRIPTION: Two sensor types that are currently being investigated at CRDEC in terms of their future usefulness as biosensors are the Surface Plasmon Resonance (SPR) Sensor and the Fiber Optic Waveguide (FOWG). Other technologies have been considered in the past or are under review. The Army requires miniaturized (hand-held) biosensors that can operate continuously for at least 24 hours and that can rapidly and unambiguously identify bioagents of concern. All approaches being considered involve antibody based assays.

Phase I: The phase I project will involve an experimental program to downsize a particular well-developed sensor technology (i.e., SPR & FOWG) or to demonstrate the feasibility of a miniaturized sensor type offered for consideration in the offeror's proposal. The contractor will concentrate on designs that lower the system power consumption and enable the system to be hand-held. Any approach must detect a model biomolecule of interest to the Government at response and sensitivity levels within current detection requirements and operate continuously for 24 hours. A prototype will be one of the deliverables at the end of the effort.

Phase II: The phase II objective will be to optimize the design concepts explored in phase I, to produce improved prototypes, and to incorporate a variety of assays of interest to the Government. By the end-of-effort, the contractor will provide a final sensor system that meets the requirements laid out in the General section above.

TOPIC: A92-050TITLE: Orbital Dynamics and Molecular Property Visualization

CATEGORY: Basic Research

OBJECTIVE: Develop a qualitative method for understanding, predicting and visualizing the effects of molecular structure for a variety of quantum chemically determined properties.

DESCRIPTION: Graphical representation of molecular structure, orbitals and other properties are an important aspect of understanding chemical behavior. In fact, visualization has now become an accepted method for qualitatively assessing a variety of chemical reactivities. This research will focus on the development of methodologies for visualizing properties calculated from ab initio and semi-empirical quantum chemical procedures. Because of the availability and general acceptance, the Guassian series of programs and the MOPAC series should be used for calculation of properties. As AVS is becoming available on a wide variety of graphics platforms, including SGI and Kuboto, all visualization should be done under AVS.

Phase I: Phase I will commence with a feasibility study to determine the properties that could be visualized graphically, and the extent to which AVS could handle the task. All pre-written AVS modules to be used should either be those included in the release version of AVS, or available through clearing houses such as the North Carolina Supercomputing Center's repository of AVS modules (public domain).

Phase II: Phase II will concentrate on the development of modularized programs that will utilize results from the quantum chemical programs to display the properties determined in Phase I.

MISSILE COMMAND (MICOM)

TOPIC: A92-051TITLE: Tactical Missile Air Turbo Rocket Propulsion System

CATEGORY: Exploratory Development

OBJECTIVE: Design, Develop, and Demonstrate an Air Turbo Rocket Propulsion System for a Tactical Missile.

DESCRIPTION: The Air Turbo Rocket (ATR) cycle in an attractive propulsion system option for a number of tactical missile applications. The ATR offers thrust levels that significantly exceed those of a comparably sized turbojet while providing fuel efficiencies that are far superior to a rocket. Thus, the ATR is a high thrust, high efficiency propulsion system. Technology is required to enable the analysis, design, development, and demonstration of a flight-weight integrated ATR propulsion system. The desired ATR system would be an integrated propulsion module which would include an ATR engine, inlets, exhausts, fuel control, fuel tankage, fuel delivery, and starting/ignition sub systems. The integrated ATR module would perform as both a booster and a sustained propulsion system integrated into a single module. On-demand boost thrust and fully throtteable sustain thrust is desired. The ATR module shall be designed to be an integrated structural component of a 5.85 diameter tactical missile airframe. Engine exhaust can assumed to be axial. Inlets must not exceed the airframe diameter, and flush or deployable configurations are required. The ATR gas generator must be fully throttleable and may utilize solid propellant, monopropellant, or storable bipropellant technology. The propulsion module must be designed for low cost production as a critical component of a tactical missile system. Storage and operational environments are typical of a tactical Army Missile. The desired boost thrust (static sea level standard day) is 500lbf. The standard day sea level maximum sustained vehicle flight Mach number is 1.5, which requires a net sustained mode thrust of 265lbf. A desired 10 to 1 turn-down ratio on thrust is desired for the sustained mode.

Phase I: Under Phase I, a detailed system design would be produced. Critical cycle parameters would be optimized. Critical system components would be analyzed and designed. To obtain performance data on critical cycle parameters, heavy wall versions of selected critical components shall be delivered to the Government for experimental evaluation on an existing heavy wall ATR test bed. Deliverable components which are of the greatest interest are compressors, turbines, and combustors. Detailed vehicle mission analysis would be conducted under the Phase I effort. A detailed design layout for the ATR Module would be delivered to the Government. In addition, an engine cycle deck would be generated and delivered.

Phase II: Under the Phase II effort, a flight-weight ATR propulsion module would be developed and delivered to the Government for experimental evaluation.

TOPIC: A92-052TITLE: Thrust Spoiler/Reverser System for Low Cost Expendable Turbojet Engine

CATEGORY: Exploratory Development

OBJECTIVE: To develop a system to cancel or reverse the thrust of a missile turbojet engine in order to achieve rapid flight vehicle deceleration.

DESCRIPTION: Low cost expendable turbojet engines have been developed as the sustained propulsion system for a number of tactical missile systems. A principal reason for utilizing turbojet propulsion in a missile system is the capability to control the vehicle flight speed. However, the relatively slow transient thrust response of turbojet engines, and the residual engine thrust even at the idle power setting, inhibits turbojet powered missiles from executing rapid flight speed changes. Technology is required to provide on-demand thrust cancellation/reversal to permit turbojet powered missiles to achieve responsive flight speed control. A thrust cancellation/reversal system is required to (as a minimum) provide on-demand cancellation of the gross thrust

of an existing low cost expendable turbojet engine. As a goal the system should provide significant negative gross thrust. The cancellation/reversal system shall be adaptable to installation in a tactical missile and must be suitable with incorporation with an existing turbojet engine utilizing bifurcated side-existing exhausts. The system shall be installed on existing turbojet engines with minimal changes to the turbojet. As a minimum, the system shall have two positions: deployed with full cancellational/reversal and undeployed with no influence on gross thrust. As a goal the system shall have variable deployment positions for precise control of the gross thrust. The system shall be designed for low cost, low weight, reliability, and tactical missile operation. The system shall deploy on demand. For the Phase I effort, the system must be configured for integration and operation with the Williams P8910 or Sundstrand TJ-90 turbojet engines (both have bifurcated exhausts).

Phase I: The Phase I objective is the design fabrication, and delivery of a heavy-wall thrust cancellation/reversal systems. The system and all associated control systems shall be delivered to the Government for experimental evaluation.

Phase II: The Phase II objective is the design development and delivery of a flight-weight integrated thrust cancellation/reversal system. The system shall be integrated with a turbojet propulsion system and delivered to the Government for evaluation.

TOPIC: A92-053TITLE: Solid Rocket Booster Based Starter System for Tactical Missile Turbojet Engines

CATEGORY: Exploratory Development

OBJECTIVE: To utilize the solid rocket booster of a tactical missile as the starter system for the turbojet sustained.

DESCRIPTION: Low cost expendable turbojet engines have been developed as the sustained propulsion system for extended range tactical missiles. These tactical missile system invariably utilize a solid rocket motor as the booster propulsion system. Technology is required to utilized the solid rocket motor to both crank and ignite the turbojet sustained, thus eliminating an expensive pyrotechnic start cartridge and a pyrotechnic ignitor. Innovative technologies are required to transmit booster combustion products from the rocket motor chamber to the turbine impingement nozzles and to the combustor igniter location. The primary technical challenges lies in the fact that booster combustion products must be assumed to have a stagnation temperature of approximately 5000R. This gas must be transported and sufficiently cooled to be utilized in the turbojet engine, For the Phase I effort, deliverable hardware is desired to demonstrate the technical feasibility of the concept. A heavy-wall starter/igniter system shall be delivered to the Government for integration with a heavy-wall booster motor and an expendable turbojet engine. The system must be designed for either the Williams P8910 or Sundstrand TJ-90 turbojet engines.

Phase I: Design, fabricate, and deliver a heavy-wall starter/igniter system to the Governm ent. The Government shall utilize this system in a Government conducted turbojet starting demonstration test.

Phase II: Design, fabricate, and deliver and integrated flight-weight starter/igniter system. The system shall integrate a booster and turbojet sustained to for a flight-weight starter/igniter system. This system shall be delivered to the Government for evaluation.

TOPIC: A92-054TITLE: Real Time Data Compression Technique

CATEGORY: Exploratory Development

OBJECTIVE: To develop real time, data compression techniques for high data rate sensors such as EO, IIR, MMW seekers, and fiber optic guidance system.

DESCRIPTION: Many presently fielded weapon systems as well as systems on the drawing boards, must transmit and store large volumes of digital data generated by EO (electro-optical), IIR (imaging infrared), and MMW (millimeter wave) sensors. The storage devices and data link equipment is large and cumberson due to the volume of data that must be processed. Real time data compression offers the advantage of smaller storage devices and data link systems by reducing the volume of data without reducing the amount of information contained in the data. Innovative ideas are sought for the design and implementation of real time data compression techniques. The design should include techniques that operate at real time speeds (real time in this case, is that the compression technique works quickly enough that no noticeable time delay occurs if the sensor data is being viewed by an operator on a monitor) while providing for a maximum retention of information in a minimum of compression data. Proposals should contain detailed description of the technique as well as a description of its implementation. Emphasis will be

placed on the techniques which operate at real time speeds and have the best information to compressed data ratios for digital data from EO, IIR, and MMW sensors.

Phase I: Provide detailed analysis of the proposed design including experimental evaluation plan.

Phase II: Develop hardware and perform laboratory demonstrations to verify the technical approach.

TOPIC: A92-055TITLE: Quasi-Optical Power Combiner Modeling

CATEGORY: Exploratory Development

OBJECTIVE: Development of models and algorithms for predicting performance of quasi-optical millimeter-wave oscillator arrays combined in Fabry-Perot resonators.

DESCRIPTION: Quasi-optical open resonator power combining refers to combining solid-state devices in a Fabry-Perot resonator. Quasi-optical power combining offers the potential for achieving high power in small packages by efficient power combining of 2 and 3 terminal millimeter-wave solid-state sources. Realization of this potential requires a better understanding of the device-resonator interaction and loaded resonator electromagnetic propagation phenomenon through analytical modeling. The models developed under this investigation should be applicable for assessing power combining efficiency, DC-RF conversion efficiency, and transient and spectral properties of the combiner as a function of the device and resonator parameters. The models should provide insight into optimum oscillator array design by simulating the interrelationship between device spacing and driving-point impedance. The oscillator array shall consist of three terminal devices and either a grid or active antenna configuration may be considered for the device array.

Phase I: Mathematical models and algorithms for predicting combiner performance shall be developed. Deliverables shall include reports and any computer codes utilized.

Phase II: Further refinement of models and algorithms. Verification of the predicted performance shall be demonstrated through experimental studies. Deliverables shall include reports, computer codes and experimental hardware.

TOPIC: A92-056TITLE: Millimeter-Wave Spacial Power Combining Techniques

CATEGORY: Exploratory Development

OBJECTIVE: An in-depth study of architectures and techniques for use in spatially combined millimeter-wave power amplifiers.

DESCRIPTION: Millimeter-wave spacial power combining refers to feeding an array of amplifiers through space with an antenna and a collimating lens to provide an equal phase-front to the amplifier array. After reception, amplification, and re-radiation of the signal, the energy is recaptured with a lens and antenna combination and routed to the load. While there appear to be several significant advantages over conventional waveguide and stripline power combining, a study is required to assess the trade-offs and to supply preferred architectures and techniques. The study shall concentrate on Ka and W-band architectures applicable to 3 terminal devices and should consider antenna and lens requirements, device topologies, as well as propagation media for the active devices. Volume and thermal issues should also be addressed.

Phase I: Analysis and trade-off study of spacial-combining techniques and architectures. Deliverables shall include reports.

Phase II: Demonstration of a spatially combined array with an optimum design architecture as determined from Phase I. Deliverables shall include reports and experimental hardware.

TOPIC: A92-057TITLE: Optical Microwave Based Technology for IFF of Unmanned Aerial Vehicles (UAV)

CATEGORY: Exploratory Development

OBJECTIVE: Identify a low cost, low probability of intercept, all weather, stand-alone, 3-Dimensional positioning technology that can provide identification of friendly or foe (IFF) for unsophisticated, lethal, unmanned aerial vehicles.

DESCRIPTION: IFF continues to plague most developmental systems involved in the support of an air defense role. Micom has been exploring technologies that would provide a solution to this IFF question under a lethal UAV concept (SAMURAI) and under an anti-UAV concept called NOMAD. Friendly UAVs could possess either an active or passive IFF capability, and currently most active IFF solutions are critical, weight-wise, toward small unsophisticated platforms deployment. Optical Microwave technology has advanced in recent years and may offer an optical sensor outlook that provides for the needed "all weather" capability, and instantaneous precision ranging capability for IFF solutions for the development of UAVs. This technology needs to be capable of monitoring multiple IFF targets in real-time, have the provision for providing this information in a 3 dimensional positioning digital form, and ultimately interface with existing intelligence data base networks (like Patriot radar).

Phase I: Identify a promising application of optical microwave technology which would enhance existing military intelligence networks for the IFF issue for lethal, Unmanned Aerial Vehicles. Provide a preliminary design to theoretically demonstrate the enhanced capability.

Phase II: Build a feasibility demonstration model of the system concept and demonstrate its performance using multiple UAVs of varying sizes, at ranges < 60 km, and in a 360 degree radius/field of view, and on UAV platforms operating < 175 mph.

TOPIC: A92-058TITLE: Low Cost Integrated Millimeter Wave Monopulse Antenna/Transceiver

CATEGORY: Exploratory Development

OBJECTIVE: Design, develop and demonstrate an advanced technique for a miniature, low cost, highly producible, millimeter wave, integrated dual polarized monopulse antenna/transceiver for smart weapon applications. The goal shall be to demonstrate an integrated subassembly to operate over a full waveguide band (W-Band), provide a minimum polarization isolation of 40 to 50 dB, produce a SSB noise figure of 3 to 4 dB, be packaged to fit within a 150mm diameter airframe, and provide the potential for a 10 to 1 reduction, with respect to typical gimbaled systems, in large quantity, design to unit production cost (DTUPC).

DESCRIPTION: Millimeter wave sensor and seeker technology has made significant advances in recent years, demonstrating its utility for autonomous, adverse weather battlefield , smart munition applications. However, one of the major drawbacks is the issue of affordability as these MMW systems have proven to be both complex and expensive once they reach a prototype package configuration. This is particularly true of dual polarized monopulse antenna and transceiver subsystems which end up having insufficient polarization isolation, limited signal to receiver noise ratio at the desired target acquisition ranges, and systems that are difficult and costly to package in a small diameter munition. Present day antenna and transceiver components must still be hand built and "hand tweaked" to achieve acceptable performance. For production, this translates to expensive manufacturing procedures, tooling and testing which results in high DTUPC costs. This severely limits the transition of MMW systems to the production of smart weapon systems.

The U.S. Army is interested in developing a new unique technology for integrating a W-Band antenna and transceiver into a high performance, highly producibility assembly. It is desired that this integrated assembly operate over the complete waveguide band from 75 to 110 GHz and provide a SSB noise figure of 3 to 4 dB in each receiver channel. This assembly is required to provide dual plane, dual polarized receiver operation for coherent target acquisition and monopulse tracking with existing signal processing applications. The integrated assembly must be amenable to both pulse and FMCW waveforms. Interface of the assembly with typical transmitter configurations must be addressed and consideration of the integration of transmitters into the complete assemble is desired. The antenna for the integrated assembly may be a fixed real antenna capable of both strapdown and gimbaled installation. Alternately, the antenna may be electronically scanned and capable of both strapdown and gimballed installation. For either case, a description of the antenna characteristics must be detailed and the plans to achieve the polarization isolation of 40 to 50 dB must be presented. Packaging studies of the selected integrated antenna/transceiver must be described to show how it can be packaged into an airframe diameter of 150mm or less. Finally, the technology to achieve the DTUPC goals must be defined, demonstrated, and verified.

Phase I: Develop a design. Perform and provide a detailed analysis of the proposed antenna/transceiver design. Describe test to be performed to demonstrate technical objectives. Show how a reduced DTUPC will be achieved.

Phase II: Develop, fabricate and demonstrate a prototype antenna/transceiver. Demonstrate that the technical objectives are satisfied and that a significantly reduced DTUPC is achieved.

TOPIC: A92-059TITLE: Fractal Geometric Techniques for Passive Single and Multiband Image Target Acquisition and Natural Background Synthesis

CATEGORY: Exploratory Development

OBJECTIVE: Passive single and Multiband Image Analysis for aiding automatic and manual target acquisition functions and natural background synthesis.

DESCRIPTION: As technology progresses a means for simulating real word conditions at higher resolutions is required to assess the impact of new technologies on modern weapon systems. Modern sophisticated target acquisition and tracking systems which are sensitive to background characteristics are pushing the state of the art in background modeling. A modern method for characterization and synthesis of natural backgrounds is required to capture the distribution and spectral characteristics of the phenomena. In addition to synthesis of natural phenomena, image analysis providing delineation between natural and man made scene attributes offers a mechanism that emphasizes specific points in images where pattern recognition post processing can employ more scrutiny. This image analysis can be applied to several different electromagnetic image bands simultaneously (co-located and registered imagery) to improve accuracy under varying meteorological conditions. In addition to the above, the mapping of the natural scene area and enhancement of man made portions for operator display purposes based on the above processes may provide a significant improvement in operator aided target acquisition capability.

Phase I: An automated method for characterizing and synthesizing natural backgrounds as a function of data distribution and spectral content shall be defined. The method shall be supported by extensive analysis of measured thermal imagery. The methods for analysis of single and multiband imagery, over varied data sets to exploit the above phenomena, with quantification of the computational requirements shall be developed and documented. The developed methodology (i.e. algorithm and software) with documentation will be delivered to the Government for separate evaluation.

Phase II: A hardware implementation for demonstration of the Phase I developed process will be designed and prototyped.

TOPIC: A92-060TITLE: Day/Night Low Light Level (LLL) TV Sensors

CATEGORY: Basic Research

OBJECTIVE: Design, develop, and demonstrate a miniaturized, low cost Gen III Image Intensified CCD TV camera/lens system with auto-gating, auto-iris, and resolution greater than 400 TV lines per picture height at light levels ranging from 10 E-4 to 10 E4 foot candles.

DESCRIPTION: The Optical Guidance Technology Area of the Advanced Sensors Directorate is interested in low cost TV systems with day time and starlight capabilities to enhance target acquisition for next generation future systems such as NLOS Man Portable Weapon System and Aerial NLOS. While automatic gating of the image intensifiers for day use is possible with current technology, achieving resolution with low signal to noise at less that 10 E-3 footcandles requires judicious lens-intensifier-camera configuration. A miniaturized low light level system could find many applications in military and non-military systems.

Phase I: First phase objective for proposed task is to design a gated Gen III image intensifier coupled with a 2/3 inch CCD TV. Design optics with automatic iris control. Develop automatic gating control, automatic gain control, and automatic level control. Design a noise reduction filter.

Phase II: Second phase objective for proposed task is to fabricate prototype devices in a miniature package. Evaluate the performance characteristics of the device. Provide a detailed set of the procedures, including a description of the necessary equipment and facilities, for producing large quantities.

TOPIC: A92-061TITLE: Non-Intrusive Technique for the Measurement of Fluctuating Density, Temperature, and Species Concentration in Turbulent Supersonic Flows

CATEGORY: Basic Research

OBJECTIVE: To measure the high frequency, fluctuating components (as opposed to the mean components) of static density, static temperature, and species concentration in mixed supersonic/subsonic, variable species flows with multi-stream mixing using non-intrusive techniques.

DESCRIPTION: There exists a need to measure the high frequency fluctuating components (as opposed to the mean components) of density, pressure, temperature, and species concentration in mixed supersonic/subsonic, variable species flows with multi-stream mixing using non-intrusive techniques.

Current optical techniques including laser induced fluorescence (LIF), Raman scattering (CARS and SRS), and electron beam excited fluorescence offer promise for the measurement of fluctuating density, temperature, and species concentration since these techniques are non-intrusive and have been used in a supersonic wind tunnel environment to determine mean values for the above properties.

Unfortunately, current non-intrusive techniques do not work well over a broad range of flow conditions (Mach number, velocity, static temperature, static pressure, static density, stagnation temperature) or species concentration as encountered with multi-stream mixing flowfields, or are restricted in wind tunnel applications due to the need for seed gases, temperature distortion and abrasion of test section windows, foreign particulate material in the tunnel flow, and the high vibration environment surrounding the tunnel. Furthermore, modest laser pulse rates, low response signals, and slow spectrometer scan rates have precluded the determination of fluctuating properties.

This effort would entail innovative adaptations of current non-intrusive techniques to develop a system suitable for fluctuating static density, static temperature, and species concentration measurements in mixed supersonic/subsonic, variable species flows with multi-stream mixing over a broad range of static pressure, density, and temperature.

Phase I: A non-intrusive measurement system would be designed to measure fluctuating static density, static temperature, and species concentration in mixed supersonic/subsonic, variable species flows with multi-stream mixing. The system will be built, assembled, and tested in a laboratory environment for system design verification.

Phase II: The system designed in Phase I would be assembled for testing in a Government wind tunnel facility.

TOPIC: A92-062TITLE: Exploiting Advanced Mathematical Signal Processing Techniques for Radar Guided Missiles

CATEGORY: Exploratory Development

OBJECTIVE: Develop advanced signal processing techniques for use in all weather radar guided missiles. Existing data bases can be exploited with new mathematically based signal processing techniques. Comparatively new fields of mathematics will be investigated for millimeter-wave radar detection of cold stationary ground targets in a clutter rich environment. Three of these promising radar signal processing techniques are wavelets, fractals, and neural networks.

DESCRIPTION: Wavelets are a family of mathematical functions which have been used in problem solving for image compression, audio compression, and transient signal analysis. These transforms may have possible application to radar signal processing. Potential advantages include no sidelobes, fewer mathematical terms, and no Gibb's phenomenon.

The definition of a fractal is "an image which repeats itself within itself." Methods of fractal interpolation for radar signal processing will be explored. Initial work indicates that fractal dimensions for target profiles are different than clutter profiles. The importance of this technique is that it depends on the structure of the profile, not on the profile's absolute magnitude, making it independent of any amplitude thresholding (CFAR).

Neural network technology offers possible advantages in speed, fault tolerance, and development effort for real-time data processing. Neutral networks process information in parallel. This offers simultaneous feature extraction and pattern recognition mechanics. The network is trained to respond only to target signatures.

Phase I: Investigate wavelet and fractal applicability utilizing neural network processing.

Phase II: Select most promising techniques and refine algorithms with existing data.

TOPIC: A92-063TITLE: Intelligent Spatial Light Modulator

CATEGORY: Exploratory Development

OBJECTIVE: To develop a liquid crystal spatial light modulator that can be programmed to perform various local image processing operations simultaneously with the conversation of the image.

DESCRIPTION: Various spatial light modulators in use today are capable of converting an electrical signal or an incoherent light image into a coherent light image for future optical processing. Local connections between the pixels of the spatial light modulator would allow the device to simultaneously perform convolutions of the image with specified convolution kernels, which could have the effect of noise filtering, edge enhancement, or feature enhancement. This would simplify some of the operations involved in optically based automatic target recognition.

Phase I: The objective of Phase I is to demonstrate the technology by which adjacent pixels of a liquid crystal spatial light modulator may be interconnected to yield a programmable convolution function.

Phase II: In Phase II, a spatial light modulator incorporating the programmable convolution kernel technology is to be fabricated, with a total resolution of at least 64 x 64 pixels, and a minimum convolution kernel size of 3 x 3 pixels.

TOPIC: A92-064TITLE: Solid State Dye Laser

CATEGORY: Basic Research

OBJECTIVE: The objective of this effort is to provide improved dye lasers. By impregnating the laser dyes in a suitable solid hostmaterial, issues such as solvent flammability, toxicity, and dye carcinogens may be repealed. This will also cut the total system weight and complexity by as much as 50% - 70%.

DESCRIPTION: The focus of this topic is to identify prospective host materials and manufacture solid state dye laser rods. The candidate host materials should allow homogenous dye impregnation, minimize lensing and distortion effects, be transmissive in the laser dye absorption and fluorescence bands, and be inclusion/bubble free down to 0.1 micron. It is encouraged that host materials other than plastics (PMMA, CR-39, and etc.) be identified.

Phase I: The initial phase of this effort is to include investigation of the host materials. Different casting techniques, absorption and fluorescence curves, dye solubility and possible limitations on rod diameter and length shall be investigated for achieving acceptable optical quality specimens. Feasibility of casting host material against parallel (<1 minute of arc) optical flats which would relieve the need for optical polishing shall be addressed. Also, the feasibility of applying an anti-reflective or laser resonator coatings directly on the dye laser rod shall be examined in this phase.

Phase II: Phase II includes manufacture of solid state dye laser rods. The information gained from Phase I shall be applied in Phase II in an effort to achieve optimum quality dye laser rods. The dye laser rods shall be doped with, but limited to, the following laser dyes: 1.) Sulforhodamine 640, 2.) Rhodamine 590 chloride and Rhodamine 590 Tetrafluoroborate, 3.) Pentamethylpyrromethene - Borondifluoride - complex, 4.) Coumarin 540, 5.) Coumarin 314, 6.) Coumarin 102 and 7.) undoped. If feasible, the following sizes of dye laser rods shall be cast: 1.) 10.0 mm X 380.0 mm, 2.) 10.0 mm X 500.0 mm and 3.) 25 mm X 660 mm. The goal of this effort is to achieve 0.5% to 1% lasting efficiency.

NATICK RESEARCH, DEVELOPMENT AND ENGINEERING CENTER (NATICK)

TOPIC: A92-065TITLE: Individual Combat Soldier Identification Technology

CATEGORY: Exploratory Development

OBJECTIVE: To develop a technology/concept which allows the individual combat soldier a means of identifying friendly forces. This effort is devoted to improving the survivability of the soldier through the Enhanced Individual Soldier System.

DESCRIPTION: Incidents of fratricide on the battlefield have historically plagued deployed forces in operational conflicts. The resolution of night vision devices (image intensifiers) is not always sharp enough to distinguish friend from foe. An individual soldier identifier is required that is detectable through ground-based night vision devices; effective at combat ranges of up to 200 meters; be detectable on the soldier from all angles; easily activated/deactivated; be fully integrated into the combat uniform or helmet; is simple and reliable; and can be cloned to provide several variation for security purposes.

Phase I: Develop a material or item for use as a soldier identifier, and demonstrate the effectiveness of the item or material against performance criteria.

Phase II: Develop three variations of the concept for use which will ensure security. Fabricate one of the following for test and initial field evaluations: 50 identifiers, each with the required number of concept variations, if the development involves a textile substrate; or, 200 linear yards (48-60 inch width fabric) of one textile material containing all variations.

Potential Commercial Market: This item would be useable by various governmental security/law enforcement offices as well as those in the private sector.

TOPIC: A92-066TITLE: Preparing of Dry Ingredients by Ultrasonic Dehydration

CATEGORY: Exploratory Development

OBJECTIVE: To produce ingredients with excellent quality for dental liquid meals, high calorie compact food modules, and other ration applications using a relatively inexpensive dehydration process.

DESCRIPTION: An ultrasonic dehydration technology can be used to dry ingredients in as short as 10 seconds. The energy cost will be far less than the freeze drying method currently being used to produce the same items. The ability to rehydrate and to retain the nutrients would be much improved due to the extremely short residence time at high temperatures.

Phase I: Will involve identifying the ingredients most suitable for ultrasonic drying and establishing the range of process parameters applicable to them.

Phase II: Will involve optimizing the process and selection of equipment with respect to organoleptic quality and cost prior to production and evaluation.

Potential Commercial Market: This technology would help the food industry in general. Food processing costs would be lowered, which could be passed on to the consumer.

TOPIC: A92-067TITLE: Development of Activated Carbon Fibers

CATEGORY: Exploratory Development

OBJECTIVE: To investigare precursors and develop activated carbon fibers with surface areas greater than 1500M2/g suitable for use in textile applications for lightweight chemical protective combat uniforms.

DESCRIPTION: The current U.S. Army Suit, Chemical Protective uses a permeable liner material which is a 90 mil thick, seven to ten oz/yd2, polyurethane foam impregnated with activated carbon. Several novel technologies have been investigated in order to develop a lighter, thinner, less bulky sorptive layer with improved protection and reduced heat stress. One of the promising technologies is an activated carbon flocked fabric. Currently this activated carbon fiber-based fabric is being developed domestically, however, activated carbon fibers suitable for this flocked fabric are available only from a foreign source.

Phase I: Activated carbon finers will be made from at least four different precursors. The focus will be on establishing carbonization and activation parameters to develop fibers that possess characteristics suitable for use in chemical protective

textiles. Surface area and pore size distribution measurements will be generated and final target physical properties will be established.

Phase II: Processing parameters will be optimized to achieve the target properties established in Phase I. The fibers will be completely characterized for physical properties; such as, tensile strength, elongation, elasticity, specific gravity, bulk density, surface area, and pore size distribution. A sufficient quantity of fibers will be made for incorporation in target textile structures. The process to produce these fibers will be defined sufficiently to allow scale-up for commercial production.

Potential Commercial Market: Companies involved with hazardous cleanup would benefit by results of this research.

TOPIC: A92-068TITLE: Development of Flexible EMI Shielding Materials

CATEGORY: Exploratory Development

OBJECTIVE: Develop Flexible EMI Shielding Materials

DESCRIPTION: Tactical shelters are traditionally made of rigid walled panels consisting of metallic sheet materials. Although highly shielding, the materials provide little flexibility and may not meet future needs of the Army. Designs of a Flexible EMI shielding material made from a highly metallic construction is desired. It is anticipated that the material will need a wire mesh, knitted wire mesh, or some pure metallic component to obtain a high shielding effectiveness and that metallized cottons on nonconductive substrates will not be able to achieve effectiveness for a 1 foot square sample of the material tested under MIL-STD-285 is approximately 20 to 25 dB Magnetic at 150kHZ although a shielding effectiveness greater than 40dB is desired. The material is expected to maintain its flexibility so that when flexed a number of times the material does not fracture or fail in terms of its initial shielding effectiveness. The material should also be of rugged construction and should provide a long service life with minimal maintenance.

Phase I: The effort would consist of generating flexible material concepts, fabrication prototypes, and performing initial proof of concept tests on the prototypes.

Phase II: The effort would consist of fabricating or purchasing quantities of the most promising material designs, and using them to conduct full scale performance and evaluation tests.

Potential Commercial Market: These materials would be useful to the computer industry and data collection companies, by lessening interference from various sources.

TOPIC: A92-069TITLE: Synthesis of Novel Protein-Based Elastomers

CATEGORY: Basic Research

OBJECTIVE: Chemical synthesis and characterization of a family of protein-based elastomers for evaluation of functional properties separately and in combinations with traditional materials.

DESCRIPTION: The goal is to determine the potential utility of novel protein-based polymers with elastomeric properties to provide enhanced performance of elastomeric materials in the areas of selective barrier properties, resistance to swelling in organic solvents, and flexibility at low temperatures. Current synthetic elastomers exhibit some limitations in the above areas, and the protein polymers used separately or in combinations with the traditional synthetic materials may afford improvements in these areas.

Phase I: To chemically synthesize a family of model protein elastomers, patterned after natural elastomeric proteins. The proteins should be synthesized in sufficient quantities and of appropriate compostition and molecular weight such that small films, sheets or fibers can be generated to evaluate barrier properties, solvent swelling and low temperature flexibility.

Phase II: To identify the best candidate polymers from Phase I above, produce larger quantities sufficient to study interactions with currently available synthetic elastomers, and produce sample materials (alone, in combinations, as coatings, ect.) in sufficient quantity to permit a materials-level evaluation of stability, performance and overall characteristics.

Potential Commercial Market: The resulting elastomers would have usages in many areas where specific usage materials are needed, including the biomedical area.

TOPIC: A92-070TITLE: Nonpowered Instant Water Heater

CATEGORY: Exploratory Development

OBJECTIVE: To develop a nonpowered high pressure hot water source for field sanitation purposes, including cooking/cleaning, laundry, showers, decontamination, and equipment maintenance.

DESCRIPTION: Current water heating is done with antiquated immersion heaters in cans or in pots held over burners. Such batch-type heaters are very slow and inefficient. They have no provision for filling the tank from its source of cold water, nor for supplying a pressurized flow for effective use of the hot water. When a continuous source of pressurized hot water is required, electrical or engine driven water pumps must be utilized.

Phase I: The basic operating principles shall be investigated through the design and development of a proof-of-principle prototype, and the overall feasibility of the concept shall be evaluated.

Phase II: A practical prototype shall be developed in the second phase to be used for preliminary field demonstration (6.3a).

Potential Commercial Market: Disaster preparedness type companies would benefit greatly by these technological developments.

TOPIC: A92-071TITLE: Improved Individual Ballistic Protective Fibers/Material Systems for Body Armor

CATEGORY: Basic Research

OBJECTIVE: Develop and demonstrate novel technology to produce textile fibers and/or ballistic protective material systems with properties that are engineered to meet the requirements for improved, lighter weight body armor systems.

DESCRIPTION: Current body armor systems are based on high strength fibers and are typically homogeneous in nature. Body armor materials absorb energy primarily as axial tensile strain energy during ballistic impact; hence, high specific axial tensile properties are desirable for these materials. However, body armor systems are subjected to intense lateral compressive and lateral shear stresses during the impact event, and may consequently fail under this mixed mode loading without absorbing the optimal axial tensile strain energy. To further improve ballistic resistance capabilities in body armor applications, advancements in fiber technology and/or methodologies for combining high strength materials are required. Protection against fragmenting munitions remains the key threat to the key threat to the individual soldier; however, increased protection against flechettes and/or bullet threats are also of interest.

Phase I: Identify and investigate novel approaches to increase/improve ballistic protection with lighter weight body armor materials against one or a combination of threats and/or identify technologies that may lead to production of a new textile fibers with high specific axial tensile strength (greater than 3X10 to the 6 th m2/s2 or =30 g/d), high ultimate axial tensile strain (greater that 5%), and which exhibit minimal axial tensile strength loss under combined loading in lateral compression, lateral shear, and axial tension.

Phase II: Produce laboratory-scale samples of concepts identified in Phase I and determine the potential for improved performance in body armor applications of these fibers/material systems using available numerical models for the prediction of impact performance and experimentally determined material properties. Optimize selected systems, complete full evaluation (ballistic and environmental) and provide final technical report with full specification for material system(s).

Potential Commercial Market: This technology would have many uses in the law enforcement area.

TOPIC: A92-072TITLE: Water/Chemical Protective Self Sealing Slide Fasteners

CATEGORY: Exploratory Development

OBJECTIVE: To develop plastic, continuous element test samples of single pull, self sealing, separating and nonseparation slide fasteners capable of providing minimum hydrostatic pressure of 50cm or 0.7 psi at the chain and meeting related V-F-106

"Fastener, Slide" requirements. Slide fasteners can be either standard single chain single chain in combination with plastic covering provided only with single locking slider configuration.

DESCRIPTION: Currently, low cost, self-sealing slide fasteners are not available for use on chemical protective or other uniforms requiring impenetrability.

Phase I: Shall produce conceptual designs and prototype of self-sealing slide fastener for at least the chain application.

Phase II: Shall culminate design stage with proposed production system and fabrication of minimum of five 30 inch separation and non-separation Size M slide fasteners in accordance with V-F-106 chain and slider requirements. The chain shall meet a minimum hydrostatic resistance pressure of 50 cm or 0.7 psi.

Potential Commercial Market: This technology would have commercial application in the garment industry, specifically where all-weather clothing is involved.

TOPIC: A92-073TITLE: Fabrication Methods for Pressurized Fabric Arches

CATEGORY: Exploratory Development

OBJECTIVE: Develop automated fabrication methods for making low cost, high reliability air-inflated fabric arches.

DESCRIPTION: Pressure stabilized fabric arches show promise as lightweight, quickly-erectable support structures for Army tents. Arches consist of curved fabric tubes with closed ends and means for air retention. When inflated, the stressed fabric tube has substantial load carrying capability.

The state-of-the-art in fabrication arches is to cut patterns from flat fabric and sew or cement seams to form the curved tube and end closures. Air-retention is provided by a separate internal bladder or a coating. Automated techniques are sought so that the fabric can be formed directly in the curved tubular structure with no or minimum seams. A means of integral air-retention compatible with the fabrication method is required. Typical arch tubes would have diameters of six to 24 inches and operating pressures of 12 to 80 psi. For lightweight arches, advanced high-strength yarns are of interest.

Phase I: Demonstrate feasibility of a proposed automated fabrication method by generating sample curved fabric tubes using the method. Samples will be strength tested to assess the structural integrity of tubes made by the proposed method.

Phase II: Refine method demonstrated in Phase I and investigate alternative means of air-retention and making end closures. Fabricate prototype arches complete with means of air-retention and end closures and evaluate.

Potential Commercial Market: This has commercial application in the water recreation product manufacture industry.

TOPIC: A92-074TITLE: Application of Hydrogen Fuel for Food Service

CATEGORY: Exploratory Development

OBJECTIVE: Develop a laboratory prototype to demonstrate how hydrogen can be used as fuel to power food service equipment.

DESCRIPTION: Petroleum fuel use will decline in the future due to dwindling supplies and increasing emphasis on emissions control. Hydrogen is projected to become the predominate fuel of the future because of its availability, renewability, high energy density, and safety. Also, in most applications it is non-polluting. distribution requirements, and lack of large-scale generating facilities. These problems, however, will be resolved as demand increases and hydrogen becomes more economical. Already, advanced in carbon absorption and metal hydride based systems have reduced the weight, volume, pressure and low temperature requirements of hydrogen storage. Concurrent development of highly efficient photovoltaic conversion technologies will establish low cost large-scale solar powered electrolysis facilities as the primary source of hydrogen gas. All this will allow increased use of hydrogen to power military and commercial equipment systems. Hydrogen gas is well suited to power food service equipment. If fact it was a major component of popular gases used for home cooking and heating in the early 1900's. Not only will it burn directly as a flammable gas, but it will also oxidize an a fuel cell and produce electricity. Consequently, this gas would be an ideal fuel to power future field kitchens that will require both thermal and electrical energy.

Phase I: Will systematically investigate and define the best approach to integrate hydrogen fuel into food service operations. Included will be a study to determine optimum storage, transmission, and utilization methods. Trade-offs expected will be in terms of weight, volume, safety, cost, and energy efficiency. Based on the results of this study a conceptual model of a completely hydrogen powered food service facility shall be fashioned to demonstrate benefits and characterize salient technical features (weight, cube, fuel usage and storage capacity, output, etc.).

Phase II: In phase II an actual working prototype shall be fabricated. The prototype can be any component of the phase I model that demonstrates hydrogen fuel storage, transfer and utilization to produce heat and electricity. Examples are an electrically controlled fuel fired oven, fabrication and successful demonstration of this model.

Potential Commercial Market: This technology would be useful anywhere remote feeding sites would be setup, including in disaster situations.

TOPIC: A92-075TITLE: Alternative Fabric Coatings for Waterproof Fabrics and Clothing

CATEGORY: Exploratory Development

OBJECTIVE: Identify alternative coating materials which would produce satisfactory performance in coated fabrics of current standard end items, meet requirements for environmental and personnel safety during manufacturing, and provide personal safety during use.

DESCRIPTION: Coated fabrics customarily produced for military waterproof clothing and equipment application use coating compounds of three basic types: solution coating (containing flammable solvents), ascender coating, and platisol coating. Components of these compounds can be hazardous to the environment, manufacturing personnel, and the military user if not properly contained, handled, or disposed.

Phase I: Would consist of a survey of the current state-of-the-art of coatings such as water based coatings, 100 percent solids coatings, electron beam curable coatings, etc. including the manufacturing methods/equipment utilized for the manufacture of coated fabrics, films, and film laminates.

Phase II: Would consist of the preparation of small quantities of coated or laminated fabric in materials constructions suitable for the specific end item (e.g., lightweight coated fabric for a wet weather poncho). Testing of the pilot production quantity of coated or laminated fabric would also be performed.

Potential Commercial Market: The transfer of this technology would help the outdoor recreation industry in general.

TANK-AUTOMOTIVE COMMAND (TACOM)

TOPIC: A92-076TITLE: Subsystem Research - Automated Depth and Remote Blade Control

CATEGORY: Exploratory Development

OBJECTIVE: Examine and develop sensing, actuation and control technologies for automated operation or remote operation of blade and plow devices (earthwork blade, mineplow) for combat vehicles.

DESCRIPTION: Emerging combat vehicles require computer assisted mine rakes/plows and earth-moving blades. These rakes can be on manned vehicles with computer assisted depth controls or on remote controlled vehicles. There is a wide range of sensors, actuators and control strategies for these systems. Possible sensors include video cameras, scanners, laser range finders, position sensors, force-feedback sensors, and hydraulic sensors. Actuators are necessary to operate, but not eliminate, the existing blade controls. The overall control strategy may encompass sensor fusion, actuator control, dynamic/kinematic models, blade tasks, control theory, and vehicle mobility. These technologies could then be applied to a tracked vehicle and provide an original demonstration of computer assisted and remote blade operation.

Phase I: The contractor will research promising sensor technologies and software algorithms for depth control, develop a concept for automated blade depth control and remote blade operation. The government will evaluate the concept and research to determine the potential for manned and remote combat vehicles. A final report will detail the Phase I effort.

Phase II: The contractor will continue to research, plan, and develop a breadboard prototype of a computer assisted blade control system. The contractor will experiment with the breadboard prototype on a military tracked vehicle to demonstrate its functionality. The breadboard will be used to explore the performance and applicability of the technologies to manned and remote combat vehicles. The deliverables from this phase will include design drawings, software, technical report, and demonstrator.

Potential Commercial Market: The Automated Depth and Blade Control supports both military and civilian needs. The CMV, M1 Breacher and Mine Clearing Rake require automated control of blade/rake functions in remote control operations. The US Army Engineer School is the proponent for mine clearing rake/blade technologies. A second application for this technology is as retrofit to the existing Battalion Countermine Set (BCS). The BCS contains a manually operated mine plow. The US Army Armor School is proponent for the BCS. Civilian applications include automated construction equipment, produced by a number of US industries including Caterpillar and John Deere. Road graders, scrapers, and bulldozers can be automated with this technology for both civil works and military earthworks.

TOPIC: A92-077TITLE: Application of Thin Film Thermoelectrics

CATEGORY: Exploratory Development

OBJECTIVE: Develop a technique to apply thin film thermoelectrics to a metal substrate.

DESCRIPTION: The project consists of development of a technique to apply relatively thin film thermoelectric materials, on the order of 2-5 mils thick, to a metal substrate for large area surface cooling. It is anticipated that a number of material mixtures with various dopant levels will be required to optimize the performance of the devices. It is also a requirement that the films be strongly bonded to the substrate. It is anticipated that the samples will be exposed to mechanical abrasive stresses. The technique should also be compatible with large surface areas, on the order of one square meter.

Phase I: Determine the feasibility of applying thin layers of both P and N type junction materials. Create and evaluate the samples for typical thermoelectric performance characteristics. A number of samples will be produced varying the material composition. Address the problems associated with P junctions in oxygen environments and solutions.

Phase II: Manufacture several full up N-P junction device, varying the material composition to achieve maximum cooling performance. These devices will be tested for typical thermoelectric performance characteristics and mechanical durability. The devices will be provided to the government for evaluation.

Potential Commercial Market: There are many commercial applications for low costs, efficient thermal electric elements. the ability to heat and cool within a single small, light weight module would be a very attractive device for many commercial products.

TOPIC: A92-078TITLE: Mission Function Automation - AVLB

CATEGORY: Exploratory Development

OBJECTIVE: Research and demonstrate a mission function automation subsystem including the sensors, software, and operator/displays necessary to provide a remote operator sufficient feedback (e.g., graphical animation, tactile feedback) to assist in bridge deployment using tactical RF communication links without a video signal.

DESCRIPTION: The US Army anticipates combat and tactical vehicles with reduced crew and remote operability. In order for a remote operator to effectively deploy a bridge, he must have critical information on the bridging site, dynamic position, and AVLB system status. There are numerous rugged, reliable, all-weather, inexpensive, passive/low-emission, devices and technique that have potential application. These include hardware sensors such as ground-pressure, proximity, inclinometers, accelerometers, and strain gauges. Producing a graphical representation of the bridging scene and deploying bridge using this information may be an effective means of providing sufficient, low bandwidth information. The goal for a Phase II (Commercial/Military Market) is a hardened package for retrofit to existing bridges and launchers.

Phase I: The contractor will study the currently fielded AVLB system and interview operators to understand the manned launch. The researcher will identify critical elements, devices, techniques, and technologies needed to actuate, sense, remotely control, and monitor mission functions. The contractor will then develop a range of non-video, mission remote control

concepts employing a variety of sensors and graphic animation. All concepts will communicate with the remote operator via military tactical radios and emply reliable, all-weather, sensing packages for remote operator launch. The contractor will then conduct a trade study to determine the optimum research approaches. He will sufficiently document the study with scaled drawings, technical descriptions, design methodology, and operational procedures to allow government engineers to analyze the trade-off study.

Phase II: The contractor will build a breadboard prototype and experiment on an AVLB a prototype of a Phase I concept selected by the government. The contractor will deliver all hardware and software purchased or developed during this effort. In addition, he will prepare a detailed final report including design schematics, experimentation procedures, results, and recommendations.

Potential Commercial Market: This research will lead to low data rate telemetry which will produce real-time graphical animation of the bridge and mission site. This technology may produce a viable non-line-of-sight radio communication technique that will allow effective remote operation of engineer bridging systems. In addition, the graphical interface work may yield an effective simulation and training tool for bridging equipment and operations. In the civilian sector, this technology may also have application in remote control of systems operating in hazardous environments. Due to the nature of the environment, the operator cannot maintain line-of-sight with the remote system and therefore cannot preserve video images.

TOPIC: A92-079TITLE: Computer Simulation Modeling of NBC Sensor Capabilities on Ground Vehicles

CATEGORY: Exploratory Development

OBJECTIVE: To develop a computer simulation model that replicates NBC Sensor capabilities and analyzes results for effectiveness evaluation.

DESCRIPTION: (1) Demonstrates ability to simulate/replicate NBC on-board sensor suites for the purpose of assisting in subsystem design. (2) Provide method to analyze results of NBC attack on protected/unprotected/partially protected vehicles and crews. Method must address casualties, duration of attack, wind direction and down-wind effects; decontamination times; additional times to repair; long duration effects on crews, supplies, vehicle operations-repair-maintenance. (3) Should interface with existing combat models (CASTFORM or ELAN+) to measure effects on combat force over time.

Phase I: Consists of a study conducted to (1) Review existing and currently fielded US Army, NATO and Soviet NBC sensors to determine the fields existing capability to detect and analyze current NBC threats; (2) Review technical literature to determine availability and capabilities of commercial or developmental sensors that could be readily procured in time of need; and (3) Assess the feasibility of developing a model that replicates NBC threat delivery systems, atmospheric conditions in various locations world-wide and predict casualties (military and civilian) under given MOPP protection level. This phase would also have the contractor propose a methodology for developing a simulation that accurately models threats against both a system/crew and against a force. This methodology would require the model to interface with existing COEA force-on-force models like CASTFOREM, JANUS or ELAN+.

Phase II: Would contract for the development and validation of the NBC model. It would demonstrate its ability to lay a threat delivered agent; measure the force's ability to detect the agent; calculate the effect on the force and surrounding civilian populace; then predict force effectiveness in measures of combat effectiveness, logistics, casualties/fatalities and vehicle repair.

Potential Commercial Market: The potential for this development to be accomplished in the commercial sector is high.

TOPIC: A92-080TITLE: Non-Hydraulic Suspension Actuators

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate non-hydraulic actuators for application in active and/or semi-active suspension systems for combat vehicles.

DESCRIPTION: A non-hydraulic actuator system capable of generating the force and displacements required of a combat vehicle is being solicited. This non-hydraulic actuator is to be used in an active or semi-active suspension.

Phase I: The design concept shall be proven from a feasibility standpoint. Laboratory bench testing shall be accomplished to prove the feasibility of this concept.

Phase II: Concept shall be demonstrated on a combat vehicle based on further direction from USATACOM engineers.

Potential Commercial Market: Active suspension is rapidly making inroads into the passenger car and light truck market. Currently such systems require hydraulics for implementation. Non-hydraulic actuators would provide a safer, less complex actuation mechanism and would quickly become the technology of choice for commercial active suspension systems.

TOPIC: A92-081TITLE: Mission Function Automation

CATEGORY: Exploratory Development

OBJECTIVE: Research and demonstrate a mission function automation subsystem including the sensors, software, and operator controls/displays necessary to provide a remote operator sufficient feedback (e.g., graphical animation, tactile feedback, etc.) to dig or perform counter obstacle operations using tactical radio communication links without a video signal.

DESCRIPTION: The US Army anticipates combat and tactical vehicles with reduced crew and remote operability. In order for a remote operator to effectively deploy a bridge, he must have critical information on the digging/breaching site, dynamic bucket position, and system status. There are numerous rugged, reliable, all-weather, inexpensive, passive/low-emission, devices and technique that have potential application. These include hardware sensors such as ground-pressure, proximity, inclinometers, accelerometers, and strain gauges. Producing a graphical representation of the digging/breaching scene using this information may be an effective means of providing sufficient, low bandwidth information. The goal for a Phase III (Commercial/Military Market) is a hardened package for the CMV or M1 Breacher.

Phase I: The contractor will study the currently fielded breaching systems and interview operators to understand the manner operation. The research will identify critical elements, devices, techniques, and technologies needed to actuate, sense, remotely control, and monitor mission functions. The contractor will then develop a range of non-video, mission remote control concepts employing a variety of sensors and graphic animation. All concepts will communicate with the remote operator via military tactical radios and employ reliable, all-weather, sensing package for remote operator launch. The contractor will then conduct a trade-off study of their concepts to determine the optimum research approach. The contractor will sufficiently document the study with scaled drawings, technical descriptions, design methodology, and operational procedures to allow government engineers to analyze the trade-off study.

Phase II: The contractor will develop a breadboard prototype based on a government selected Phase I concept. The contractor will install the prototype on an existing engineer vehicle for system experimentation. The contractor will deliver all hardware and software purchased or developed during this effort. In addition, he will prepare a detailed final report including design schematics, experimentation procedures, results, and recommendations.

Potential Commercial Market: This research will lead to low data rate telemetry which will produce real-time graphical animation of the breaching/counter-obstacle sites. This technology may produce a viable non-line-of-sight radio communication technique that will allow effective remote operation of engineer counter mobility systems. In addition, the graphical interface work may yield an effective simulation and training tool for this type of engineer equipment and operations. In the civilian sector, this technology may also have application in remote control of systems operating in hazardous environments. Due to the nature of the environment, the operator cannot maintain line-of-sight with the remote system and, therefore, cannot preserve video images.

TOPIC: A92-082TITLE: Unified Flexible Body Load Derivation (DEMO)

CATEGORY: Exploratory Development

OBJECTIVE: Investigate the modification of dynamic analysis models to account for nonrigid body analysis.

DESCRIPTION: Dynamic analysis codes such as the Dynamic Analysis & Design System (DADS), are used to predict structural loads on vehicles due to terrain inputs. These codes provide a rigid body solution. For structures which are primarily designed for ballistic protection and, hence, overdesigned for terrain induced loads, these results are an accurate representation of the real

world. However, a flexible body solution is needed when optimizing a vehicle design for terrain induced loads due to the flexure of this lighter weight vehicle. This is especially true of composite based vehicles.

Phase I: Choose the optimum path/codes to account for body flexure in vehicles. Apply and demonstrate its use on a mock composite structure supplied by the government.

Phase II: The contractor will verify and refine the analysis by modeling the Composite Infantry Fighting Vehicle (CIFV) fabricated under a Materials Technology Laboratory (MTL) contract with FMC Corporation. Measurements were made on the composite structure during field evaluations.

Potential Commercial Market: Currently there is no means to convert data from rigid body analysis codes to where it can be non-rigid body codes. There is a need for this capability in industry. A company that developed such a package would have a giant market that has been looking for such a solution.

TOPIC: A92-083TITLE: Universal, Programmable Automotive Remote Control System

CATEGORY: Exploratory Development

OBJECTIVE: The contractor will explore the remote actuation of automotive controls for unmanned ground vehicles. The goal is to produce a low cost, programmable, robust, automotive control system that the military can apply to a broad spectrum of wheeled and tracked ground mobility systems.

DESCRIPTION: The US Army anticipates combat and tactical vehicles with reduced crew and remote operability. These ground mobility systems will perform a variety of combat, combat support, and combat service support missions. Possible chassis range from small recreational vehicles to main battle tanks. They include adaptations of existing manned vehicles as well as new unmanned designs. Developing new control systems for each type of research and production chassis is costly, duplicative, and time consuming. ideally, the military needs a control system that a user could easily array to accommodate a variety of actuators, feedback sensors, and chassis. It should be flexible to allow the user to quickly adapt and reprogram the controller for use on a different type of vehicles and with varying actuators and feedback sensors. Compatibility with existing and future military electronic and communication protocol standards is desirable.

Phase I: During this initial phase, the contractor will identify critical elements, devices, techniques, and technologies needed to actuate, sense, remotely control, and monitor automotive functions. They should include comparisons of these factors as a function of possible chassis. The contractor will then develop a range of programmable control system concepts communicating with the remote operator via military tactical radio. Documentation must be sufficient to allow government engineers to determine if they could satisfy current or future requirements for unmanned ground vehicles. Reports must include scaled concept drawings, technical descriptions, design methodology, operational procedures, and work descriptions.

Phase II: After documenting a sound Phase I concept, the contractor shall fabricate and experiment with a breadboard prototype of a government selected Phase I concept on tracked and wheeled chassis. The contractor will deliver the prototype controller(s), operator control unit, actuators, feedback sensors, and programming device. In addition, he will provide design schematics and experimentation and final reports.

Potential Commercial Market: The US Government has remotely actuated numerous ground mobility systems as technology testbeds, training devices, and now combat systems. These systems typically have unique and uniquely developed remote controls devices. The non-recurring costs and non-standard components have cost the government significant resources. As we field these systems, the logistic and supportability become even more critical. This device will not only standardize testbeds and technology demonstrators, but may apply to the US Army-Marine Corps Tactical Unmanned Ground Vehicle and other emerging automotive automation programs. Hardened and durable military remote control kits may have use in the civilian sector for controlling heavy earth-moving and hazardous clean-up equipment in dangerous situations. The mining and toxic waste cleanup industries suffer from a similar lack of standardization in remote control devices.

TOPIC: A92-084TITLE: Advanced Supervisory System

CATEGORY: Advanced Development

OBJECTIVE: To develop a knowledge-based supervisory system that will act as a watch dog to monitor vehicle AI functions in different modes (manual, autonomous, semi-autonomous) and prioritize the different functions.

DESCRIPTION: With the increased complexity of future combat vehicles and the reduced crew size, there will be more functions to oversee and less people to do it. Therefore, it has become necessary to develop some sort of supervisory system to watch over vehicle functions.

Phase I: The Phase I effort will consist of the development of hardware and software for a knowledge-based Supervisory System that is capable of monitoring all vehicle functions (i.e., target acquisition, navigation, communications) and will prioritize these functions in any given situation (i.e., combat, surveillance). The system should also be capable of giving a status report for all functions at any given time.

Phase II: The Phase II effort will be a stepping stone to the ultimate goal of developing and integrating the Knowledge-Based System with the Vetronics of the Integrated Two-man Crew Station (ITCS). This will consist of the total hardware and software development.

Potential Commercial Market: The AI based Supervisory System developed under this effort has wide application in the commercial sector. any vehicle system (i.e., automobiles, aircraft, etc.), which employs a computerbased architecture can incorporate this supervisory system to aid operators in the command and control of vehicles.

TOPIC: A92-085TITLE: Embedded Automotive Control Technology for Robotic Vehicle Application

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate digital/analog servo control technology embedded within automotive systems to allow robotic control of combat vehicles.

DESCRIPTION: Emerging combat vehicles require robotic control capabilities to perform such missions as countermine and counterobstacle, convoying and battlefield logistics (resupply, rearm and refuel). A significant means of reducing operation and support (O&S) costs and maintenance costs for robotic systems integrated on combat vehicles is to embed robotic automotive controllers within the design of the manned system. The goal of this program is to determine, design and demonstrate control technologies that implement both manned and unmanned automotive control. Development scope include digital/analog servo control, control theory, pressure, temperature and flow rate sensors, and vehicle mobility.

Phase I: The contractor will study automotive control requirements for the Common Chassis Advanced Technology Transition Demonstrator (CCATTD) and the Family of Medium Tactical Vehicles (FMTV) to determine automotive control requirements. The contractor would identify promising technologies, develop a concept for embedded robotic controllers for manned combat vehicles and perform scale development and testing of critical portions of this concept. The government will evaluate the concept and testing to determine the potential for manned and remote combat vehicles. A final technical report will detail the Phase I effort.

Phase II: The contractor will plan, integrate and fabricate a breadboard embedded robotic automotive control system. The contractor will install the breadboard on a military tracked vehicle to demonstrate its functionality. The breadboard will be used to explore the performance and applicability of the technologies to manned and remote combat vehicles. The deliverables from this phase will include design drawings, software, technical report, and demonstrator.

Potential Commercial Market: The application of this technology to the Family of Medium Tactical Vehicles (FMTV) provides a direct commercial application to civilian trucks. Material hauling, mining operations are beginning to require automated operation for open pit and underground applications. This SBIR program directly supports this requirement by developing the technology on the FMTV, essentially a NDI commercial truck. A Phase III program would complete transition of this technology and test on commercial trucks.

TOPIC: A92-086TITLE: Integrated/Durability Repair

CATEGORY: Exploratory Development

OBJECTIVE: Develop methods/techniques that can be used in the repair of thick section composite laminates.

DESCRIPTION: Repair techniques for thick section composite laminates must be developed. Thick section composites are becoming more attractive in vehicle structures such as combat vehicle hulls. These structures, when damaged out in the field,

must be repaired so as to (1) restore the structure back to its original strength and stiffness, (2) ensure that the damaged area does not propagate further, or (3) restore sufficient strength to where the vehicle can "limp" back to a place of safety.

Phase I: Repair techniques will be developed for a given set of structures. Testing will be performed to validate the adequacy of the repair and the degree to which the structural health was returned.

Phase II: A composite repairs handbook shall be developed based on actual repairs and validation testing.

Potential Commercial Market: A company that put together a "Repairs Handbook" could market this text similarly to companies that market material property information or guides on safe handling of hazardous materials.

TOPIC: A92-087TITLE: Electronic Map Display and Route Planner

CATEGORY: Exploratory Development

OBJECTIVE: To research and develop software, hardware and display technologies to provide combat vehicle commander with real-time display of electronic map data and vehicle locations with the ability to provide very high speed planning of vehicle route and display same.

DESCRIPTION: Advanced combat vehicles will have reduced crews and unmanned operability. To maximize reduced crew vehicle commander and remote vehicle operators battlefield understanding and minimize workload, electronic displays of the battlefield and map overlays are necessary. Furthermore, the commander must be able to quickly plan, transmit and display vehicle routes. The goal of this program is to research and develop extreme high speed algorithms to plan vehicle routes based on mission, enemy forces, terrain; real-time display and refresh to minimalist map data of vehicle environment, location and routes; and high-resolution flat-panel display technologies. In the final phase, the software, hardware, and display are integrated into a single module. The Phase III goal will be to produce a single board display driver with ROM based route planning and map display driver software integrated with a flat panel display and a plug-replaceable digital terrain database module.

Phase I: The contractor will review past research and formulate plans and software for extreme high-speed route planning and map display. Flat panel display technologies will be reviewed and evaluated for potential. The contractor will prepare a concept for integrated EMDRP and validate critical software algorithms. A Final Technical Report will document this phase.

Phase II: The contractor will develop breadboard route planning software and map display software. The software will use standard digital terrain database products for map information. The software will use standard digital terrain database products for map information. The software will execute on either a high-speed single board computer and government Commander's Independent Thermal Viewer display or a 80386/68030 equivalent notebook computer. The breadboard model will be evaluated by combat vehicle developers and military end-users for functionality and potential. The deliverables from this effort will include design drawings, software, technical report and breadboard.

Potential Commercial Market: The Electronic Map Display and Route Planner supports several major military and civilian requirements. The US Army Armor School "2 Man Crew" requires commander and crew automated systems to reduce workloads. the Route Planner supports this requirement by providing high-speed automation of planning, to free the commander for other actions. The Electronic Map provides enhanced command and control information further reducing the commander's workload. Combat Service Support units can benefit from the EMD/RP through automation of convoy planning and real-time display of vehicle locations for C3I purposes. The civilian Intelligent Vehicle Highway Systems (IVHS) program, sponsored by the Department of Transportation and industry consortium, requires electronic map displays and route planners. The IVHS relies on "smart" sensor equipped highways and intelligent vehicle display systems such as the EMD/RP to assist and enhance driver capabilities. The SBIR EMD/RP immediately addresses the IVHS requirements and can be quickly transitioned to IVHS programs.

TOPIC: A92-088TITLE: Terrain Database Generator System

CATEGORY: Advanced Development

OBJECTIVE: To develop a Terrain Database Generator System for the Vetronics Crew Display Demonstrator's (VCDD) Computer Generated Imagery (CGI) for use in future combat vehicle development.

DESCRIPTION: The VCDD is a research and design tool used to optimize the Soldier-Machine Interface (SMI) in new or improved combat vehicles. The current terrain database that exist for the VCDD is a 10KM X 10KM area of the Fulda Gap in Germany with no roads or rivers. The vehicle models are M1A1's and T-72's. With the location and threat changing all the time, the VCDD needs to be capable of creating and loading new terrain databases and vehicle models. The VCDD's current CGI system use Trilliums, Hughes Photovision 4 and Silicon Graphic Irises.

Phase I: The Phase I effort will consist of the development of software for a Terrain Database Generator System, which can then be used to enhance the current VCDD database by adding new features. The Terrain Database Generator System will interface with the VCDD computers and CGI system. A Phase II plan for building a Terrain Database Generator Workstation and new databases will also be developed.

Phase II: The Phase II effort will consist of developing a Terrain Database Generator Workstation and building several new databases. The workstation will be capable of running the Terrain Database Generator software and will be used in the development of new databases. The new databases will be larger (i.e. 50 KM X 50 KM), contain features such as trees, rocks, buildings, roads, rivers, and objects such as tanks, trucks, scout vehicles, helicopters and aircraft for both friendly and enemy vehicles. The effort will be completed when both the workstation and new databases have been integrated with the VCDD and are capable of responding to inputs and outputs from the VCDD.

Potential Commercial Market: The work being done on terrain databases could be used in various vehicle simulations. In the auto industry, on and off-road applications are likely for other transportation industries. The models can easily be changed to suit commercial application.

TOPIC: A92-089TITLE: Embedded Training for Integrated Two-Man Crew Station

CATEGORY: Advanced Development

OBJECTIVE: To develop an embedded training system for the Vetronics Crew Display Demonstrator (VCDD) and the Integrated Two-man Crew Station (ITCS).

DESCRIPTION: One of the most advanced forms of training on complex machinery is Embedded Training. Therefore, this is an essential task for development of the ITCS.

Phase I: The Phase I effort will consist of the development of software and hardware for an embedded training system, which could be used on the VCDD. At all times, it should be kept in mind that the software for this training must eventually be compatible with the ITCS architecture.

Phase II: The Phase II effort will consist of developing and integrating the software and hardware for an embedded training system to be integrated in the ITCS. The effort will be completed when the system has been integrated with VCDD and ITCS and is capable of responding to inputs and outputs from both VCDD and ITCS.

Potential Commercial Market: The Embedded Training Software Development Approach demonstrated and applied under this effort can be used to develop interactive embedded training systems for any computer-based system.

TOPIC: A92-090TITLE: Integrated Two-Man Crew Station (ITCS) AI Application Study

CATEGORY: Advanced Development

OBJECTIVE: To conduct a study of AI Applications for the ITCS.

DESCRIPTION: Many complex AI functions will be necessary to develop the ITCS. When crew size is reduced, many tasks will be forced to become autonomous or semi-autonomous. A study needs to be conducted to identify the tasks that are necessary to develop the ITCS as well as identification of other features that would enhance the ITCS.

Phase I: The Phase I effort will consist of an in-depth study of AI Applications that would be necessary to develop the ITCS. Trade-off studies of existing hardware and software will be conducted. This effort will also consist of features to enhance future combat vehicles using artificial intelligence.

Phase II: The Phase II effort will consist of determining the two most critical AI features for development of the ITCS and developing the hardware and software for integration into the ITCS.

Potential Commercial Market: The Embedded Training Software Development Approach demonstrated and applied under this effort can be used to develop interactive embedded training systems for any computer-based system.

TEST AND EVALUATION COMMAND (TECOM)

TOPIC: A92-091TITLE: Remote Site Wind Measurement Capability

CATEGORY: Exploratory Development

OBJECTIVE: Develop a naturally illuminated scene scintillometer for passive remote site wind and turbulence measurement.

DESCRIPTION: Scintillometers provide crosswind and optical turbulence intensity measurements requirements for target acquisition systems. Existing scintillometers rely on a downrange transmitters to provide a light source for measurements along an optical path defined between the transmitter and receiver. Recent developments in optical theory indicate that a receiver could be designed to utilize the natural background scene as a source. A passive scintillometer could provide crosswind and optical turbulence information on remote, uncooperative targets or at otherwise inaccessible sites.

Phase I: The contractor would apply the new optical theory to the design of a passive scintillometer.

Phase II: The contractor would develop and test an operational naturally illuminated scene scintillometer.

Potential Commercial Market: remote site wind measurement capabilities for runways, across ravines, and other inaccessible locations.

TOPIC: A92-092TITLE: Automatic Smoke and Obscurant Cloud Pattern Recognition from Visible and Thermal Imagery

CATEGORY: Exploratory Development

OBJECTIVE: Develop an automated method to determine the frame by frame spatial extent of smoke and obscurant clouds from recorded television images.

DESCRIPTION: Field tests of battlefield smoke and obscurants require quantification of dimensions, volume, centroid, and location for the resulting clouds. Test data are collected from visible and thermal images placed at various angles from the cloud. The two-dimensional cloud extent from each imager is used by a computer program to calculate these parameters. At the present time, two dimensional cloud extent is determined by an operator who manually locates points on the cloud perimeter. An automated method to measure cloud extent will reduce data reduction time and test cost. It will also provide more reliable data by eliminating human judgement and differences between operators. Additional data such as cloud density could also be determined from automated methods. Automated methods such as simple image subtraction are not suitable because of changes in background and temperature changes of the scene.

Phase I: Review previous work and present technology and perform limited testing with smoke and obscurant data. Recommend a hardware platform and programming methods for development.

Phase II: Develop and test methods recommended in Phase I into usable software programs. Provide documented and tested software to automatically determine cloud spatial extent.

Potential Commercial Market: unknown.

TOPIC: A92-093TITLE: Geophysical Range Impact Detection System (GRID)

CATEGORY: Advanced Development

OBJECTIVE: Develop a real time projectile impact detection system that can be installed on a high-volume artillery or mortar firing range. The GRID system shall detect, acquire, and record the impact location of any projectile with an accuracy of one meter. The GRID system shall detect and characterize the projectile detonation action to establish whether functioning was super-quick (instantaneous) or delay (to the nearest millisecond), high order or low order, or non-functioning.

DESCRIPTION: Develop the systems configuration, software, algorithms, and computer operating parameters for the GRID system. Design, develop or incorporate existing sensors for seismographic, acoustic, infrared, and/or shock wave detection with sufficient resolution to accurately determine the exact projectile impact and detonation signature of inert and high explosive artillery and mortar ammunition fired onto a controlled impact area. The projectiles range in size from the 7.5 kilograms 60mm mortar with a lower velocity of 50 meters per second (MPS) up to the 420 kilogram 203mm (8") artillery projectile with an upper velocity of 1000 mps. The GRID system shall detect the projectile, impact and functioning; transmit the data/signals to a remote work-site; process and compute the range accuracy data; record and display the information in text, graphics, and plotted matrix; and maintain round by round data logs and records on magnetic media. The system shall generate final test records from all information generated. Typical controlled impact areas are rectangle plots measuring 300 meters by 500 meters (typically). The ultimate system shall include all sensors, interface devices and modems, and all microprocessor equipment configured as a turn-key operation for the GRID requirement.

Phase I: Design a real time projectile impact detection system that can be installed on a high-volume artillery or mortar firing range.

Phase II: Implement the design proposed during Phase I.

Potential Commercial Market: unknown.

TOPIC: A92-094TITLE: Transportable High Resolution Target Plane Analysis of Tactical Laser Beams

CATEGORY: Advanced Development

OBJECTIVE: Demonstrate concept and approach for a transportable high resolution capability to effectively characterize tactical laser beams at the target plane.

DESCRIPTION: Develop the system design of a prototype Transportable High Resolution Laser Target Plane Image Analysis System capability to support test and evaluation of U.S. directed energy tactical weapons and support systems. Determination of the applied environment at the target plane is crucial to the comprehensive diagnostic evaluation of the total system effectiveness. Due to the operational environment dictated by tactical field testing, the developed technology must be rugged and highly reliable and suitable for both ground and airborne platforms. Parameters to be measured include beam jitter, beam divergence, laser intensity (near and far fields) total energy and beam quality. This tactical laser Directed Energy Weapon (DEW) testing capability will support multiple services. This construct augments the target plain test capabilities required to support multi-service test and evaluation requirements.

Phase I: Fabrication of the diagnostic system and system integration will be performed.

Phase II: Conduct system characterization, validation and demonstrate the system IOC.

Potential Commercial Market: applicable to communications and surgical laser technology.

TOPIC: A92-095TITLE: 3-D Radiography and Image Analysis for Defect Detection

CATEGORY: Advanced Development

OBJECTIVE: A system of near real-time high-energy radiographic imaging and display techniques using minimal additional equipment which allow faster and/or more reliable defect analysis through the use of the stereoscopic capabilities of the human eye.

DESCRIPTION: Yuma Proving Ground uses a robotic radiographic real-time imaging system to inspect ammunition components from fuzes to 8 inch artillery shells. The purpose of the radiographic inspection is to verify the presence or absence of defects in this ammunition. Image enhancement tools are used to aid the operator in his determination. Automated defect detection is not performed because of the large numbers of different items examined.

Phase I: Develop techniques to take multi-aspect high-energy radiography requiring minimal modifications to existing equipment. Examine methods for integrating technique and associated imaging displays with real-time system. Obtain radiographs of ammunition components along equivalent aspects. Demonstrate visually with the radiographs that the technique gives a "3-D" effect that allows interpretations of internal part position. Demonstration of "3-D" effect does not have to be on video displays but should correlate with effect that would be generated on proposed near real-time display systems.

Phase II: Develop software, techniques and equipment to allow automatic acquisition by the robotic radiographic

system of the multi-aspect radiography required. Specify and acquire or develop equipment and techniques to allow efficient display and interpretation of the "3-D" imagery. Integrate acquisition and display techniques with existing system to allow continued operation with existing personnel.

Potential Commercial Market: improved 3-D imaging techniques.

PROGRAM MANAGER, TRAINING DEVICES (PM TRADE)

TOPIC: A92-096TITLE: Next Generation Tactical Engagement Simulation (TES) System

CATEGORY: Exploratory Development

OBJECTIVE: Develop innovative concepts, and approaches for next generation TES that will permit an effective integration of current direct and indirect fire weapons with new smart and fire and forget weapons.

DESCRIPTION: Combined arms maneuver training as conducted at the Army's Combat Training Centers (CTC) is the finest available in the world. Laser and radio frequency (RF) techniques and technologies have been reasonably successful in simulating the operation and effects of the current direct and indirect weapon systems. But with the introduction of new smart, and fire and forget weapons which can engage targets at extended ranges and under extreme environmental conditions current TES techniques and technologies may be ineffective in simulating the operation and effects of these weapon systems and new or next generation TES paradigms may be needed to satisfy the requirement. Although our vision of a next generation TES is unclear, the high speed data communication, networks and processing, and advances in embedding simulations and instrumentation in weapon systems should be considered in future TES concepts.

Phase I: Develop innovative next generation TES concepts, models and/or designs.

Phase II: Simulate or implement TES concepts, models, and/or designs to establish feasibility.

TOPIC: A92-097TITLE: A Next Generation Audio and Visual Cueing System

CATEGORY: Exploratory Development

OBJECTIVE: Develop innovative non-pyrotechnic system concepts/ prototypes for providing audio and visual signatures to support tactical engagement simulation (TES) exercises.

DESCRIPTION: Force on force combined arms training as conducted at the U.S. Army Combat Training centers (CTC) utilize TES equipment and instrumentation to emulate both direct and indirect fire weapons and their effects. Given these equipments and the controlled "free-play" nature of the exercises, it is essential that individual trainees and their units act/react in a "natural" way to engagement events as they unfold during the training exercise. A crucial element of the TES equipment is the component that produces the audio and visual cues (i.e. flash, bang, and smoke) associated with indirect fire engagements. These cures have been produced by a pyrotechnic based systems, i.e., system that produce the effect through controlled explosions. There are problems with the pyrotechnic based approach that includes safety, special handling and storage requirements, and a high degree of variability in the audio and visual signatures produced. Typically, the audio and visual cue specification calls for: an audio

signature sound intensity that does no exceed 140 db or fall below 130 db as measured at two (2) meters; and flash and smoke visible at 1500 meters on a clear day.

Phase I: Develop cost effective concepts/designs for producing audio and visual cues by non-pyrotechnic means.

Phase II: Implement the non-pyrotechnic approach in sufficient detail to demonstrate the feasibility of concept.

TOPIC: A92-098TITLE: Application of Virtual Reality to Weapon System Concept Evaluations in a Distributed Simulation Environment

CATEGORY: Exploratory Development

OBJECTIVE: Develop innovative approach to analyze and expand the applications of virtual reality to weapon system concept evaluations in the Battlefield Distributed Simulation environment.

DESCRIPTION: Currently, weapon system concept evaluations in a Battlefield Distributed Simulation environment require physical mock-ups of the controls and displays of the crew stations. Construction and modification to these mock-ups is both expensive and time consuming. Innovative solutions to man-in-the-loop simulator-based weapon system concept evaluations, such as creating virtual mock-ups of crew station controls and displays, are needed to reduce the time and cost of performing such evaluations.

Phase I: Develop cost effective man-machine interface concepts/designs based upon virtual reality technological principles.

Phase II: Implement the man-machine concept in sufficient detail to demonstrate the feasibility of concept.

ARMY RESEARCH OFFICE (ARO)

TOPIC: A92-099TITLE: Laser Process Characterization

CATEGORY: Basic Research

OBJECTIVE: Characterization research of refractory ceramic coating film formation.

DESCRIPTION:Materials surface modifications at temperatures 1500-3500 degrees C are difficult to characterize during laser processing. Research is needed to correlate in-situ temperature/materials properties with coating wear/corrosion/erosion resistance. High performance ceramic coatings are expected in commercial applications such as turbines, auto engines, and wear resistant surfaces.

Phase I: The goal of Phase I is to identify potential characterization techniques and to carry out proof of concepts experiments that measure appropriate in-situ properties form 1500-2000 degrees C and are broadly applicable for structural ceramic systems.

Phase II: The goal of Phase II is to design, build, and operate a prototype materials/laser processing characterization instrumentation system.

Potential Commercial Market: This research would find commercial utilization in processing characterization and inspection of commercial products.

TOPIC: A92-100TITLE: Synthesis of Fullerenes

CATEGORY: Basic Research

OBJECTIVE: To develop a cost effective process for the synthesis of fullereness.

DESCRIPTION: Fullerene is a new form of carbon having potential DoD application in such areas as propellants, energy storage, superconductivity, electronics and medicine. Currently, fullerene compounds are costly and available in limited supply. Research is needed to develop a cost effective manufacturing process. Fullerenes are a new class of materials the commercialization of which is limited by excessive high cost and availability.

Phase I: The goal of Phase I is to establish the mechanisms and identify the variables that control fullerene synthesis. The investigation should also focus on an effective procedure for the separation of fullerene compounds into homologues of specific molecular weighs. Proof of concept will be demonstrated by the development of a high yield system.

Phase II: The goal of Phase II is to design, scale-up and build a prototype system.

Potential Commercial Market: If fully successful, this program can reduce the cost of fullerenes from $400/gram to a few hundred dollars per pound and hasten the implementation to commercial/military applications including rocket fuels, telecommunications, and air and water purification.

TOPIC: A92-101TITLE: Synthetic and Degradative Bioprocessing in Extreme Environments.

CATEGORY: Basic Research

OBJECTIVE: Explore the possibility of using molecular biological techniques to identify and biochemically characterize a cellular pathway or isolated subcellular system capable of novel synthetic or degradative processing in engineered or extreme natural environments.

DESCRIPTION: Microbial populations have been coping for centuries with the problem of nasty chemical substances or physical extremes in their environment, and have long since learned how to turn adversity into opportunity for their survival and, indeed in some cases, into enhanced competitiveness in that environment. Indications are strong that synthesis or degradation of militarily and commercially relevant chemical compounds might be accomplished at a fraction of the environmental and economic cost of conventional production or treatment, respectively, using microorganisms or biocatalytic systems derived from those organisms. For example, hyperthermophilic microorganisms may provide heat-stable enzymes able to catalyze efficient high-temperature reactions of importance to the Army and commercial materiel communities such as destruction of toxic wastes and combustion. What is sorely needed is basic research to more clearly define and characterize these systems, and to learn how these might be improved by means of molecular genetics and protein engineering, and eventually be put to use.

Phase I: Identify, and partially characterize, best candidate system for detailed study and further evaluation of biosynthetic/ biodegradative reaction pathway.

Phase II: Development and validation of methodology for defining mechanisms involved and potential for use in synthesis/degradation process; implementation in test system demonstration.

TOPIC: A92-102TITLE: Hydrogen Supplies for Fuel Cells

CATEGORY: Basic Research

OBJECTIVE: To carry out fundamental studies which will lead to logistically acceptable sources of hydrogen for battlefield fuel cells.

DESCRIPTION: The Army is exploring the feasibility of using fuel cells for producing power on the battlefield. In particular, fuel cells have been identified as one possible technology for individual soldier power. (Individual soldier power supplies, in the current context, are 200-500 watt supplies which can power the soldier's communications, position finder, microclimate cooling system, and other devices which may be carried by each soldier.) The ideal hydrogen supply would be a small, light, inexpensive device which could convert a readily available material to hydrogen of sufficient purity for operating fuel cells. This ideal source has been sought after for years; it does not exist. This announcement is looking for innovative approaches to hydrogen supplies; the proposed supply system may involve reforming existing fuels, conversion of various chemicals not normally considered to be fuels, innovative storage technologies, or any other technically sound approach which can reasonably be expected to further the goals of providing hydrogen supplies to individual soldiers in the battlefield.

Phase I: Characterize, in terms of chemical/physical processes/ properties, the positive and negative aspects of current or proposed systems/processes and propose means of reducing or eliminating the limitations.

Phase II: The objective of phase two will be to demonstrate that the work proposed in phase one could lead to improved device performance either by direct incorporation of the new ideas into a device or by cogently demonstrating improved rates/properties/performance of a system component or process

Potential Commercial Market: It is anticipated that this same technology or closely related technology will have a number of commercial applications in areas such as portable power for communications/news teams and portable medical instrumentation used by rescue teams.

TOPIC: A92-103TITLE: Molecular Scale Electronics/Information Processing

CATEGORY: Basic Research

OBJECTIVE: To carry out fundamental studies which will lead to better understanding of chemical/physical/electronic processes/properties of materials which have potential to result in molecular scale electronic devices and/or information processing systems. The materials/devices/processes sought under this announcement will be innovations within the broad area of activity called molecular electronics or molecular scale electronics. The materials/devices/processes will emphasize molecular level Conventional microelectronics approaches will not be considered.

DESCRIPTION: The Army has a need for a broad range of information processing, electric power processing, and sensor/transducer devices. Over the past few years there has been a great deal of activity in chemical studies of charge generation/separation/transfer and in molecular level assembly by LB film technology, atomic force microscopy and other processes. There has also been much progress in understanding biological information gathering and processing systems. Progress in nanotechnology and in chemical design of molecules with variable, controlled conformation suggest that ultra small mechanical systems may have some role in information processing. This announcement calls for proposals which propose basic research in the above or related areas.

Phase I: Characterize, in terms of chemical/physical/electronic processes/properties, the positive and negative aspects of current or proposed devices/molecular assemblies and propose means of reducing or eliminating the limitations.

Phase II: The objective of phase two will be to demonstrate that the work proposed in phase one could lead to improved device performance either by direct incorporation of the new ideas into a device or by cogently demonstrating improved rates/properties/performance of a system component or process.

Potential Commercial Market: This technology has the potential to provide improved commercial and military information processing systems.

ATMOSPHERIC SCIENCE LABORATORY (ASL)

TOPIC: A92-104TITLE: Enhanced Propagation Path Characterization

CATEGORY: Exploratory Development

OBJECTIVE: Develop enhanced capabilities for assessing impacts of atmospheric effects upon electro- optical and electro-acoustic systems performance.

DESCRIPTION: The effective assessment of atmospheric impacts on Army optical and acoustic systems requires a knowledge of the atmospheric propagation conditions under which the system is tested and operated. In addition to the temperature, pressure, and wind fields, atmospheric parameters of particular importance are the moisture content, the aerosol and hydrometer concentrations, and the dynamic and optical turbulence structure along the paths between source and detector or between system and target. Instrumentation for determining these parameters remotely is being developed at the Atmospheric Sciences laboratory. Present systems include radars, lidars, sodars, radiometers, transmissometers, and scintillometers. The Army requires enhancements to the capability of any of these systems for characterization of propagation conditions. These enhancements may be in the form of modifications to the system, improved measurement techniques (E.G. combined instrumentation output), or improved analysis algorithms.

Phase I: development of a specific program for enhancing the capability to remotely sense critical propagation parameter(s) along a slant path in the atmosphere. Spatial and temporal resolution and accuracy of the measurement should be specified. After approval by the government, implement this program.

Phase II: Evaluation of the performance of the enhanced system by conducting tests in conjunction with other remote and in situ sensing techniques.

Potential Commercial Market: A potential commercial market exists in the application of the enhancement techniques to propagation problems in the communications industry.

BALLISTICS RESEARCH LABORATORY (BRL)

TOPIC: A92-105TITLE: Concepts for Improved Energy Coupling

CATEGORY: Basic Research

OBJECTIVE: The objective is to demonstrate warhead concepts that improve the coupling of the energy available in high explosives to targets that they are intended to defeat.

DESCRIPTION: Warheads for many systems are either weight or volume limited and thus suffer a constraint on the total explosive energy that they can carry to a target. To maintain or increase lethality in lighter systems is a desire for the future that may be achievable with concepts that enhance the efficiency of energy coupling, provide a controllable focussing effect and/or demonstrate projection of metal fragments/liners at speeds in excess of current state of the art with practical masses.

Phase I: A successful phase I will demonstrate analytically that one or more concepts that achieve improved energy coupling is feasible and will define a critical set of experiments to be performed in Phase II.

Phase II: A successful Phase II will demonstrate experimentally the feasibility of the concept. At a minimum this means that critical features of the concepts will be validated by experiment.

TOPIC: A92-106TITLE: Utilization of Composites

CATEGORY: Basic Research

OBJECTIVE: The objective of this initiative is to demonstrate ways in which composite materials may be used in lieu of conventional materials to reduce the weight and increase the utility of Army equipment.

DESCRIPTION: Use of composite materials typically offers components which are lighter and stronger than conventional materials. Other attributes which may be attractive are corrosion resistance, spall resistance, ballistic shock, noise, and vibration suppression, and signature reduction. One of the potential applications for use of such materials is in armor modules for the next generation combat tank. Increased protection levels and use of modular construction require the use of more efficient structural and armor materials and geometries.

Phase I: A study which details with analyses and designs the advantages which the use of composite materials or combination metal/composite structures offer over conventional or current designs. The design would be expected to show a reduction of weight with perhaps attendant increases in survivability in one or more of the areas described above. The application can be in armor technology or other ballistic technology.

Phase II: This phase would include construction or fabrication of items and testing of same in realistic environments. An examination of possible deleterious characteristics such as delamination, fatigue properties and ease of battlefield repair should be addressed. Quantification of improvements (weight, signature, etc.) should be determined.

ELECTRONICS TECHNOLOGY AND DEVICES LABORATORY (ETDL)

TOPIC: A92-107TITLE: Merged Hydride/OMVPE Epitaxial Growth System

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a thin film growth system for the epitaxial growth of semiconductor thin films using the combined features of the OMVPE and hydride growth techniques.

DESCRIPTION: Recent developments have demonstrated that high quality epitaxial GaAs and InP films can be grown using a merged hydride/ OMVPE (organometallic vapor phase epitaxy) growth technique. It combines the best attributes of both methods in that it has the capability to grow ultra-thin layers as with the OMVPE technique, and requires significantly less arsine or phosphine and has an increased ability for selective area growth as with the hydride method. As an example, GaAs can be grown in a hot wall reactor by paralyzing diethylgallium chloride (DEGaC1) or reacting trimethylgallium (TMGa) with HC1 to form GaC1 in the reaction zone and then flowing it downstream to react with arsine. Thin layers of GaAs can now be grown by switching the TMGa or DEGaC1 flow on and off, and much less arsine will be required because it reacts much more readily with GaC1 than with TMGa.

Phase I: Phase I should result in a design and analysis of a growth system. Topics to be included concerning the design of the system are the flow systems, gas mixing chamber, hot wall reactor, and pumps for low pressure growth. An analysis of the different chemical reactions and the potential for carbon contamination should also be included.

Phase II: The primary goal of Phase II is to build and test the growth system. Because the system can contain toxic gases, it will have to be leak tight and contain the necessary safety equipment. Epitaxial films will be grown and electrically, optically, and chemically characterized, and optimum growth conditions will be determined using this data. Device structures will then be grown, and devices will be fabricated from them and tested.

Potential Commercial Market: The ability to grow thin layers of GaAs and InP based compounds with better selectivity and with reduced amounts of arsine and phosphine would have a tremendous impact on the electronics and opto-electronics industry. This is especially true for long wavelength fiber optic communications at 1.30 and 1.55 μm which utilize InP/InGaAsP quantum well lasers that are difficult to make using present growth technologies. Commercial applications include high-speed optoelectronic data communications

TOPIC: A92-108TITLE: Suppression of Vibration-Induced Sidebands

CATEGORY: Exploratory Development

OBJECTIVE: Develop a method of electronic compensation of the acceleration-sensitivity of quartz crystal resonators for the purpose of reducing vibration-induced sidebands on the output of crystal oscillators.

GENERAL: Although there has been progress recently in reducing the acceleration sensitivity of quartz resonators and in external compensation of vibration, there is still a need for at least another factor of 100 reduction in acceleration-sensitivity. Simple analog compensation techniques suffer from phase errors, which limit the level of suppression over 10 - 2000 Hz band to about - 15 dB. A different approach, possibly employing digital signal processing (DSP), is needed which is easily adapted for each oscillator during calibration.

Phase I: Phase I will explore analog and digital techniques for improved acceleration compensation. The study includes adaptive techniques to enable tailoring the response for each individual oscillator/resonator pair. Prototypes of a working circuit will be fabricated and evaluated to demonstrate acceleration compensation along at least one direction.

Phase II: Phase II will develop a system for acceleration compensation along all directions, and refine the configuration of the system to package the oscillator/suppression circuit in a self-contained unit. A calibration system will be developed which will conveniently establish the proper circuit elements/coefficients to enable automatic compensation.

Potential Commercial Market: Acceleration-sensitivity is one of the major limitations on Doppler radar performance. Improved compensation will produce higher probability of detection, higher probability of identification, longer range and fewer false targets. Acceleration can also be catastrophic to the performance of communication systems which employ phase-lock

loops (PLL) or phase-shift keying (PSK). Commercial applications include aircraft and mobile communications systems where vibration is a problem.

TOPIC: A92-109TITLE: High Energy Density Polymer Capacitor

CATEGORY: Advanced Development

OBJECTIVE: Fully develop and productize spirally wound, polymer capacitors based on specific U.S. Army Electronics Technology and Devices Laboratory (ETDL) inventions/patents which have already been prototyped and successfully demonstrated.

DESCRIPTION: Adhesion of vapor deposited aluminum as well as the breakdown voltages of a number of polymer films have been markedly increased after these polymer films have been briefly exposed to various low pressure, low temperature gas plasmas. These concepts have been adequately described in the following publications: a.) Polymer Preprints Vol. 32(2), June 1991 p 66-67; b.) Extended Abstracts of the Fall 1991 Electrochemical Society Meeting, Phoenix, AZ, Oct 13-18, 1991; c.) J. Applied Polymer Science Vol. 43(9), p. 1589, 1991; d.) IEEE Transactions Insulation and Resistance, Dec. 1991, e.) Polymers for Advanced Technologies Vol. 2, Dec 1991. In addition, initial evaluations on prototype, spirally wound polymer capacitors (where the full capacitor had been briefly exposed to a 96% CF4/ 4% 02 gas plasma) have shown that at least a doubling (and in some instances, a fourfold increase) of breakdown voltage can be achieved. It is important to better understand the reasons for this rapid and inexpensive improvement and to select the type of gas plasma, exposure time and applied plasma power levels in order to optimize the breakdown voltage without causing any undesirable effects on other bulk properties of the polymers or capacitors.

Phase I: Prototypes of various polymer capacitors will be developed and demonstrated based on specific ETDL inventions/patents. The contractor will identify specific military and commercial candidate applications and users for this particular technology.

Phase II: Finalized development and optimization of these of the most promising subject polymer capacitors will be accomplished with consideration given to manufacturing and transitioning into actual circuits and devices for both military and commercial applications. The results of Phase II should be a marketable product line of wound polymer capacitors, with a fully developed marketing plan. The contractor will be licensed by the Federal Government, under a Patent License Agreement (PLA), to make these subject devices available
commercially.

Potential Commercial Market: The contractor is expected to successfully market products developed under Phase I and Phase II, for both military and commercial applications such as portable lasers and medical equipment.

TOPIC: A92-110TITLE: Microwave/Millimeter-Wave "Drop-In" Circulators and Switches

CATEGORY: Advanced Development

OBJECTIVE: Fully develop and productize microwave/millimeter-wave "drop-in" circulators and switches based on specific US Army Electronics Technology and Devices Laboratory (ETDL) inventions/ patents which have already been prototyped and successfully demonstrated.

DESCRIPTION: Microwave/Millimeter-wave microstrip "drop-in" circulators operating under fixed magnetic biasing and in switchable format have been designed and successfully prototyped by ETDL technologists for operation in both hybrid and monolithic circuit applications (i.e., communications and radar transceivers). These patented designs (patent #4,749,966 & #4,754,237) provide for a simplified design structure operating at frequencies where device parts and pieces become very small such that tolerances and impedance matching techniques present costly fabrication problems. The subject drop-in devices were designed to minimize these potential problems while preserving the high isolation and low insertion loss required over operating bandwidths. Initial evaluation (published in the MICROWAVE JOURNAL, April 1989) of these microstrip circulators and switches indicate that these devices can be fabricated into an integrated or a monolithic circuit configuration and would be fully compatible with Microwave/Millimeter-wave Monolithic Integrated Circuits (MIMIC) Transmit/Receive (T/R) module designs based on monolithic Gallium Arsenide (GaAs) integrated circuit technology.

Phase I: Prototypes of microwave/millimeter-wave "drop-in" circulators will be developed and demonstrated based on specific ETDL inventions/patents. The contractor will identify specific military and commercial candidate applications and users for this particular technology in both the microwave and millimeter-wave frequency regions.

Phase II: Finalized development and optimization of these subject switches and circulators will be accomplished with consideration given to manufacturing and transitioning into actual circuit, subsystem and system utilization for both military and commercial applications. The results of Phase II should be a marketable product line of switches and circulators, with a fully developed marketing plan. The contractor will be licensed by the Federal Government under a Patent License Agreement (PLA), to make the subject devices available commercially.

Phase III: The contractor is expected to successfully market products developed under Phase I and Phase II for both military and commercial applications.

Potential Commercial Market: The contractor is expected to successfully market products developed under Phase I and Phase II for both military and commercial radar and satellite communications applications.

TOPIC: A92-111TITLE: Miniature Display Device Technology

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop and demonstrate display techniques potentially applicable to head mounted displays. Goals are for high performance display technology capable of providing more than 1000 lines of image in a very compact, lightweight, low power device.

DESCRIPTION: New concepts of providing visual information directly to the individual soldier including thermal images, video, maps, drawings, and text messages are limited by the lack of miniature displays that are acceptable in terms of performance, reliability, size, weight and power consumption. This program should concentrate on alternative electro-optic mechanisms for producing a miniature virtual image display.

Phase I: Phase I should result in an analysis of one or more approaches to miniature image generating device technology and identifying specific techniques with potential application to video displays. Simple proof-of-concept demonstrations of these techniques is a requirement and may take the form of static displays. However, translation of the demonstrated approach must be reasonably shown to be applicable to high resolution displays. Selection of prototypes will be made and approaches will be determined which satisfy objectives that are representatives of Army tactical situations.

Phase II: In Phase II, a prototype display device having at least one million pixels will be demonstrated. The approach will be evaluated for further refinement and development of full color capability. The end products should be capable of demonstration which video camera and computer inputs. Approaches should be documented towards several Army needs and how the application of these techniques will be applied to Army systems.

Potential Commercial Market: Identified applications include the thermal weapons sight, Soldier's Integrated Protective Ensemble (SIPE), maintenance and logistics applications, and telepresence displays for robotics applications. Commercial applications would include those areas where display technology requirements dictate small, lightweight and portable displays such as in inventory control and robotics.

TOPIC: A92-112TITLE: Very High Speed Integrated Circuits (VHSIC) Hardware Description Language (VHDL) Package Library/Common Packages

CATEGORY: Exploratory Development

OBJECTIVE: Identify and develop an IEEE 1076 (VHDL) 'package library' or 'common packages' which will be used by the government and government contractors during the development of their VHDL models. Some of the common packages needed are in the area of I/O routines, math routines and model development.

GENERAL: The government has invested over thirty million dollars in the development of VHDL. Government contractors will be spending hundreds of thousands of dollars in developing VHDL models of their ASIC devices as required by the government in MIL-STD 454 Requirement 64. This requirement may soon change to include all digital devices, not just ASICs.

VHDL common packages form the foundation for all VHDL models developed and are considered tools used to facilitate the development of models and testbenches.

One of the purposes of having contractors deliver these models in VHDL is to be able to reuse their models for future designs. Although the VHDL language is well defined, model developers will often create their own common packages. If an entire system is developed by one company, there is seldom a problem. If however, a contractor or the government attempts to integrate models from different companies, they may find it to be an extremely difficult, if not an impossible task. This very often is because the developed models use a different library package. In order to prevent this problem from occurring, the same common packages should be used by all model developers. In their proposal, the proposer should clearly identify the approach they are taking and how they plan on interacting with the IEEE 1076 working groups.

Phase I: Identify the common packages which should be developed. These packages will address all levels of VHDL, from the abstract behavioral down to the gate level.

Phase II: Develop the common packages which the government selects from those identified in Phase I.

Potential Commercial Market: These common packages would be used by all services of the government and their contractors in the development of all future systems and thus save millions of dollars. Likewise, electronic (chip) technology in commercial application such as VCRs, camcorders, etc. would benefit.

TOPIC: A92-113TITLE: Enhanced Direct Digital Synthesizer (DDS) Designs

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate advanced DDS designs for low power military communications systems.

GENERAL: Conventional DDS designs depend upon high speed, high resolution and accuracy Digital to Analog Converters (DACs) to reduce DDS spurious output far below the carrier frequency for military systems. The DACs required are beyond the state-of-the-art and available DACs do not allow the DDS to meet most military system spurious output and power consumption requirements. This effort is to develop innovative DDS circuit designs which will reduce phase and amplitude quantization noise output greater than the 6 db per bit common to conventional DDS designs.

Phase I: The goal of this effort is the development and analysis of innovative DDS circuit designs, to include but not be limited to, phase and amplitude dither which will reduce output quantization spurs well beyond the 6 db per bit level associated with conventional Accumulator - Sine ROM - DAC architectures. All designs developed must be useable for wide bandwidth DDS devices operating at clock speeds up to 500 MHz.

Phase II: Phase II efforts will include the design and simulation of promising circuit architectures which would significantly reduce DDS spurious emissions without complete reliance on high resolution DACs. The most promising circuit design will be demonstrated by a Proof-of- Principal brassboard of the enhanced DDS.

Potential Commercial Market: Identified applications include Joint Advanced Special Operations Radio System (JASORS), Speak-easy, AN/PRC-126 specifically and all future Special Operations Forces (SOF) radios and all digital communications systems. Commercial communications systems would be improved through this effort.

TOPIC: A92-114TITLE: High Rate, Ultra-Safe Primary Lithium Pouch Cell Battery

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop and demonstrate an ultra-safe primary lithium manganese dioxide pouch cell technology that could potentially replace existing lithium primary batteries, providing higher performance and safety at a lower cost, per battery.

GENERAL: Recent development in lithium manganese dioxide primary battery technology have focussed on reducing weight and cost by housing the active materials in sealed pouches rather than welded steel cans. This effort will evaluate the feasibility of applying pouch cell technology to military lithium batteries, and, if successful, could eventually replace the current lithium batteries used by the Army.

Phase I: Initial efforts focus on optimizing the electrodes and electrolyte to meet or exceed the current lithium battery safety and performance requirements. The most critical feature, hermetic sealing of the pouch material with protruding polarity

connections, will be developed and demonstrated. Proof-of-principle cell samples will be fabricated and evaluated to demonstrate the capability of this technology to meet or exceed the safety and performance requirements imposed on the current Army lithium batteries.

Phase II: Proof-of-principle pouch cell technology will be translated into a multi-cell prototype prismatic battery design. Corresponding High Capacity bipolar pouch cells will then be fabricated, tested and evaluated. Bipolar pouch cell stacks will then be packaged into the representative prototype battery to demonstrate feasibility of this battery technology for military use. Prototype battery samples will be furnished to ETDL for technology demonstration. Plans for the advanced development of the technology will be formulated to prepare for specification of a final battery design for eventual mass production.

Potential Commercial Market: Pouch cell batteries would directly replace all existing primary lithium battery configurations for military and commercial applications. Identified applications include manpack radios and satellite communications equipment. Longer battery operating life and lower battery life cycle costs would result from the greater volumetric efficiency of pouch cell battery designs and the lower manufacturing labor costs required to produce them.

TOPIC: A92-115TITLE: Rechargeable Lithium Battery for Communications, Robotics and Pulse Power

CATEGORY: Exploratory Development

OBJECTIVE: Develop a high energy lithium battery utilizing a polymer electrolyte.

GENERAL: The Army requires rechargeable lithium batteries to power manportable circuits for communications, target acquisition, sensor, robotics and systems requiring short, but very high power bursts of electrical energy. For communication equipments, target acquisition and sensor devices, the lower end of the requirements are:

Weight: $\leq$ 1 kg
Operating Voltage: 20 volts
Current: $\geq$ 2 amps
Cycle Life: $\geq$ 50
Charge Retention: > one month at 71°C Operating
Temperature range: -34 to 71°C
Battery Capacity: > 7 amp-hours

For robotics, the above requirements (except for temperature) can be multiplied by a factor of ten, and for pulse power applications, the above requirements can be multiplied by a factor of one hundred (except for temperature for which a maximum value of 500°C is acceptable).

Past Army efforts to meet the above requirements have focussed on different chemistries for each specific application: e.g., on liquid and-solid state electrolytes for communications devices, liquid electrolytes for robotic applications, and molten salt electrolyte which can bridge all three types of the above applications. Using ionically conductive polymers as an example, the electrolytes can be made extremely thin and readily lends itself to the construction of bipolar cells. Other advantages of solid-state electrolytes include safety and diminished problems in battery manufacture. Problems requiring attention include increasing conductivities of solid-state electrolytes, elimination of interfacial corrosion, and elimination of cell failure due to dendrite formation. The latter problem can, in part, be addressed by considering lithium intercalating anodes. What is desired in this program is the development (e.g., new syntheses) and/or identification of candidate solid electrolytes of high conductivity over a wide temperature range which are compatible with lithium and/or lithium intercalating anodes and high energy positive plate materials.

Phase I: Phase I should result in the synthesis/identification of at least one candidate solid electrolyte with the characteristics discussed above.

Phase II: This phase provides for further exploration and refinement of electrolytes and compatible electrochemical couples seeking the highest possible combination of energy and power densities, long cycle life, good charge retention and all-temperature operation. Electrode and cell fabrication techniques will be developed, and prototype cells and/or bipolar battery modes will be demonstrated.

Potential Commercial Market: Rechargeable power source for military and commercial manportable electronic equipments, future robotics and pulse power applications. manportable electronic equipments, future robotics and pulse power applications.

TOPIC: A92-116TITLE: High Power, Solid-State Ku-Band Transmitter

CATEGORY: Exploratory Development

OBJECTIVE: Produce a lightweight, miniature, high power transmitter and integral modulator that operates at Ku-Band frequency. The target specifications will be: Frequency 17 GHz; Stability better than 1 MHz over an operating temperature of -45°C to +70°C; Power Output of 50W pulsed, with a width of 0.35 +/-0.05 microsec, rise time 0.1 microsec (10% to 90%) and rep rate 100-20,000; Power consumption less than 7 watts DC; Spur/harmonics -70/-25 dBc; Aging less than 10 kHz/yr; Frequency set-on to better than 100 kHz within 3-4 seconds; Size less than 6 cubic inches; Weight less than 5 oz; Cost less than $3K.

GENERAL: Ku-band transmitters are employed in a number of military beacon and transponder systems. Currently, magnetron tubes are used as the frequency source. The tubes provide a high output power, however, extended warm up periods are required to achieve the desired frequency stability. In man-transportable systems, the additional battery capacity required adds significantly to the size and weight of the system. The relative merits of employing various solid-state devices to such an application will be studied and an approach promising low-cost, lightweight, small size and high efficiency is desired.

Phase I: Perform a study in which the relative merits of employing various solid-state components to provide frequency transmitter and modulation functions at Ku-band will be explored. The virtues of direct vs. harmonic/multiplied frequency techniques and means for their implementation will also be examined. Proof-of-concept analysis, supplemented by limited breadboards of select circuits supporting proposed techniques will be a requirement. Phase I outputs should be capable of demonstrating the technology chosen is translatable to a complete development of a transmitter with the desired specification under a Phase II program.

Phase II: The effort is to carry the feasibility demonstration of Phase I further by actually building the transmitter and modulator circuits, completely packaged, to provide performance required. The development will be tested and documented. Interoperability with Army beacon and transponder systems will be considered as the unit is being developed, thus target performance parameters may change slightly from those specified as intended system insertion requirements are better understood.

Potential Commercial Market: The Army is planning the development of a self-contained, lightweight man-portable ground-emplaced radar transponder known as the Miniature Multiband Beacon (MMB), to replace an existing transponder system, the AN/PPN-19. Primarily emphasis is to not only improve on the AN/PPN-19 performance, but to reduce the size and weight to one third of its present form. The transmitter and modulator portion of the unit is considered the critical technology area in achieving the planned MMB development. Commercial applications would include commercial aviation/navigation.

TOPIC: A92-117TITLE: High Temperature Superconducting (HTS) Microwave Receiver

CATEGORY: Exploratory Development

OBJECTIVE: To develop the high temperature superconducting (HTS) microwave technology in receiver applications for communication, radar, and EW systems.

DESCRIPTION: Recent advances in HTS materials has led to the development of passive and active microwave circuits with improved performance and other advantages in resonator, filters, and oscillators. This effort seeks to asses and study the applicability and implementation of developing a receiver front end with an HTS based oscillator, filter and antenna all integrated on a single substrate.

Phase I: The first phase should result in an analysis of one or more approaches to integrating an HTS 8*8 or 4*4 antenna patch array on a substrate with an HTS stabilized resonator and HTS prefilter. The frequency range of interest for this work is 20-30 GHz. Analysis should include simulated results of reduced antenna feed loss and oscillator phase noise on system performance. The system to be analyzed are Doppler radar, communications, and EW systems. Particular emphasis should be

placed on coherent communication receiver analysis relating HTS component performance to bit error in the signal demodulation process. Analysis in the communications system should pertain to high data rate phase shift keying (PSK) and minimum phase shift keying (MSK) modulation formats.

Phase II: The second phase will be the actual hardware development of the receiver front end on a large area HTS film (4 inch diameter). The design will be chosen by the Army from the design proposals presented in phase I. This effort will involve a code development process with ETDL in the fabrication and testing of the microwave components to reduce development costs. The delivered hardware will be a functional receiver providing an IF output complete with cryogenic packaging. IF processing hardware will be provided by ETDL.

Potential Commercial Market: This receiver technology will have various impacts depending upon the specific application. The increased sensitivity of the receiver will have the advantage of extended range capabilities and reduced system detectability as outlined in the Army Technology Base plan, Vol I, page II-24 for NLOS. The cryogenics required for HTS components will make this a natural candidate to combine the receiver and infrared (IR) technology for dual mode sensor purposes. The dual mode technology will have the impact of improved target detectability for smart weapons which supports the integrated multi-sensor target acquisition as outlined under next generation capabilities under A3 System Capabilities, Army Technology Base plan, Vol I, page II-16. Commercial applications would include satellite communications systems and radar for collision avoidance and law enforcement.

TOPIC: A92-118TITLE: Semiconductor Optical Amplifiers for Microwave Applications

CATEGORY: Exploratory Development

OBJECTIVE: Identify, develop and demonstrate semiconductor optical amplifiers base in GaAs and/or InP for compatibility in microwave monolithic integrated circuits (MMICs).

DESCRIPTION: Recent advancements in high-speed lasers and detectors have led the way for the distribution and control of microwave devices, circuits and systems via fiber optics. Applications which have benefit from this technology are fiber optic delay lines and fiber optic memory loops (FOML). The limitation of these types of circuits come from repeated conversion of the electrical signal to the optical domain and back, due to losses and noise associated with this process. Much longer delay times and improved performance could be obtained by keeping the signal in the optical domain via an optical amplifier. Due to size and weight requirements, MMICs are being used in these applications. Therefore, the components developed under this topic must be compatible with MMIC for integration of optical and microwave components.

Phase I: Under Phase I, the technology to implement the optical amplifier in semiconductor based material must be identified. Designs must be approached which are compatible with current and future MMIC technology. The amplifier must be capable of amplifying intensity modulated optical signal at microwave frequencies. Performance issues should address noise, dynamic range, and maximum frequency of operation. Development should also include optical waveguide structures for routing of the optical signal. Development should concentrate, but not be limited to the wavelengths of 0.85 μm and 1.3 μm.

Phase II: Under Phase II, the final designs will be processed and tested. The test must include a maximum frequency of operation, and determination of the signal-to-noise ratio. It is encouraged that the final product be tested in a delay line system or FOML. A complete plan for integration into a MMIC should then be presented. A design of a circuit should then be realized which shows some level of integration of microwave and optical components such as switches. This design would then be fabricated and tested.

Potential Commercial Market: Applications include long optical delay lines for the delay of microwave frequency signals and for fiber optic memory loops used in electronic jamming equipment and phase array radars. Commercial applications would include telecommunications
systems.

HARRY DIAMOND LABORATORY (HDL)

TOPIC: A92-119TITLE: High Performance Electronically Scanned Antenna

CATEGORY: Basic Research

OBJECTIVE: Future Army systems will require target acquisition and fire control sensors which will allow all weather, long range target detection, classification, and recognition of ground and low/slow aircraft targets. The Radar Branch is developing a multi-mode radar which will address present and future Army deficiencies in battlefield surveillance and target acquisition. This radar will have the flexibility to address a variety of requirements, including wide area search and surveillance, tracking, and target recognition and classification. A key component of this radar will be its antenna. In order to optimize performance under a wide variety of radar modes and operating conditions, the antenna must incorporate very robust performance features, which in some cases lead to conflicting design parameters. The multimode radar will transmit waveforms which are suitable for MTI, ultra-high range resolution, and SAR modes. The objective of this program is to design and develop a high performance electronically scanned antenna which will be used as part of a test bed radar.

DESCRIPTION: The objective radar will be used to acquire high range resolution and fully polarimetric diverse signatures of complex targets. In addition monopulse information in elevation is required to investigate 3-D SAR concepts. The primary emphasis in the radar design will be on optimizing the antenna's performance so as not to limit the quality of the data that can be achieved by the rest of the radar. However, consideration will be given to future operational utility. Therefore, factors such as cost, complexity, size, weight,power consumption, and antenna efficiency will be considered. For instance, radiating elements that are compatible with smart skins, such as patch array, will be preferred. The following parameters are desired: + or - 45 degree scan angle, 3 degree azimuthal beam width, fixed 30 degree cosecant squared elevation pattern, full polarization diversity (phase and amplitude control of vertical and horizontal vectors) with low axial ratio for circular polarizations, monopulse in elevation, 5% bandwidth at 16 GHz center frequency, less than -25dBi sidelobes. If power amplifier elements are not used as part of the antenna design, a TWTA with an average power output of 10W will be supplied by the Government.

Phase I: The Phase I effort will be a parametric analysis of the proposed design which includes a simulation of the radiation pattern of the antenna under a variety of operating conditions. The study will propose a detailed electrical and mechanical antenna design and a discussion of error sources and their effect on performance.

Phase II: The antenna designed as part of the Phase I effort will be fabricated and characterized. The proposer should have in-house, or have access to, facilities for fabricating and testing the antenna.

Potential Commercial Market: Concepts for adapting the antenna to a specific application will be studied, and a producible design selected. An antenna which meets the form, fit and function requirements of the application will be fabricated and tested.

TOPIC: A92-120TITLE: III-V Semiconductor Optoelectronics for Signal Processing

CATEGORY: Exploratory Development

OBJECTIVE: Development of III-V semiconductor optoelectronic components or integrated circuits of interest for optical signal processing architectures.

DESCRIPTION: III-V semiconductor optoelectronics already provides individual semiconductor laser diode and 1-D diode array sources of utility for signal processing. 2-D diode laser arrays are also beginning to emerge. Progress is also being made in the area of III-V semiconductor spatial light modulators with 2-D arrays beginning to appear. Optically bistable elements have the potential of functioning as optical logic elements in optical signal processing. III-V semiconductor optical waveguides have a demonstrated capability of integrating individual functional elements together on a chip. Any one of these or related areas of exploratory development could be pursued from the point of view of signal processing with considerable promise of advancing the state of the art. Examples of desirable signal processing functional capabilities include image processing, correlation, convolution, and synthetic aperture radar processing. Work pursued under this topic should identify a key building block or module needed for such processing.

Semiconductor optoelectronics is currently undergoing rapid development. This development is facilitated by the fiber optic communications networks that are aggressively being developed, and by the aggressive development of III-V semiconductor microwave circuitry. Despite the progress being made in the III-V-semiconductor material system the impact on optical signal processing is just beginning to emerge.

Phase I: Identify the desirable III-C optoelectronic building block or module. Determine realistic achievable performance characteristics that would be of utility for a desirable optical signal processing capability. Identify potential users of this building block or module. Formulate a plan for its development and demonstration.

Potential Commercial Market: Develop and demonstrate the III-V optoelectronic building block or module identified in Phase I. Deliver prototypes for testing at HDL. Acquire adequate financing and bring this building block or component to commercial availability.

TOPIC: A92-121TITLE: Knowledge Based Target Classification Using Baseband Doppler Audio Frequency

CATEGORY: Exploratory Development

DESCRIPTION: HDL, through its various surveillance radar programs, is investigating the techniques involved in automating many of the functional concepts and methods utilized by trained radar operators to interpret signal returns from targets detected by surveillance radar sensors. We have found that one such technique has been very effective in its ability to classify certain types of targets. The technique is human operator's interpretation of the radar baseband audio doppler return from the particular target classes.

The baseband doppler frequencies generated by a target give rise to a characteristically unique sound pattern based on the radial motion of the particular target over time. In many cases, a target can be type classified, and in some cases identified, by an operator listening to this audio signal over a relatively short period of time. This type of classification differs from what is normally called doppler, or spectral, classification in that the spectral classification is performed over a very short interval of time, usually called a "coherent processing interval" (CPI). The data gathered in one CPI is sufficient for "Spectral Analysis" techniques for target classification, but is too small a sample for audio "Feature Extraction" pattern matching. Such a machine analysis would require a prior knowledge concerning the audio pattern, over time, generated by each target class for a particular range of baseband doppler frequencies which vary for changing radar-to-target aspect angles.

This proposed technique is not unlike "Voice Template/Pattern Matching" used in some automated entry security systems, and also used in Speech Recognition. Currently, radar operators are trained in this "Pattern Matching" technique by listening to recorded Doppler signals from various targets under different conditions. In order to achieve the automation desired, these audio features, in the form of overlay templates or patterns, must be stored in the system so as to allow rapid search, analysis, and reporting. Initial work on this subject would define the methods and concepts for implementation of a limited audio pattern knowledge base which would support knowledge based processing, Artificial Intelligence, Neural Networks or Artificial Neural Systems (ANS). Using these techniques and concepts, the data would then be autonomously utilized by the system to produce valid conclusions relative to the classification of particular targets detected by the radar sensor system.

Phase I: In addition to the basic question of over all feasibility of such an automated "Expert" and/or "Neural" system, there are at least three fundamental questions to be answered in the initial phase of the project: (1) What is the minimum sample time interval required to produce a valid feature pattern for knowledge base comparison? (2) Can such an interval be constructed using the combined data extracted from periodic hits on a tracked target from a scanning radar, or, must the radar dwell on the target over the required interval in order to obtain the appropriate pattern? (3) Keeping in mind that the objective is only to identify, not understand, how may the methods and techniques of Speech Recognition technology coupled with Artificial Intelligence and Neural Network concepts, simplify and enhance our ability to autonomously classify radar targets using the baseband audio Doppler?

Phase II: Following the initial phase of the effort, during which the methods and techniques are firmly established, actual implementation of a knowledge base system test bed can be accomplished during a second phase using suitable recorded, as well as real time, Doppler audio data and appropriate processing equipment.

TOPIC: A92-122TITLE: Diffractive Optical Element Mask Generator and Fabricator

CATEGORY: Exploratory Development

OBJECTIVE: There exists a great potential for applications of diffractive optical elements in commercial markets, for example, improving the performance of laser scanners in compact disk players. Other potential applications include improved performance optical sensors. Potential markets such as these should stimulate small scale research for which a low cost PC-based DOE fabricator-generator is required.

To reach Phase III, the objective is to develop a low cost system, for example, a PC-based system, for generating masks that are necessary for fabricating thin diffractive optical elements (DOEs). Minimum feature size should be at least 25 microns over a 50 x 50 millimeter field; 10 microns is preferred. Positioning accuracy should be less than 1 micron. System output should be directly to film, but also have the capability for hardcopy output. Software support is desired and should include, for example, routine for computer hologram coding such as Lohmann-Brown, iterative Fourier routine for hologram design, and routines for Dammann grating design, as well as a facility for incorporating new designs developed by the end-user.

DESCRIPTION: The fabrication of a high fidelity DOE currently requires a substantial investment of capital. However, for research purposes, DOEs having micron or sub-micron feature sizes are unnecessary. A low cost mask generator having minimum features on the order of a 10 microns is needed to allow researchers in optical processing and computing the ability to fabricate and test DOEs in optical architectures easily and inexpensively.

Phase I: System design and development. Phase I will include the identification of a candidate system to obtain the objective, including specification of input devices, output devices, and control units, and the development of same to verify operation.

Phase II: Advanced development and testing. Upon successful demonstration of the technology and design as a viable DOE mask generator and fabricator in Phase I, development of a prototype system will be conducted in Phase II.

TOPIC: A92-123TITLE: Panoramic Image Translation of Microelectronic Assemblies

CATEGORY: Advanced Development

OBJECTIVE: This project develops hardware and techniques for high speed inspection of surface flaws in microelectronic assemblies and components, using panoramic image capture hardware and to translate the captured image with a high speed image processor. Manual inspection of microelectronic assemblies with hundreds of components such as dies, capacitors, diodes etc. is time consuming, expensive and subject to human error. This problem is compounded when precise verification of a component's manufacturing process is warranted. These requirements extend beyond the normal presence or absence of components in the assembly. A good example of this requirement can be cited in paragraph 3.1.4.2a (Adhesive Element Mounting) of MIL-STD-883 Method 2017: "No device shall be acceptable that exhibits - adhesive not visible around at least 50 percent of the element perimeter or continuous on two sides of the element for class B of the element and 75 percent of the element perimeter or continuous on three sides of the element for class S".

Under this requirement, the operator has to inspect all four sides of the component for full compliance of the quality specification. This is time consuming, expensive and subject to human error. With today's automation advancements, attempts have been made to fulfill the above inspection requirements by using high speed computers and machine vision technologies. The standard approach for capturing images of all four sides of a component is to use 4 cameras, focused at the die but 90 degrees apart, and to capture each side of the die sequentially.

The image processor then integrates the four images together and determines its pass or fail condition. This method requires 4 images to be capture, analyzed and processed - time consuming task. Another approach is to use one camera, focused perpendicular (sideways) to the assembly at a designated location. The component (die) to be inspected is presented to the camera, one side at a time, by an XY / rotation table. Since the component (or die) is only part of an assembly (refer to Fig. 1) any rotational movement of the table will throw the component off center. To accommodate this deficiency, a refocusing and/or realignment operation is required before a new side of component can be inspected. Tough technically feasible, this technique is time consuming and unreliable.

DESCRIPTION: Due to the limitation of traditional 2D sensor array technologies such as machine vision, laser dimensional measurement equipment etc., multiple view of the cylindrical surface must be taken for flaw detection and analysis. In frequent situations, manual inspections were employed to detect and interpret these flaws. This is time consuming, labor intensive, and subject to human error. With the advancements of computer technologies, today's image processing techniques should be able to stop beyond a human's stereo image analysis barrier. Technologies for capturing and analyzing a panoramic view of an object with a single snap short or machine cycle time must be explored. Innovative ideas are sought using a combination of these technologies to substitute a human's image acquisition and decision making process.

Phase I: Develop a novel approach to acquire the panoramic image of an object, then develop an image analysis process to interpret the image and isolate predetermined flaws. Detection and identification of adhesive flaws around a microelectronic component such as a die, is good test for the concept. This concept must address the illumination technique, image acquisition technique, and flaw identification scheme. A feasibility of the technologies proposed in this application in terms of speed, precision, a resolution and reliability should also be addressed.

Phase II: Finalize the design and build a prototype system. Integrate the system into a manufacturing environment for the real-rime inspection of flaws. Document the performance of the inspection including the accuracy, speed, cost of operation, and the savings achieved.

TOPIC: A92-124TITLE: Solder-Plating Process Control

CATEGORY: Advanced Development

OBJECTIVE: This effort is to develop and implement a scientifically based solderability tester as a process control tool during solder plating of electronic circuit boards. The study in particular is to minimize "weak knee" solderability problems on the curved radius of plated thru-holes.

DESCRIPTION: A scientifically based solderability tester is described in the article "Electrochemical Assessment of Sn-Pb Solderability", by D. Tench and D. Anderson, Plating and Surface Finishing, August 1990, pp. 44-46.

This tester was designed to quantify and identify surface oxides on solder plating, and oxides in turn are correlated to solderability. Prove-out on full scale production lines is being performed in the US Army MANTECH program, and is expected to be completed in December 1992. The prove-out will primarily determine the ability to detect weak-knee defects prior to soldering electronic assemblies. This SBIR program is intended to transition results of the MANTECH program into the small business industrial base. Specific manufactures are those associated with solder plating of DoD printed wiring boards defined in MIL-P-55110, Qualified Products List of Military Specification Printed Wiring Boards.

Phase I: The contractor shall provide a proposal describing the organization, capabilities, facilities, research staff resumes, Dunn and Bradstreet rating, DoD contract history, small business status, and current volume of circuit board plating operations. The proposal is to describe how variables from the solderability tester will be correlated to perturbation in critical process controls on the plating line. This is to include descriptions of samples, numbers of samples, etc. The proposal is to describe how the tester is to be implemented on the contractor plating line upon completion of the Phase I study. More than one SBIR contract may be awarded depending upon the availability of funds, and the government will provide solderability testers as GFE to each contractor receiving an award.

Phase II: None, implementation is expected in Phase I.

TOPIC: A92-125TITLE: Very Small Rugged RF Filters and Low Power Oscillators

CATEGORY: Exploratory Development

OBJECTIVE: Development of stable oscillators and filters.

DESCRIPTION: Future artillery launched systems will take advantage of high levels of circuit integration to achieve sophisticated signal processing capabilities in a small, rugged package (the artillery environment consists of a setback acceleration of 20000 Gs for 1 millisecond and spin up to 300 rps). Two areas that do not presently lend themselves to miniaturization are filters and oscillators.

Fuzing systems will require 2% bandwidth filters from baseband to several gigahertz for signal processing applications. Filters that are innovative in their use of space and integrate well with MMIC devices are desirable.

Future fuzing, guidance, and other sophisticated gun-launched electronics systems will require highly stable crystal oscillators that can function through an artillery launch and the ensuing dynamics without offset, drift or modulation. A short period of time is available before launch for frequency stabilization.

Development of stable oscillators and filters will have direct application to a wide variety of applications where the environment is less severe as well such as mobile communications equipment, satellites, missile electronics, etc. They could allow improvement in reliability, size and weight of these devices.

Phase I: Study various filter and oscillator construction techniques, focusing on electrical performance and material specifications.

Phase II: Demonstrate filter and oscillator performance by constructing prototypes and airgun testing.

TOPIC: A92-126TITLE: Low Power Monolithic Microwave Integrated Cicruited

CATEGORY: Exploratory Development

OBJECTIVE: To achieve a monolithic FM-CW radar transceiver on a single chip with a power consumption equal to or less than 200 milliwatts.

DESCRIPTION: The radar transceiver contains a voltage controlled oscillator, circulator, power amplifier, mixer and if amplifier interconnected to provide a single chip 50 OHM FM-CW transmitter/receiver for proximity fuzing applications. The transmitter operates in the C Band with an output power that will be maximized within the power consumption goals.

The purpose of this SBIR is to develop a GAAS MMIC transceiver chip using a lower power consumption geometry while still maintaining the performance characteristics of galium arsenide. Some of the possible geometries to be investigated should include the use of enhancement/depletion mode and HBT. Both of these geometries have the potential to reduce power consumption and they will still support the active device structures required on a MMIC FM-CW transceiver.

Phase I: This phase of the program will be concerned with performing tradeoff studies and simulations of candidate structures to be used in the MMIC chip. The product of this phase will be a simulated schematic that will be fabricated in phase II.

Phase II: The MMIC developed in phase I will be fabricated and the die will be packaged and tested to compare performance against simulation results. Additional studies will be performed to improve performance, producibility and yield for production quantities.

Potential Commercial Market: In this phase, production quantities of the MMIC will be fabricated to provide a statistical database for future production buys. It is anticipated that this phase will be funded by a sponsor as a product improvement to the XM773 MOFA program am as the basis for the transceiver for the advanced mortar fuze.

TOPIC: A92-127TITLE: Field Uniformity Enhancement for AURORA

CATEGORY: Exploratory Development

OBJECTIVE: The goal of this SBIR is to develop a method for improving the vertical field uniformity in the AURORA test cell, with the ultimate objective of developing a capability for high fidelity simulations of SREMP coupling to antennas on Army systems.

DESCRIPTION: Flash x-ray machines such Aurora have been increasingly capable of producing radiation pulses with realistic pulse widths for tactical source region simulation. Unfortunately the fact that they are point sources limits the fidelity of the EM Environments, particularly in the case of the vertical electric fields. These vertical fields tend to change sign at a distances of only one to two meters above the ground, and thus provide a very poor simulation of the environment of interest for antenna coupling in the tactical source region.

The purpose of this SBIR is to develop and evaluate approaches for improving the vertical field simulation fidelity in the AURORA test cell. Among the approaches to be considered is the possibility of using a transmission line in the AURORA test cell that would produce the required field, while the AURORA pulse would provide the necessary air conductivity. Any approach proposed should evaluate the effects of timing, pulse shape, humidity, gas constituents, and transmission line fields on

the resulting electric field. The proposed effort should also evaluate the effectiveness of the proposed modification in simulating SREMP coupling.

Phase I: During Phase I the effort should propose one or more designs for enhancing the field uniformity in AURORA, and provide environment and coupling calculations to demonstrate the expected results. The Phase I effort should also include plans and costing for the proposed upgrade to AURORA.

Phase II: During Phase II the effort should include final design and construction of proposed modifications, together with a detailed test plan for demonstrating the new SREMP capability this provides. Detailed test plans and supporting calculations should address coupling to complex structures, and other experiments of interest to the Army.

TOPIC: A92-128TITLE: Low Noise Power Supplies for Fluidic Sensors and Circuits

CATEGORY: Exploratory Development

OBJECTIVE: Fluidic sensors, components, and circuits offer exceptional reliability, are inherently rugged, and low in cost. Fluidic sensors (acoustic, angular turning rate, etc.) also offer extremely high signal to noise ratios. Many applications have no available pneumatic power for these fluidic devices and consequently cannot take advantage these benefits. Applications in Future Soldier Systems, vehicle navigation, flight controls, and Smart Mines could be greatly accelerated if suitable pneumatic power supplies were available.

DESCRIPTION: Recent efforts in fluidics have begun to enhance the state of the art by reducing the physical size of the components much like microelectronics. Fluidic amplifiers, operating as acoustic detection devices, can offer Smart Mine systems and Future Solder Systems, superior acoustic detection capability and exceptional ruggedness to burst overpressures and electromagnetic pulse. This effort will focus on the development of pneumatic power supplies for fluidic sensors and circuits which will provide very low noise pressure and flow.

Phase I: This phase will involve a literature search for work in low noise pneumatic power supply development, selection of a candidate pump, and a preliminary engineering design. Current development programs (SBIR and HDL Tech Base) will provide appropriate requirements for pump output power and permissible noise level. The power supply must be sized to be suitable for applications where long field operation, small size, and low weight are very important. Chemical, thermal and electrolytic concepts will be included in this study. The program plan for Phase II will be formulated to develop an acoustic detection device powered by the selected power supply and configured from fluidic devices provided by HDL. These fluidic components could range from nozzle widths of below .001 in. to as much as .005 in. Laminar flow conditions within the pump and fluidic circuitry must be maintained.

Phase II: This phase consists of the manufacture, test, and evaluation of power supplies designed in Phase I. The acoustic detection device will be tested for its' sensitivity, length of performance and suitability for use in military systems. These tests will include; man portable implementations, static deployment as in smart mine systems, and vehicle based utilizations, as might be found in robotic applications. Cost of this package must be kept as low as possible to enable the fielding of many of these systems.

Potential Commercial Market: Phase III potential should be high. The power supply could be utilized to power fluidic rate sensors as well as acoustic detectors. This would enable the manufacture of low cost angular rate sensor circuits for man portable navigation aids and vehicle based systems as well as miniature flight control componentry which is insensitive to electromagnetic energy. The pump and fluidic controls could also be used to generate and monitor breathing gases for biomedical application.

TOPIC: A92-129TITLE: Wideband Analog Fiber-Optic Links Using Integrated Phase Modulators

CATEGORY: Exploratory Development

OBJECTIVE: To reach Phase II the objective is to develop, test, and fabricate an analog wideband fiber-optic link using integrated phase modulators (IPM).

DESCRIPTION: When performing High Power Microwave vulnerability assessments on electrical devices it is necessary to optically transmit measured currents and voltages from the device under test, (placed within anechoic chambers), to remotely

located instrumentation. Optical transmission of the measured signals is required to prevent contamination of the measured signal from the intense electromagnetic environment within the anechoic chamber. It is preferred that the optical link be based upon IPM techniques so that this device could be used with 1.3nm laser/receiver units currently in use by the Army. Requirements:

Bandwidth: 10 KHz- -5GHz
Wavelength: 1.3nm
Dynamic range (tangential noise to 1dB compression): 40dB
Minimum sensitivity: 20u V
Size of transmitter: 40 x 40 x 40 mm
Minimum operating time: >4 hours
Output stability (=-1dB): -23 to 44 degrees C
Fiber lengths: >200m
Remote features: On/Off
Adjustable input sensitivity
End to End calibrator

Phase I: Survey and identify candidate IPM device and circuitry necessary to demonstrate feasibility of optimum design as well as bandwidth, dynamic range, sensitivity, and temperature stability requirements. Theoretical and circuit analysis models can be employed to demonstrate size and remote function capabilities.

Phase II: Additional testing and fabrication of a fully operational prototype to demonstrate all requirements, as well as reliability and practicality of use. Field testing of prototype link will be required.

MATERIALS TECHNOLOGY LABORATORY (MTL)

TOPIC: A92-130TITLE: Transparent Polymers with Enhanced Ballistic Performance

CATEGORY: Exploratory Development

OBJECTIVE: Develop transparent polymers to provide greater protection against high-rate ballistic impact threats for applications such as canopies, windscreens, eye protection and security glazing.

DESCRIPTION: A significant improvement is sought in the performance of transparent polymers to provide greater ballistic protection against high-rate impact. Conventional bisphenol-A-polycarbonate (PC) provides better protection from small caliber fragments than other available transparent polymers. Mechanical studies have shown that PC yields during failure rather than crazing and/or cracking, which is observed in other materials. This yielding failure is preferred because it requires more energy and does not produce spall. Little if any improvements have been made in the ballistic performance of monolithic PC since it was commercially introduced over thirty years ago. Recent advances in molecular modeling techniques provide a capability to examine the structure of polymers. Perhaps these techniques can be used to examine the differences that exist between PC and other commonly used materials such as polymethyl methacrylate (PMMA). Parameters could then be established to explain known differences. Finally, new molecular structures could be proposed that should have improved properties to enhance the ballistic performance of new transparent polymers.

Phase I: Model the structure of PC and determine what elements of the structure give PC it's unique ballistic properties. Propose new transparent polymers that should have significantly improved performance.

Phase II: Synthesize sufficient quantities of these new polymers for ballistic screening tests and then update models based on these test results. Produce sufficient quantities of the most promising candidate materials and conduct characterization and processing studies and then develop and deliver prototype items of the best materials for Army ballistic and other tests.

TOPIC: A92-131TITLE: Single Crystals of Tungsten and It's Alloys

CATEGORY: Exploratory Development

OBJECTIVE: Develop the processing capability to produce tungsten for penetrator applications in the form of large single crystals of known orientation. Alternatively, develop the technology required to directionally solidify tungsten heavy alloys that results in crystallographically oriented tungsten grains in the heavy alloy.

DESCRIPTION: It has been reported in the open literature that single crystals of pure tungsten in the <100> orientation (with respect to the axis) perform as well as depleted uranium in laboratory scale ballistic experiments. Consequently, there is a strong desire to scale-up the size of the oriented tungsten material for full-scale ballistic tests. Two alternative approaches are immediately apparent. The first is to develop the technology to grow large single crystals of pure tungsten. The state-of-the-art limits these crystals to less than 10mm in diameter. A second route to a solution may be through the heavy alloy system: tungsten-nickel-iron. These alloys are produced by liquid phase sintering during which a mechanism known as solution-reprecipitation causes significant growth of the tungsten grains. The tungsten grains in a heavy alloy are typically non-oriented single crystals, but the use of controlled processing may allow the orientation of these grains. The obvious advantages of the second approach are lower processing temperatures and the in situ formation of the single crystals.

Phase I: Demonstrate the processing technique proposed and deliver samples of the oriented material. Ideally, Phase I will be able to demonstrate the production of samples sufficient to perform quarter-scale ballistic tests. This requires a diameter of at least 10mm and a length of ten times the diameter. All work must be supported by x-ray diffraction and mechanical property testing.

Phase II: Exploit the knowledge gained in Phase I and scale-up the process to produce material that can be used in full-scale ballistic tests. Phase II should ultimately deliver full-scale tungsten (alloy) penetrators with the proper crystallographic orientation. Extensive property and microstructural characterization should be performed along with all necessary x-ray diffraction characterization.

TOPIC: A92-132TITLE: Production of Butyl Rubber Coated Cloth by Latex Process

CATEGORY: Exploratory Development

OBJECTIVE: Development of butyl rubber latex process for production of butyl rubber coated cloth (BCC) for use in chemical protection applications.

DESCRIPTION: BCC is used in the production of gas mask hoods, helmet covers and chemical agent suits. The majority of BCC consumed is produced according to MIL-C-51251A or MIL-C-12189H for light (6.8-8.0 oz./sq. yard) and heavy (11.0-13.5 oz./sq. yard) weight BCC respectively. Current methods for production of BCC involve spread coating of nylon fabric materials by a butyl rubber solution. Multiple applications are required to obtain the desired weight, with a solvent drying step between each application. Following spread coating, additional butyl rubber is applied to one side of the coated fabric by calendaring. Problems associated with current BCC production include lack of process control, high scrap rates, and use of large amounts of hazardous solvents. The use of a latex based fabric coating process for BCC would eliminate the need for hazardous solvents, and should reduce the number of coating steps and process energy requirements versus solvent coating at a given fabric weight. Latex BCC would have to show comparable chemical resistance to current BCC and meet the requirements of MIL-C-51251A and MIL-C-12189H.

Phase I: Investigate and demonstrate the feasibility of producing BCC meeting MIL-C-51251A and MIL-C-12189H by a latex based process. Demonstrate the chemical resistance of samples produced to meet each specification.

Phase II: Develop and demonstrate continuous processes for production of materials demonstrated in Phase I. Demonstrate large scale producibility of BCC using the latex process by producing sample rolls of materials meeting MIL-C-51251A and MIL-C-12189H not less than 30 inches in width. Samples must meet respective specification along the entire length and width of each sample roll, and show good chemical resistance at all points.

TOPIC: A92-133TITLE: Advanced Nondestructive Evaluation and Sensors in Manufacturing

CATEGORY: Exploratory Development

OBJECTIVE: Develop software and hardware tools which control the manufacturing process through the monitoring and measurement of product parameters.

DESCRIPTION: The development of new nondestructive evaluation (NDE) and sensor technologies for manufacturing is advancing rapidly. Work in this area can be categorized into several areas: interactive design, novel sensors, intelligent controls, and expert systems software.

Interactive design includes unique ideas and concepts which facilitate the planned application of NDE methods and sensors to the inspectibility, production monitoring, and life cycle monitoring of components and assemblies during the design process. The design tools will be computer based knowledge tools which will augment and compliment one or more computer aided design (CAD) packages commonly used by designers. For example, an expert system may provide the designer with advice on sensor selection, parameters, and placement to ensure condition monitoring during manufacturing and field use. The design tools should also be capable of recommending design changes to improve manufacturability.

Novel sensors include those used during the manufacturing process to monitor the condition of the part during fabrication, thereby facilitating process control and, ideally, the use of embedded sensors for continuous monitoring of part condition following manufacture. Intelligent adaptive controls includes those capable of collecting data from various sensory inputs and using neural net logic to monitor/assess part condition either during processing or use. Then, based on the condition of the part, adjusting process parameters to compensate for changing conditions.

Expert systems software is an integral component of intelligent sensors and controls. Innovations in this technology are of interest for manufacturing and life cycle monitoring based on sensor data describing material condition/parameters.

Phase I: Demonstrate the feasibility of the technology proposed using simulations or small-scale laboratory demonstrations.

Phase II: Develop and deliver a full-scale prototype of the Phase I hardware/software and demonstrate against a realistic application.

TOPIC: A92-134TITLE: Engineered, Ceramic Reinforced, Ceramic Matrix Composites

CATEGORY: Exploratory Development

OBJECTIVE: Develop processing technology to produce large, complex shapes of ceramic reinforced, ceramic matrix composites (CMC's) with emphasis on exploiting technology currently employed in processing organic matrix composites (OMC's).

DESCRIPTION: Many ceramic reinforced, CMC's are produced via laborious manual techniques. These methods do not produce uniform microstructure, nor are the products reproducible, which makes their characterization and analysis very difficult. Processing technology currently used to produce OMC's has significant potential to solve such problems associated with processing CMC's. Techniques such as: filament winding, braiding, weaving, and lay-up can be combined with: slurry infiltration, polymer pyrolysis, and sol-gel to produce reproducible CMC's.

Phase I: Employ modified OMC processing technology to demonstrate the feasibility of producing CMC's with less than ten percent residual porosity. Perform property characterizations on the CMC to evaluate anisotropic behavior.

Phase II: Scale-up the technology and produce ceramic reinforced CMC's and demonstrate the processability and reproducibility of the material. Evaluate the performance of the CMC's produced at elevated temperatures. Devise and demonstrate appropriate methodologies for attachment of these CMC's in practical applications.

TOPIC: A92-135TITLE: Development of Ceramic Reinforcements (Fibers) for Ceramic-Matrix and Metel-Matrix Composites

CATEGORY: Exploratory Development

OBJECTIVE: Develop low cost polycrystalline or single crystal, ceramic fiber reinforcements for ceramic and/or metallic matrices for increased toughness, strength, and/or oxidation resistance.

DESCRIPTION: Reinforcements are often necessary to increase properties of materials for specific applications. For ceramics, these reinforcements can increase the fracture toughness from a factor of two to almost an order of magnitude. On the other hand, metallics benefit from an increase in strength when reinforcements are added to the matrix. Two areas of focus that need to be addressed are costs and oxidation resistance. Low cost fiber reinforcements need to be developed for both severe and moderate environments.

Phase I: Demonstrate producibility in the development of either low cost or high performance polycrystalline or single crystal fibers for either a ceramic-matrix or a metallic-matrix composite. Conduct initial compatibility studies with the matrix material to demonstrate the property enhancement sought. Lengths of fibers and, if possible, tows will be delivered at the end of the Phase I effort.

Phase II: Scale-up the Phase I fiber/tow material(s) and demonstrate processability of the material system(s). The fiber/tow will be characterized and optimized for a specific matrix material and target application. This material will be used in the fabrication of composite demonstration components.

TOPIC: A92-136TITLE: Biomimetic Magnetite

CATEGORY: Exploratory Development

OBJECTIVE: Development of biomimetic methods to produce magnetite particles of controllable size and shape for applications to materials synthesis to enhance microwave absorption.

DESCRIPTION: When dispersed in a dielectric material, magnetite particles with high aspect ratios are good candidates for microwave absorbing materials with a markedly decreased weight penalty. Existing methods of making whiskers or fibers with suitable properties are expensive, and whisker handling is heavily regulated and can be hazardous. Biomimetic processes proceed under ambient conditions and in the absence of most hazardous materials. In addition, with a fully controllable process it may be possible to grow whiskers in situ for later infiltration by matrix materials, thus eliminating handling problems. Biomimetic processing methods mimic the physico-chemical pathways by which organisms conduct synthesis reactions. To understand these pathways, biological analogues must be investigated and the controlling factors of the synthesis reactions determined and duplicated. The goal of this work is not to make microorganisms do the actual synthesis, but to elucidate and mimic the manner in which they do so, so that the process can be detached from the organism and applied to materials synthesis technology. Although biomimetic production of magnetite and other ceramic materials has recently sparked great interest in the biotechnology field, it has not yet been demonstrated how the process can be separated from the organism or its parts.

Phase I: Investigate and demonstrate the feasibility of mimicking biological pathways to produce magnetite particles with controlled morphology. The fibers or whiskers should have an aspect ratio of 1:10 (good) to 1:100 (better), with a maximum diameter of 1-3 microns.

Phase II: Produce sufficient magnetite particles of the specified size and aspect ratio; manufacture and test microwave absorption of a composite material consisting of the particles in a dielectric matrix.

TOPIC: A92-137TITLE: Nanocrystalline Tungsten

CATEGORY: Exploratory Development

OBJECTIVE: Develop the processing procedures to produce nanocrystalline tungsten for fully dense tungsten components.

DESCRIPTION: In metallic materials, the advantages of finer grain sizes are well known, i.e., higher strength. Nanocrystalline materials have crystal sizes that are on the order of a few nanometers in at least one direction and represent a reduction of scale of several orders of magnitude. The nanocrystal grains are separated by boundary core regions (grain boundaries) that are lower in density and higher in energy than the bulk grain. The density decrease is due to the poor crystallograph match across the boundary. In nanocrystalline materials the boundaries can occupy up to 50 volume percent of the structure and as a result can control the properties and the atomic structure of the overall solid. It is thus these boundaries that represent the essential structural component in nanocrystalline materials. Equiaxed nanocrystals are characterized by: (1) higher diffusivity and reactivity, (2) alloying of typically insoluble elements due to the open boundary structure, (3) ductile behavior of small grained

materials, and (4) reduced Young's modules compared to the bulk as a result of increased interatomic distances. The group VIB elements (Cr, Mo, and W) show a lack of tolerance, (a low solubility), for excess impurities, which then are rejected to the grain boundaries. This segregation leads to a loss of cohesion between the grains and is manifested as brittle failure when stressed. For tungsten, the ability to tolerate typically insoluble impurities (oxygen, carbon, nitrogen, hydrogen, etc.) at the grain boundaries along with the reduced grain size may result in ductile pure tungsten. Military applications may include kinetic energy penetrators, shaped charge liners and explosively formed projectiles.

Phase I: Demonstrate the processing technique proposed and deliver samples of nanocrystalline tungsten material for examination. Mechanical and physical properties along with supporting metallographic characterization will be required. An improvement in the ductility, strength, toughness or other property should be demonstrated.

Phase II: Exploit the knowledge gained in Phase I and scale-up the process to produce larger quantities of the nanocrystalline material for delivery to the Army for additional tests.

VULNERABILITY ASSESSMENT LABORATORY (VAL)

TOPIC: A92-138TITLE: MSE UHF ECCM Antenna Appliques

CATEGORY: Exploratory Development

OBJECTIVE: Determine what are the most cost effective ECCM antenna applique enhancements for Mobile Subscriber Equipment (MSE).

DESCRIPTION: The proposed SBIR effort involves studying and analyzing the most cost effective ECCM applique or combination of appliques that would enhance the survivability of MSE UHF links operating in the presence of hostile ECM. The study and analysis must be capable of employing the existing and any future DIA approved ECM threat assets which may consist of different severities and different types of intelligent ECM actions. It must also include the effects of local friendly interference sources and frequency management techniques which unintentionally adversely affect link survivability. The study must result in an analysis algorithm and associated computer program which enables its user to identify those ECCM appliques or combinations of appliques that allow a multiple node UHF communications network to achieve different degrees of link connectivity in the presence of different degrees of hostile ECM at given costs, where the costs consist of initial applique costs and life cycle costs including the costs of logistics and maintenance.

Phase I: Identify candidate ECCM antenna applique techniques in order of their respective effectiveness as determined by the results of computer program based model simulation of MSE functioning in the presence of the most current ECM threat. This phase necessitates an examination of the candidate ECCM technique computer program models that utilize or function as part of the MSE SPM model to determine the validity of the model's prediction of the respective ECCM techniques performance in the scenario under examination and an algorithm characterizing their interaction when employed together. This phase includes an examination of the viability of expanding the scope of the model to allow an expanded model module to be generated which can be used to predict the implementation and maintenance costs incurred over the life cycle of the combination of appliques being modeled.

Phase II: This phase involves preparation of software models from the algorithms developed in Phase I, that will allow the model operator to determine initial and life cycle costs of employing the identified ECCM fixes. Any such model must function as part of or interact with the MSE SPM model. It must also provide output data that can be directly used for planning for material acquisition and logistic support for those ECCM fixes or groups of fixes including the cost and quantity of components and sub-systems essential to their functioning besides providing a realistic cost assessment of the antenna applique ECCM fix selected for the given ECM threat. The model must be capable of identifying the most cost effective approach for any future ECM threat and produce the necessary planning data for that realization. No commercial application for this topic has been identified at this time.

TOPIC: A92-139TITLE: BI-Static Chaff Signature

CATEGORY: Exploratory Development

OBJECTIVE: Determine the bi-static signature of deployed chaff.

DESCRIPTION: Different types of chaff fielded in CONUS have been statistically characterized in both amplitude and phase . However, the effects of aspect angle or look angle on chaff signatures have not been quantified. Correlation has to be established between the chaff signatures obtained simultaneously at different aspect angles. In tactical scenarios, chaff is viewed by different threat systems deployed along and behind the FEBA. Knowing the signature correlations as functions of look angle can aid in increasing the predictability of chaff EW effectiveness.

Phase I: Development of a mathematical model of the bi-static signature of chaff. The model should address both the statistical amplitude and phase characteristics as functions of the transmit and receive angle.

Phase II: Validate the mathematical model developed in Phase I with actual measured characteristics. Develop algorithms how to increase the EW effectiveness of chaff by the availability of the bi-static signature. Algorithms developed under this program may have commercial application to aircraft control radars. Understanding of the bi-static signature of chaff may be applicable to other types of clutter such as rain and fog which may effect aircraft traffic control radars.

CONSTRUCTION ENGINEERING RESEARCH LABORATORY (CERL)

TOPIC: A92-140TITLE: Reuse of Energetics in Industrial Processes

CATEGORY: Exploratory Development

OBJECTIVE: Identify industrial processes which could use energy from waste and obsolete propellants, and develop a method or apparatus to safely deliver the energy to the process.

DESCRIPTION: The U.S. Army has aging and obsolete propellants, as well as waste propellants from manufacturing processes, which require disposal and safe demilitarization. These materials contain a great deal of energy which may be applicable in other industrial processes (e.g., cement kilns, steel mills) if they could be safely applied to the process. The purpose of this project would be to determine which industrial processes that require high temperature operation would be compatible with propellants such as nitro-cellulose. If such processes exist, the second phase objective would be to develop a method or apparatus to deliver the energy contained in propellants safely to the process.

Phase I: Evaluate feasibility of propellent use in high temperature industrial processes.

Phase II: Develop an apparatus to deliver the energy contained in propellants to high temperature industrial processes.

Potential Commercial Market: The U.S. Army, DOD and private explosives manufactures all have a need to dispose of excess energetics which could be used productively in high temperature industrial processes.

TOPIC: A92-141TITLE: Removal of Lead Paint from Buildings Prior to Demolition

CATEGORY: Exploratory Development

OBJECTIVE: Develop innovative technology for cost-effective removal of lead-based paint from buildings designated for demolition, without hazard to workers, occupants, or the environment.

DESCRIPTION: Lead is toxic to humans, and it is young children who are at greatest risk. The damage from lead to the developing brain is irreversible. Adults who have occupational exposure to lead are also at risk. The use of lead paints on residential surfaces was banned in 1977, but buildings constructed before that time may still have old coats of lead paint. The Army maintains 1.04 billion square feet of buildings constructed in 1980 or earlier. A major problem faced by the Army is the demolition of World War II era wood buildings which have lead-based paints throughout. The debris from demolition may be classified as a hazardous waste due to the lead paint, and the cost of disposal soars. The disposal costs will be greatly reduced if the paint can be removed from the substrates and the volume of hazardous waste is minimized. A method is needed for de-leading demolition debris so that the lead paint wastes can be segregated from other debris. The method must provide for control of the lead paint wastes to prevent exposure of workers to lead and release of lead into the environment.

Phase I: Analyze the state-of-the-art methods for paint removal and identify potential methods for separation of paint from the total demolition debris, so that the bulk volume of the debris can be treated as non-hazardous waste.

Phase II: Fabricate a prototype and marketable system for removing lead-based paint from surfaces of a building to be demolished.

Potential Commercial Market: Lead-based paint is a very significant environmental issue, considering the age of America"s infrastructure. Therefore, there is a very high potential for commercialization.

TOPIC: A92-142TITLE: Adaptive Construction Specification Generator and Evaluator

CATEGORY: Basic Research

OBJECTIVE: The objective is to provide Architect/Engineer (A/E) firms and government agencies with the capability to automatically adapt and evaluate construction specifications.

DESCRIPTION: The result of this project will be a system that automatically adapts and evaluates past construction specifications used on similar successful projects to create a new specification for a new construction project. The way in which various specification sections and/or paragraphs conflict will need to be identified. Ways to compare variations in the content of specification sections and/or paragraphs will also be developed.

Phase I: A minimum of ten sets of characteristics by which specification sections may be indexed will be identified. These characteristics will be assigned to each section, sub-section, and paragraph of Corps of Engineers Guide Specifications. Procedures to evaluate similarity of project characteristics will also be developed. A minimum of ten types of conflicts that may occur between specification sections, sub-sections, or paragraphs will be identified. A matrix showing each section, sub-section, and paragraph of the Corps of Engineer Guide Specifications and their potential conflicts with any other section, sub-section, or paragraph of the Guide Specifications will be developed. Ways to identify conflicts between specifications and successful/unsuccessful construction practice will also be included in the matrix. A prototype system will be developed that allows the creation of project specifications based on either Corps of Engineer Guide Specifications and/or past project specifications that have characteristics the same or similar to a new project. The system will also evaluate conflicts between a partial or completed set of specifications based on the conflict matrix.

Phase II: NAVFAC, GSA, NASA, and VA specifications will be indexed by appropriate characteristics and conflict matrixes will be developed. These other specifications will be included within the prototype system. A graphical user interface (GUI) will be developed to allow users to navigate through the process of specification development. Several specific features to be included in the system are: (1) users will be able to index any new section, sub-section, or paragraph of any specification in the system, (2) users will be able to access and utilize specification sections, sub-sections, or paragraphs based on either exact matches of project characteristics or by "close" sets of project characteristics pairs, (3) users will be able to identify sets of "close" project characteristics, (4) users will be able to resolve conflicts between various portions of the specifications, and (5) the system will be able to automatically identify significant changes between specifications and adapt the results to new specifications developed.

Potential Commercial Market: There are currently several organizations that have systems to assist designers develop specifications. Unfortunately, these systems only provide an electronic version of the traditional method of specification development -- "cut and paste". In spite of the limitation of existing systems, these systems are frequently used by private and public designers. The proposed enhancements to the traditional "cut and paste" methods, described by this topic should improve specifications and thus reduce overall project cost. A properly designed system that contains these capabilities will be highly marketable.

TOPIC: A92-143TITLE: Automated In Situ Inspection Systems for Underground Fuel Storage Tanks

CATEGORY: Exploratory Development

OBJECTIVE: Develop an automated in situ inspection system for underground and above ground storage tanks. The robotic inspection system will be capable of inspecting the interior surface of the tank without defueling or removing the contents of the tank.

DESCRIPTION: The Army currently operates and maintains over 20,000 underground storage tanks (USTs) many of which are untested. In addition to federal requirements stated in 40 CFR part 280, Army Regulation 200-1 requires all USTs to be in

compliance with the most stringent federal, state, local or Army policy including leak detection corrosion protection and spill/overflow prevention. One problem facing any owner of an existing UST is tank assessment, which is critical to the decision making process for tank management. The "Automated In Situ Tank Inspection System" would utilize robotic technology to inspect the interior surface of a tank using an ultrasonic sensor to develop a wall thickness profile. These data can then be used to develop a current condition index. The system would consist of: 1) Manipulator (6 DOF), 2) Sensor for collision avoidance, 3) Ultrasonic sensor, 4) Force sensor for sensor application, 5) PC based computing environment, and 6) Custom software for testing procedures.

Phase I: Design Robotic In Situ Inspection System.

Phase II: Integrate system in order to provide a detailed tank wall profile which can be used to develop a current tank condition index.

Potential Commercial Market: The marketability of such a system should prove to be extremely viable for not only the DOD but all federal and state agency"s who own and operate UST. The technology could easily be adopted to above ground fuel or chemical storage tanks by performing an inspection of the tank bottom and obtaining a wall thickness profile.

COLD REGIONS RESEARCH AND ENGINEERING LABORATORY (CRREL)

TOPIC: A92-144TITLE: Automatic Measurement of Cloud Liquid Water Content and Droplet Size

CATEGORY: Advanced Development

OBJECTIVE: To develop a system for measuring cloud liquid water content and the median droplet diameter under icing conditions. Frequent measurements of these parameters during a storm would contribute to our understanding of the small-scale structure and time-dependent nature of icing events.

DESCRIPTION: The rotating multicylinder has been used to determine the liquid water content (LWC) and median volume droplet diameter (MVD) in fogs at subfreezing temperatures. A description of the instrument design, deployment, and analysis of the measurements is contained in Howe (CRREL Report 91-2, 1991). Briefly, the mass of ice accreted in a known time period on six cylinders of different diameters is measured, along with the wind speed, air temperature and atmospheric pressure. With these data and curves relating the collection efficiency to Reynolds number and inertia parameter (e.g., Finstad et al., A Computational Investigation of Water Droplet Trajectories, J. Atmos. Ocean. Tech., 5, 1988) the cloud LWC and MVD are determined and a rough idea of the droplet size distribution is obtained. The method is labor intensive and time consuming, precluding frequent measurements during an icing storm. We would like an automatic system, exploiting, like the multicylinder, the variation in droplet collection efficiency of different size cylinders (or other shapes). Because only two parameters, LWC and a typical droplet size, are to be determined, the accreted ice mass need be measured on only two cylinders. The masses must be measured precisely (to at least 0.5%) under potentially windy (up to 40 m/s) and cold (down to -10 C) conditions. The device must also survive, but not necessarily operate in, windier and colder weather. The measurement frequency should be at least once per hour with minimal labor required by the site personnel.

Phase I: Determine feasibility for construction of such an instrument. Develop a working "breadboard model" which will meet above requirements. Conduct laboratory tests to verify proper performance of the "breadboard model." Assume that temperature, atmospheric pressure and wind speed measurements are made independently and are available as frequently as needed by the automatic multicylinder. It can also be assumed that the instrument will be used at a manned site with electrical power available.

Phase II: Design and build a prototype instrument meeting the above requirements. Modify the instrument based on the Phase I tests. Deploy the instrument in the field under icing conditions. Deploy the instrument in the field under icing conditions.

Potential Commercial Market: This device would be useful in any ground based investigation to determine the icing susceptibility of potential sites for power lines, transmission towers, radar installations or wind farms. The airport industry may find this device useful in forecasting the icing of airplanes.

TOPIC: A92-145TITLE: Light Transmission Through Floating Ice Covers

CATEGORY: Advanced Development

OBJECTIVE: To develop a spectroradiometer for measuring spectral incident, reflected, and transmitted irradiance by floating ice covers at visible wavelengths (400-700 nm).

DESCRIPTION: Light transmission through sea ice is important in a number of problems. Areas of particular interest include assessing the impact of shortwave radiation on biological activity in and under the ice and investigating through-ice communication capabilities. Existing submersible spectroradiometers are designed to be used in open water and consequently are not sensitive enough for the low light levels found under snow covered thick ice and are too bulky for easy under-ice use. The instrument must be sensitive enough for measurements under snow covered ice, where light levels are typically less than 1% of incident values. The transmitted light field exhibits a strong spectral dependence (more blue light, less red) making spectral light leakage a significant concern. A cosine-corrected irradiance collector is a critical component of the instrument. This is a field instrument so it must function at cold temperatures (-20 to 0 C) and be lightweight for portability. Since drilling large holes through ice several meters thick is difficult, the submersible portion of the instrument should fit down a small hole (ideally with diameter less than 9 inches). On board data storage would be a useful feature.

Phase I: Design and develop a breadboard spectroradiometer for use under floating ice covers.

Phase II: Finalize under-ice spectroradiometer and test prototype under Arctic field conditions.

Potential Commercial Market: This device would be used by oil companies involved in resource extraction in the Arctic.

TOPOGRAPHIC ENGINEERING CENTER (TEC)

TOPIC: A92-146TITLE: Development of a Hierarchical Dual-Function Terrain Data Set

CATEGORY: Exploratory Development

OBJECTIVE: Develop the concept of a hierarchical dual function data set that can be symbolized as a map background on one level and that can be used as an analysis resource on another level. The hierarchical dual function data set as described above will also have utility in the private sector. Depending on the density and/or content of the database, it could be integrated into various Geographic Information System (GIS) platforms and provide valuable support in such fields as environmental studies, urban planning and analysis, or natural resource exploration.

DESCRIPTION: A data set that transparently provides the user the ability to display feature information as a map background while concurrently providing underlying attribution that can be retrieved for analysis could potentially be of benefit to Army users. Current digital product specifications have been developed to support a single function, i.e., display or analysis. Multiple Product Operation (MPO) compilation within DPS at DMA does not fully integrate the product lines. Tactical Terrain Data contains selected TLM features but otherwise contains undefined overlap with other map features. For example, it is envisioned that for map background display, a woodland symbol would be generated that combined coniferous, deciduous, and mixed forests. The latter features would only be used in analysis functions such as generation of concealment tactical decision aids.

Phase I: Review existing 1:50,000 scale product specifications and develop a compilation strategy that will result, as an end product, in a hierarchical dual function data set.

Phase II: Demonstrate the concept of a dual function data set by developing a prototype for a small area of interest

TOPIC: A92-147TITLE: Personal Navigation and Reporting

CATEGORY: Exploratory Development

OBJECTIVE: Develop a troop level navigation capability with reporting of the individual positions to unit leader and others in the unit. If unit cost of the developed system is low enough, the system could be attractive to several commercial markets including orienteers and outdoorsmen.

DESCRIPTION: Successfully navigating through the lethal battlefield of the future will be a key to winning the battle. Currently, maps and compasses are being used for navigating; advanced orienteers use altimeters to supplement maps and compass information to navigate; the Global Positioning System (GPS) offers an affordable solution in the not too distant future

for navigating. Each of these methods has its own limitations - natural and manmade obstacles which significantly limit vision and reception of satellite information; lack of uniquely identifiable terrain on a map, etc. An integration of current techniques using digital compass, altimeter, and digital maps with GPS may offer a navigation capability for the individual soldier and/or his unit. The ability to safely and covertly report the individual positions to others in the unit will significantly reduce the potential for "friendly fire" accidents. A potential method for accomplishing the identification feature is to use a crystal which responds when excited at predetermined frequency. Currently, this technique is used by surveyors to locate buried survey markers. The reporting of the units location and status can then be integrated into the command and control system.

Phase I: The first phase of this project will be a six month effort to: 1. review current and future technologies and techniques for potential integration into a personal navigation and reporting system; 2. develop the concept of the personal navigation and reporting system, and 3. design a prototype system which is man-portable which would demonstrate the feasibility of the personal navigation and reporting system. Adapting the personal navigation and reporting system to the Soldier Computer Program shall be considered in the design.

Phase II: Based on the design developed in Phase I, design and demonstrate a personal navigation and reporting system.

TOPIC: A92-148TITLE: Feature Code Conversion Software

CATEGORY: Exploratory Development

OBJECTIVE: Develop software for analyzing, reconciling, and converting feature coding schemes within a Geographic Information Systems (GIS) environment. The continued spread of GIS technology ensures that the need to more effectively use existing spatial data will continue to increase in an expanding commercial market. Development of enhanced data transformation tools and utilities incorporating various automated feature code conversion techniques can provide an effective means of support for revision of existing digital geographic information and integration of diverse spatial data.

DESCRIPTION: The exchange of geographic data involves the transfer of the spatial locations of features as well as non-spatial information describing the features. Considerable effort has been made toward developing software to convert spatial locations and numerous solutions are commercially available. This effort focuses on the development of tools and utilities to convert the non-spatial or feature information.

Feature information generally includes the names of features, feature codes, attribute names, attribute codes, attribute value ranges, and compilation specifications. Tools and utilities are needed to facilitate the transfer of data from one feature information scheme to another. This would involve viewing feature information from two or more feature coding schemes, automatically or interactively translating one feature coding scheme to the other, and reporting on the quality of the conversion (including entity relationships, range mismatches, and loss of precision in value information).

Phase I: Develop a conceptual design for a feature code conversion system and demonstrate the design by working through a simplified conversion on paper.

Phase II: Develop a prototype feature code conversion system and demonstrate the system by working through an actual feature code conversion.

TOPIC: A92-149TITLE: Neural Network Environmental Monitor

CATEGORY: Exploratory Development

OBJECTIVE: Develop an innovative architecture, using neural networks and other techniques, for monitoring environmental applications such as pollution, disaster assessment, and surface changes. The system developed under this program could be very attractive as a commercial product in the pollution monitoring and environmental clean-up market.

DESCRIPTION: Neural networks have emerged as a dynamic computer technology with the ability to learn, and subsequently recognize patterns. Many environmental monitoring applications - land use and land cover determination, vegetation mapping, soil surveys, forest delineation, pollution detection, water body analysis, surface change from storms, floods, earthquakes and other disasters, etc. - involve recognition of patterns from various sources of imagery (airplane, satellite, etc.). Recent research

shows a trend toward new neural network architectures which combine neural networks with other technologies such as expert systems, fuzzy logic, genetic algorithms and statistical techniques to achieve optimum pattern recognition from available imagery and other information.

Phase I: Study existing architectures using neural networks for environmental pattern recognition. Recommend an optimal architecture for environmental monitoring applications. Determine basic feasibility by training and testing at least one architecture prototype on a specific environmental application in a proof-of-concept experiment.

Phase II: Expand the best architecture to handle a variety of environmental monitoring applications and develop a complete system, including a man-machine interface.

WATERWAYS EXPERIMENT STATION (WES)

TOPIC: A92-150TITLE: High-Shock Insensitive RF Transmitter/Locator (TL) Circuit

CATEGORY: Exploratory Development

OBJECTIVE: Develop a high-shock insensitive, miniature, solid-state, frequency-selectable, RF transmitter/locator (TL) circuit which can transmit a pulse-tone signal through air and through several meters of earth.

DESCRIPTION: The RF transmitter/locator circuit should be designed to operate from a miniature battery power supply, occupy minimum volume and require minimum power, with provision for built-in and external antennas. The transmitter circuit should have sufficient power to transmit signals from a remote site within an instrument transmitter canister, to a receiver, over a range of up to 5 miles in air or several hundred feet through a soil/air system. The unit should be capable of transmitting a pulse-tone at selected frequencies, such that air transmission at high frequency or transmission through several meters of soil at very low frequencies can be accomplished. The circuit should have a selectable, transmission delay capability to conserve battery power until transmitter activation is required.

Phase I: Phase I work will consist of three activities. First, conduct a feasibility study, based on currently available technology. The study should determine if the required features can be included in a single integrated circuit. A design review with the Army sponsor will be made at this point, before proceeding. At the conclusion of the design review, the second step will be to design, layout, and simulate an Application Specific Integrated Circuit (ASIC) using computer-aided design tools and furnish the design and simulation to the Army sponsor for final review. The third step should include investigation and design of antenna configurations.

Phase II: The Phase II work will consist of four major activities. First, submit the designs developed in Phase I to a silicon foundry for fabrication. Second, test and verify a number of prototype units. Third, furnish the results and 10 packaged devices, with antenna(s), to the Army sponsor for evaluation. If approved, provide 50 units in plastic surface mount packages for prototype production. Validated antenna systems design hardware should be delivered under this phase as well.

TOPIC: A92-151TITLE: Heavy Metal Decontamination of Soil Using Electrochemical Transport Processes

CATEGORY: Exploratory Development

OBJECTIVE: Evaluate the feasibility and demonstrate the effectiveness of electrochemical transport processes for treating metal contamination problems in soil environments.

DESCRIPTION: Limited basic research has shown that electrochemical transport processes have the potential to extract heavy metals from contaminated soils. This technique is a promising alternative for the in situ removal of metals from contaminated soils. Additional research is needed to determine the efficiency of the procedure for treating metals, overcoming operational problems, and demonstrating this technology in the field.

Phase I: The first phase will investigate, under laboratory conditions, the movement of water and metals in a variety of media. Also, laboratory experiments will be conducted to determine if fluids other than potable water can be used in the electrochemical procedure to extract heavy metals from contaminated soils. This research will enable the mass transfer limitations of the systems to be determined and will provide information on system effectiveness and costs. In addition to

investigation of the effects of the electrochemical potential on the removal of metals, a hydraulic gradient will be induced on the system to determine its effects.

Phase II: The treatment process(es) selected in Phase I will be tested under simulated field conditions using an "undisturbed" metal contaminated soil sample.

TOPIC: A92-152TITLE: Acoustic Buoy Release for Locating Underwater Instruments

CATEGORY: Exploratory Development

OBJECTIVE: To develop an inexpensive acoustic release, featuring the cutting of monofilament line, that allows instant location of seafloor instruments.

DESCRIPTION: An inexpensive acoustic release system is needed to provide easy location and recovery of instruments sited on the seafloor in shallow water (to 25-m depth). The system will eliminate diver costs and reduce vessel costs associated with instrument recovery. For exercises like Joint Logistics Over the Shore(JLLOTS), where short-term instrument deployments are typical, these cost savings could be a meaningful percentage of the total instrumentation budget. Other markets for such acoustic releases include Corps of Engineers District Offices and research laboratories, universities conducting coastal engineering field research, private coastal engineering consulting companies, and government agencies (NOAA, EPA, etc.) which use instruments to monitor the coastal zone.

Phase I: Design and develop either a non-redundant or a double-redundant release system. For the double-redundant system, redundancy should be provided for each component of the seafloor unit except the housing. The results of Phase I should be a working prototype that will perform all functions listed below, conform to all specifications, and work under actual conditions. Demonstrate the prototype by releasing a recovery buoy from working depth. The desired system should consist of (1) a deck unit with a directional hydrophone for acoustically homing in on the seafloor unit and for sending an acoustic signal to trigger the release and (2) a seafloor unit which responds to the homing pulse from the deck unit and releases a buoy at the proper signal. Costs can be reduced compared to existing releases by designing the device to function only with small buoys tethered by light lines and to operate only over short ranges. The release should function at temperatures from -5 to 40 degrees celsius and operate for 18 months on internal battery power at +20 degrees celsius. The release actuator should have a minimum of moving parts and be designed to cut 30- to 60- lb test monofilament line. High-frequency acoustic signals should be used such that the shipboard unit can trigger the release from a distance of at least 20 meters but not more than 30 meters. The seafloor unit should have a depth capability of 5 to 25 meters and be housed in a non-metallic cylinder which is less that 46 cm long and 10 cm in diameter; in use the long axis will be horizontal. The deck unit should be waterproof and rugged, use modular components, support the use of at least 1,024 separate release codes, and signal the operator when release occurs.

Phase II: Develop production techniques and specifications which can be used to produce either non-redundant or double-redundant acoustic release systems meeting the target costs and delivery times below. Produce and deliver three units of the selected type for testing by the Army sponsor.

Target costs:

deck units - less than $10,000 each
seafloor units:
non-redundant - 10 units for less than $600 each,
- 50 units for less than $500 each,
double redundant - 10 units for less than $1,000 each,
- 50 units for less than $800 each
Target delivery times - 4 to 6 weeks for both deck and seafloor units.

ARMY RESEARCH INSTITUTE FOR BEHAVIORAL AND SOCIAL SCIENCES (ARI)

TOPIC: A92-153TITLE: Measuring the Costs and Benefits of Army Service

CATEGORY: Exploratory Development

OBJECTIVE: To develop methods and data sources for evaluating the economic and social costs and benefits of Army service.

DESCRIPTION: To provide a more objective basis for military personnel decisions such as determining appropriate compensation levels, the Army needs to develop data sources and method for measuring the economic and social costs and benefits of military service for individuals. These methods and measures must account for the long-term as well as the short-term costs and benefits. There is a particular need to evaluate these costs and benefits of Army service for women and minorities.

Phase I: The major task for Phase I is to identify relevant data sources and statistical methods and procedures for modeling the economic and social costs and benefits of Army service. A preliminary model or models would then be specified.

Phase II: In Phase II, a prototype model or models would be fully developed, articulated, and evaluated using data sources identified in Phase I.

TOPIC: A92-154TITLE: Cognitive and Metacognitive Skill Development

CATEGORY: Exploratory Development

OBJECTIVE: To develop technologies for early identification and accelerated development of the cognitive and metacognitive skills required for successful executive-level performance.

DESCRIPTION: Current research on performance requirements at mid- and top-levels of large scale organizations strongly suggests that cognitive skills are of very great importance. For example, conceptual (integrative) skills are quite important in the performance of senior executives, and their selection for advancement. In addition, recent findings that the same or similar conceptual skills may be required for full adult maturity (necessary for objectivity in executive decision-making) as defined by Kegan. However, relatively little is known about how these skills develop in adulthood, methods for accelerating their growth, and the role, if any, of so-called "metacognitive" skills.

Several taxonomies of cognitive skills already exist. However, not a great deal is known about metacognition--or metacognitive skills--and the processes by which cognitive skills develop in adulthood. Further, little is known about individual differences in adult development, though lay experience suggests that substantial individual differences exist. (By inference, cognitive skill self-awareness--metacognition--ought to be important, in that it could be argued that self-generated feedback loops are necessary for development.) Finally, when progressive development does occur, the relative contributions of potential and experience are unclear.

The requested research would develop low cost automated technologies for assessing these skills, investigate skill development profiles (i.e., essentially norm the technologies for the key transition points in an officer's development, notionally at the points in time when sent to schools), confirm their importance in executive performance, and produce technologies (preferably automated) to accelerate their development at the various points at which they can be assessed.

Phase I: Phase I will require the development of a theoretical model which links cognitive and metacognitive skill development, and will identify low cost techniques for measuring these skills.

Phase II: Phase II will require the development of measurement techniques, norming them, and producing technologies which can be used to accelerate their acquisition. The Phase II development will also require experimental demonstration of the effectiveness of these technologies, and a further demonstration that growth in these skills enhances performance in executive decision-making tasks.

TOPIC: A92-155TITLE: Training-based Requirements for Semi-Automated Forces

CATEGORY: Exploratory Development

OBJECTIVE: To develop requirements for Semi-Automated Force (SAF) performance on the basis of unit training objectives.

DESCRIPTION: Distributed Interactive Simulations (DIS), such as the current SIMNET (Simulation Networking) or the future CATT (Combined Arms Tactical Trainer), are a method of providing tactical training that supplements field training. The

efficiency of training using DIS can be greatly enhanced using SAF instead of actual soldiers to represent the Opposing Forces (OPFOR), adjacent units, and supporting elements. The effectiveness of SAFOR should be determined by the extent to which they present to the unit being trained and evaluated. There is presently no methodology for developing SAFOR performance requirements on the basis of training objectives.

Phase I: Develop the conceptual approach for developing SAFOR performance requirements on the basis of training objectives and apply it to Armor platoon collective tasks as represented in Army Mission Training Plans.

Phase II:Refine the approach and expand the analysis up to and including the Battalion Task Force. Develop a demonstration using a representative sample of the performance requirements.

MEDICAL RESEARCH ACQUISITION ACTIVITY (MEDICAL)

TOPIC: A92-156TITLE: Membrane Protein Insertion Test System

CATEGORY: Exploratory Development

OBJECTIVE: Develop a test system and synthesize compounds which prevent insertion of polypeptide channel-forming toxins into neuronal membranes.

DESCRIPTION: Several polypeptide toxins of biologic origin gain entry into cells through insertion of amphipathic regions of their structure into susceptible cell membranes, in effect forming de novo, exogenous ion channels. These studies would be directed towards establishing a system for detecting this event and then identifying a series of prototype agents capable of preventing its occurrence.

Phase I: develop methodology appropriate for detecting insertion of polypeptides into neuronal membranes. Studies would entail initial identification or synthesis of peptide segments which mimic the amphipathic regions of known polypeptide toxins. Validation could include digestion of polypeptides with enzymes, treatment of polypeptides with antibody, and/or measurement of changes in physical/chemical properties of the membrane such as ph, conformation or fluidity, or ion-passing capability (active or passive).

Phase II: synthesize prototype compounds capable of blocking or interfering with polypeptide insertion, the ultimate goal being identification of a common molecular feature which could be incorporated for potential prophylaxis or treatment of channel-forming toxin pathophysiology. Use the validated test system to screen compounds for physical chemical changes or interactions with polypeptides which prevent their insertion. Compounds for physical chemical changes or interactions with polypeptides which prevent their insertion.

Potential Commercial Market: the understanding of the mechanism of action of entry of various toxins of biologic origin into otherwise healthy cells, offers broad application to the prevention or treatment of injury caused by these toxic agents. A commercial market must exist for such products as there is currently no suitable treatment or preventive measures for many of the agents in this class.

TOPIC: A92-157TITLE: Identification and Diagnosis of Toxin Exposure and Infectious Diseases

CATEGORY: Basic Research

DESCRIPTION: Develop systems to identify/diagnose toxins or infectious diseases in biological samples. Development of means of detection or diagnosis of exposure to toxins or infectious diseases of interest. Systems must be simple, sensitive, specific, reliable, and rapid for field use, without cumbersome equipment requirements. Systems should be applicable to biologic matrices such as blood, urine or other clinically obtainable samples. Toxins of principal interest include ricin, microcystin, botulinum toxin, palytoxin, saxitoxin and staphylococcal enterotoxins, clostridial perfringens toxins as well as other low molecular weight, peptide, and protein toxins. Infectious agents of interest include anthrax, plague, tularemia and selected virus diseases. Ability to identify/diagnose engineered organisms would be of special interest. Diagnostics for channel active toxins, pre- and post-synaptic toxins, and protein syntheses inhibitors are also of interest.

Phase I: Show proof-of-principle.

Phase II: Show utilization of the system for a variety of toxins in a variety of biologic matrices.

Potential Commercial Market: Several toxins and infectious agents that present a military threat also pose a significant pulic health hazard. These diagnosis kits would be of great value in determining the cause of outbreak of food poisoning or undetermined infectious disease.

TOPIC: A92-158TITLE: Test Strips for Evaluating Field Drinking Water

CATEGORY: Exploratory Development

OBJECTIVE: Develop test-strip technology specific for pesticides, herbicides, and other toxic organics and heavy metals such as lead, cadmium, and mercury to provide for the rapid evaluation of field drinking water.

DESCRIPTION: Off-the-shelf test-strip technology exists for numerous inorganic constituents. These test strips provide for rapid and fairly accurate evaluation of field drinking water. They can be used for individual water supply analysis and for both pre- and post-treatment water evaluation in conjunction with water purification units. This test-strip technology needs to be expanded to include additional heavy metals such as lead, cadmium, and mercury and pesticides, herbicides, and other toxic organics.

Phase I: Develop and demonstrate the performance of additional test strips for constituents at levels that would be considered toxic in drinking water. Evaluate test-strip response against interferences which would commonly be anticipated.

Phase II: Modify chemistries and packaging, and conduct accelerated aging experiments to demonstrate a shelf life of about 5 years. Provide the U.S. Army with 100 prototype test-strip kits, each containing 50 test strips, for additional evaluation and field testing.

Potential Commercial Market: Potential marketability of final test strip products under this research is high based on the current technology development and marketing of similar test strip indicators for selected chemical contaminants in water. Potential product customers include regulatory authorities at the federal, state, and local levels in their efforts to screen for water treatment and wastewater discharge compliance limitations for selected chemicals; and also those potential water treatment and wastewater discharge sources (e.g. Private industrial operations, public facilities, etc.) responsible for water treatment and wastewater discharge control.

TOPIC: A92-159TITLE: Miniature Infrared Multigas Analyzer

CATEGORY: Exploratory Development

OBJECTIVE: Develop a small portable infrared gas analyzer which could be used to monitor low levels of toxic combustion gases under field conditions.

DESCRIPTION: Military weapons systems generate combustion products which contain potentially dangerous levels of air toxics. In order to accurately assess the health hazards, portable real-time monitoring instrumentation needs to be developed. Recent advances in the development of miniaturized semiconductor optical sources and solid state detectors could lead to relatively small infrared gas analyzers with low power requirements. This instrumentation could be used in crew compartments to monitor short-term concentration excursions of several toxic gases simultaneously.

Phase I: Using off-the-shelf miniaturized electronic components, demonstrate the feasibility for measuring the following gases: hydrogen chloride, hydrogen fluoride, hydrogen cyanide, hydrogen sulfide, carbon monoxide, carbon dioxide, nitric oxide, and nitrogen dioxide.

Phase II: Build a prototype multigas infrared analyzer which will measure five air toxics simultaneously. Establish linear response range and provide for electronic storage for about 2 hours of data for each of the gas-measuring channels.

Potential Commercial Market: Potential marketability of a miniature infrared monitor sensitive to the gases specified in this topic is moderately high, with primary application for occupational safety and health related issues. Potential customers would include both regulatory agencies for a range of air contaminants; and private industry and public sector employers responsible for managing workplace environments to achieve compliance with air contaminant limits for these gases.

TOPIC: A92-160TITLE: Auscultation of Patient Breath Sounds During Patient Evacuation

CATEGORY: Exploratory Development

OBJECTIVE: Develop a small, light weight piece of equipment to assist medical personnel in the auscultation of breath sounds in patients during transportation in military evacuation vehicles.

DESCRIPTION: Auscultation of breath sounds is fundamental to the physical assessment of critically ill patients. During evacuation of patients in military vehicles, auscultation can be compromised by high ambient noise levels. A recent report in the literature indicates that conventional and amplified stethoscopes are inadequate for auscultation during aeromedical evacuation, and nonauscultatory monitors may signal a respiratory problem but fail to identify its nature or location. A device to meet this requirement could incorporate active noise cancellation technology into the stethoscope design, or it could use other innovative methods to enhance the medic's ability to hear critical sounds.

Phase I: Develop a prototype device for the auscultation of patient breath sounds in different military evacuation vehicles.

Phase II: Test the device and optimize hardware/software. Deliver at least one functional prototype model with documentation verifying its operational characteristics and establishing that its design and operation has been optimized based on laboratory test data.

Potential Commercial Market: This specialized stethoscope product could be useful in any emergency medical treatment situation where high background noise is encountered. It would have use as part of basic equipment set on any emergency medical vehicle (ground or air).

TOPIC: A92-161TITLE: Development of Diagnostic Probes for the Detection and Surveillance of Drug Resistant Parasitic Infections

CATEGORY: Exploratory Development

OBJECTIVE: To develop probe(s) that will provide rapid field identification of drug resistant plasmodium falciparum malaria and leishmania species.

DESCRIPTION: The phenomenon of resistance to drugs by prokaryotic and eukaryotic pathogens is a matter of great practical concern. The prevalence of multidrug resistant strains of p. Falciparum and the unresponsiveness of cutaneous and visceral leishmaniasis to antimonial therapy is a serious clinical problem that represents an important threat to the management of these diseases. There is a growing demand for the development of a rapid diagnostic test that will allow a complete direct identification of drug-resistant parasites in easily obtainable patient samples. The probes would call for a single reading of results by semi-skilled technical staff. The probes should be specific, sensitive and inexpensive. The quantities required for in vitro and field testing of each probe submitted is aoubt 100 and 1000 reactions respectively.

Phase I: Submission of potential probe(s) in the appropriate quantity and quality for in vitro testing against reference drug resistant and sensitve parent clones of the parasites.

Phase II: Submission of additional quantities of specific probe(s) for field testing and evaluation.

Potential Commercial Market: Malaria is a world wide health problem. Rapid, specific, sensitive test for malaria would have broad market application.

TOPIC: A92-162TITLE: Neutralizing Monoclonal Antibodies Against Biological Toxins

CATEGORY: Basic Research

OBJECTIVE: Provide neutralizing humanized monoclonal antiboides for specific toxins and threat agents.

DESCRIPTION: Using traditional approaches or novel techniques of in vitro stimulation of human spleen or peripheral cells or recombinant conversions of mouse monoclonals, produce humanized neutralizing monoclonal antibodies with specificity for important toxins and threat agents. Antibodies for specific toxins such as: blue-green algal toxins (microcystin), dinoflagellate toxins (saxitoxin, gonyautoxins, brevetoxin, palytoxin), vertebrate toxins (tetrodotoxin, batrachotoxin), protein synthesis

inhibiting plant toxins (ricin), protein and peptide toxins of other biological origin (including pre- and postsynaptic neurotoxins, and membrane active substances), and other bacterial toxins such as clostridium prefringens toxin, are of particular interest. Physiologically active compounds of biological origin are also of interest as are anthrac, tularemia, q-fever and human pathogens of alphaviridae, flaviviridae, bunyaviridae, filoviridae and areaviridae.

Phase I: Generate antibodies and demonstrate neutralizing specificity in a model system.

Phase II: Produce research quantities of the specific humanized monoclonal antibodies.

Potential Commercial Market: Several militarily relevant toxins (eg., Saxitoxin, brevetoxin, botullinum toxin) present significant public health hazards through oral ingestion. No specific treatment regime exists. Neutralizing monoclonal antibodies against these toxins would be a significant advance in protecting the public health.

TOPIC: A92-163TITLE: Rapid Field Toxicity Test for Water Supplies

CATEGORY: Exploratory Development

OBJECTIVE: Develop and demonstrate a rapid field test to determine general toxicity of water for consumption.

DESCRIPTION: A number of biological systems have been shown to be feasible for the detection of specific groups of toxic chemicals. Additional work is necessary to develop a rapid toxicity indicator system which can be taken into the field and operated by a single person having limited electrical power and laboratory facilities. The toxicity indicator system will have the capability to detect the toxic materials at the human threshold acute toxicity levels and discriminate between general types or classes of toxicants based upon their effects on the biological assay system. The method should be rapid, be capable of providing results in less than 1 hours, and be capable of semiquantitatively determining the level of toxicant present. The system must be able to work in the presence of typical waterborne constituents such as turbidity, organic materials, microorganisms, plus variable ph, temperature, and ionic concentration. The system must be capable of detecting both soluble or insoluble chemicals.

Phase I: Develop the system and demonstrate that it can rapidly detect a wide range of representative acute human toxic substances in water.

Phase II: Develop a full-scale prototype toxicity assay system including any hardware or software which are required to make it functional in a portable field mode. Demonstrate the systems ability to meet the minimum requirements described in the narrative above.

Potential Commercial Market: Potential product commercialization is extremely high, with principal application focus on water quality analysis for treatment and waste discharge compliance regulatory requirements. A rapid monitor capable of screening for a range of waterborne contaminants and overall quality parameters has a wide use potential in both the private industrial sector, and within the public sector with organizations responsible for monitoring, treating, and controlling water supplies.

TOPIC: A92-164TITLE: Oral Delivery of Viral Vaccines by Biodegradable Polymeric Microcapsule with Bioadherence Properties

CATEGORY: Basic Research

DESCRIPTION: To achieve maximum protection, most vaccines require two or three booster doses, causing logistical difficulties. Furthermore, parenteral administration of the vaccine by trained medical personnel considerably increases the cost of vaccination. Therefore, biodegradable microspheres for the encapsulation of viral vaccines with or without immunoadjuvants are needed which would evoke complete protection for a duration of at least one year by single oral administration. The microcapsule should adhere to intestinal mucosa for several days to assure uptake by antigen processing cells located in peyer's patches.

Phase I: Demonstrate feasibility in laboratory animals, using viral vaccines representing militarily relevant arboviruses at biocontainment level 2.

Phase II: Extend utilization to viral and bacterial vaccines at biocontainment level 3.

Potential Commercial Market: Microencapsulation of vaccines present a significant advancement in vaccine technology by allowing one oral vaccine to replace a vaccine and several boosters. All commercial vaccine manufacturers would be a potential commercial market for development of this technology for viral vaccines.

TOPIC: A92-165TITLE: Medicinal Chemistry - Synthesis of Potential Drugs Effective Against Toxic Agents of Biological Origin

CATEGORY: Basic Research

OBJECTIVE: Develop prophylactic/therapeutic compounds for treatment of intoxications caused by toxins of biological origin.

DESCRIPTION: Toxic agents of biological origin such as botulinum toxins, palytoxin, saxitoxin, staphylococcal enterotoxins, ricin, etc. are potential threat agents for which protective measures are required. There is an interest in chemical compounds which potentially will prevent (pretreatment) and/or counteract (antidote-treatment) the toxic effects of such agents. Airways or systemic applications will be considered. The drugs need to be reasonably non-toxic and fast acting. The compounds proposed should be based on a biological rationale and the compounds prepared are to be submitted in 3-5 gram quantities for biological evaluations. The submitted compounds are to be fully characterized, and of high purity (>99.5%), For screening against the targeted threat agents.

Phase I: Demonstrate efficacy of the compound in a model system.

Phase II: Demonstrate efficacy against other toxins.

Potential Commercial Market: Several militarily relevant toxins (eg., Saxitoxin, botullinum toxin) present significant public health hazards through oral ingestion. No specific treatment regime exists. Chemical compounds for treatment or protection against these toxins would be a significant advance in protecting the public health.

TOPIC: A92-166TITLE: Medical Countermeasures Against "Toxic Agents of Biological Origin"

CATEGORY: Basic Research

OBJECTIVE: Refine or develop new model systems to determine pathophysiologic mechanisms. Provide new methods of therapy and prophylaxis for biological toxins.

DESCRIPTION: Biological toxins, such as ricin, anthrax, and staphylococcal enterotoxins have been suggested as potential threat agents for which protective measures are required. The molecular sites of action of several of these toxins have been identified, however, cellular and organ pathophysiology as well as integrative mechanisms in whole animal models require further study. Prophylaxis and therapy are also not available. Research proposals designed to determine pathophysiologic mechanisms and for developing potential medical countermeasures such as vaccines, antibodies, or drug prophylaxis and treatment regimens are strongly encouraged.

Phase I: Demonstrate usability of new methodology for a single toxin.

Phase II: Demonstrate usability of methodology for a variety of biological toxins from various diverse sources, plant, bacteria, etc.

Potential Commercial Market: Several militarily relevant toxins (eg., Saxitoxin, botullinum toxin) present significant public health hazards through oral ingestion. No specific treatment regime exists. Study of the molecular sites of action leading to medical countermeasures against these toxins would be a significant advance in protecting the public health.

TOPIC: A92-167TITLE: Cellular Immune Response to Diseases of Military Importance

CATEGORY: Basic Research

OBJECTIVE: To develop new, sensitive, quantitative tests to monitor cellular immunity as a response to vaccinations.

DESCRIPTION: Recovery from, and perhaps protection against, several diseases of military importance is mediated by cellular immunity. Sensitive, quantitative, and easily applied tests to detect relevant responses are needed both in evaluation of the immune status of antibody-negative subjects and to monitor vaccine development. Typical systems in which such responses are thought to be biologically relevant include diseases caused by arenaviruses, filoviruses, hantaviruses and q fever.

Phase I: Demonstrate proof-of-principle using an organism from those listed.

Phase II: Demonstrate applicability in specimens from infected individuals.

Potential Commercial Market: Monitoring cellular immunity may be used to evaluate immune status of antibody-negative individuals vaccinated against a variety of infectious diseases. Development of a sensitive quantitative test of cellular immunity would be of potential interest to all vaccine manufacturers in order to quantify level of protection demonstrated by a new or existing vaccines.

TOPIC: A92-168TITLE: Non-Invasive Determination of Central Neuronal Injury

CATEGORY: Exploratory Development

OBJECTIVE: Develop and validate a method to non-invasively identify and quantitate the occurrence of brain damage in laboratory animal species.

DESCRIPTION: Exposure to a variety of toxic chemical agents results in regionally specific neuropathology, either due to direct neuronal insult or as a sequelae of the agent toxicology (e.g., Convulsive seizures). At present there is no good non-invasive means of detecting such damage unless it is severe enough to affect the animal's behavior. These studies should identify and validate such a non-invasive methodology specifically targeted for use in screening potential pretreatment/therapeutic compounds for their ability to prevent neuronal damage following systemic chemical agent challenge.

Phase I: Develop a non-invasive method for identification of central neuronal damage which is sufficiently sensitive and specific to quantitate neuronal damage commensurate with its earliest histologic appearance (i.e. Within the initial 24 hours). This method will be suitable for screening large numbers of experimental animals rapidly and at moderate expense. For example, one possible approach might focus on rapid detection and quantitation of some neuron-specific enzyme or constituent present in the peripheral circulation as a consequence of damaged neuronal cell membranes.

Phase II: Validate methodology by comparison of the non-invasive test results with concomitant evaluation of histologic neuronal damage induced by systemic administration of known neurotoxic chemicals.

Potential Commercial Market: Development of a sensitive non-invasive method for identifying early neuronal cell damage would have potential commercial market among drug testing companies and toxicology laboratories.

STRATEGIC DEFENSE COMMAND (SDC)

TOPIC: A92-169TITLE: High Energy Laser Beam Diagnostic Development

CATEGORY: Basic Research

OBJECTIVE: The objective of this effort is to identify beam diagnostic methods which will provide a near real time spatial image of high intensity IR laser beams in the near field.

DESCRIPTION: High Energy Laser (HEL) testing at the High Energy Laser Systems Test Facility (HELSTF) will be significantly enhanced as additional methods for measuring beam characteristics are developed. There is a current active effort to relieve past doubts about the characteristics of the HEL beam reaching the target. Additional beam diagnostic information would diminish the uncertainties in the laser test community and improve the results of the analytical processes. It is intended that the new measuring device would operate in all HELSTF test areas, namely, Test Cell-B (TC-B), Effects Test Area (ETA), and the Large Vacuum Chamber (LVC). Currently, beam diagnostic measurements are made in both the Low and High Power Optical trains. Ideally, the measurements made by the diagnostic equipment developed in this effort would confirm parameters which are currently used to measure beam quality. HEL beam power has previously been measured using both ball calorimeters and scatter plates. Specifically required new beam quality information included both intensity profiles and power measurements. Compensation for both turbulence contributions and beam smoothing techniques is also a consideration in this effort.

Phase I: Review previous beam diagnostic efforts both at HELSTF and in general, determine appropriate additional near field beam diagnostic capabilities, and possibly demonstrate a sub-scale proof of principle device.

Phase II: Design full scale beam diagnostic equipment and begin fabrication of hardware and/or generation of software. Fabricate and test hardware and associated techniques at HELSTF. Phase II proposals will also include an assessment of commercial markets for the beam diagnostic equipment.

TOPIC: A92-170TITLE: High Energy Laser Wavefront Analysis

CATEGORY: Advanced Development

OBJECTIVE: The objective of this development is to create an effective means for measuring the wavefront of a high energy laser beam that is acceptable to the High Energy Laser (HEL) test community.

DESCRIPTION: HEL testing at the High Energy Laser Systems Test Facility (HELSTF) would be significantly enhanced if a reliable and effective means of measuring the wavefront of an HEL beam could be found. Devices used in the past have proven to be unreliable and subject to intense maintenance. Additionally the results of measurements from these devices have proven to be suspect.

The developed device would have to be contained within the low power optical train of the HELSTF. However, it would be desirable if the device could be portable and flexible enough to be transported and used at other locations. While the device is initially intended to be used on lasers operating in the 3.6 micron range, consideration should be given to what modifications or design changed would be required to use the same or similar device on laser operating at different wavelengths.

Phase I: The objective is to conduct a thorough search of previously used or possible methods of conducting the desired measurement and recommend a viable method for exploitation in Phase II.

Phase II: The objective is to design and fabricate the breadboard wavefront analyzer, demonstrate its utility, and prepare a design for a final product. Phase II proposals will also include an assessment of commercial markets for a High Energy Laser wave front analyzer.

TOPIC: A92-171TITLE: Use of High Energy Lasers in Materials Research Develop

CATEGORY: Basic Research

OBJECTIVE: The objective of this development effort is to thoroughly study and make recommendations for the design of a chamber(s) required to conduct basic materials research using High Energy Laser (HEL).

DESCRIPTION: HEL testing at the High Energy Laser Systems test Facility (HELSTF) frequently involves switching the beam into and among the primary tests areas at the site, namely, Test Cell-B (TC-B), the Effects Test Area (ETA), and the Large Vacuum Chamber (LVC). In this switching process large percentages of the laser energy is typically switched into beam dumps. Currently there is a continuing effort to use some of this "wasted" energy in a new "Auxiliary Test Area" (ATA). There is an active interest in pursuing a set of novel material experiments using the energy in the ATA. During a recent experiment, an attempt to create Buckminsterfullerene (C-60) was made utilizing small Helium filled chambers. The attempt was partially successful, however, the chambers material window failed.

This project would require a thorough study of possible methodologies to use HELs to create new materials, such as fullerenes, thin film diamond, superconductors, and high temperature lubricants (or other exotic materials defined by the study). With these methodologies defined, the study would then concentrate on design and development of test chambers that could be used to produce the materials discussed above using waste energy at HELSTF. Design parameters required in this study would include size, pressure, temperature, window material, and material collection methods used within the chamber.

Phase I: Review previous efforts to create new materials using HELs. Determine possible new methodologies to create exotic materials using HELs. Define and design possible experiments to be conducted at HELSTF. Begin preliminary design work on the experimental chambers and equipment needed to produce these materials using waste HEL energy at HELSTF.

Phase II: Complete hardware design and production. Test and validate the proposed material production methodologies, chambers and equipment at HELSTF using waste HEL energy. Phase II proposals will also include an assessment of commercial markets for the sum of the specialty products that might be synthesized through the use of high energy lasers.

Potential Commercial Market: Upon refinement and validation of production methodologies, define and design the requirements and equipment for possible large scale production of the new materials.

TOPIC: A92-172TITLE: Signal and Data Processing

CATEGORY: Basic Research

OBJECTIVE: New and innovative approaches offering order-of-magnitude improvements to sensor signal and data processing performance, power, weight, size, and cost.

DESCRIPTION: The Kinetic Energy Anti-Satellite Program sensor design will produce electronic signal information which must be processed quickly and accurately to perform surveillance, target discrimination, tracking, ranging, and image definition functions. Signal processing of the sensor data is first performed to identify object detections. Data processing is then performed to handle target tracking, intensity growth, discriminate target shapes, and other high-level functions. Advances are needed both in hardware architecture and in algorithms to better handle functions such as structured background removal, object dependent processing, target glint tolerance, extended dynamic range, and sub-pixel resolution

Phase I: A Phase I effort will identify one or more specific functional elements of the signal and data processing chain and seek a sizeable and realizable improvement. This will include design and simulation of the improvement and proof of its technical merits.

Phase II: A Phase II effort will develop the signal or data processing improvement for a more detailed simulation/prototype demonstration of the advantages of the resulting hardware or algorithm. Phase II proposals will also include an assessment of commercial markets for the signal processing improvements identified in Phase I.

Potential Commercial Market: A Phase II effort will include the application of the processing innovation to real systems with a level of maturity sufficient to be introduced into either an ASAT or commercial demonstration program.

TOPIC: A92-173TITLE: Satellite Kill Mechanisms

CATEGORY: Basic Research

OBJECTIVE: Innovative concepts, designs, and devices for ASAT application to negate the functional capabilities of target satellites while minimizing the creation of space debris.

DESCRIPTION: A challenging technical problem for the Kinetic Energy Anti-Satellite Program is to provide a high kill (target negation) probability that can be confirmed by the kill vehicle or the Space Surveillance Network and not create unnecessary space debris in the process. For this purpose a kinetic energy kill device will be activated by the kill vehicle at close range to the target satellite. Alternative concepts and designs for kinetic energy kill mechanisms, devices to be used in conjunction with a kinetic energy kill mechanism in order to enhance kill effectiveness, and devices to determine kill effectiveness are being sought. Desirable qualities are large kill diameter, rapid fuzing, low size/weight, low power requirements, long term storage reliability, and low cost.

Phase I: A Phase I effort will provide proof of concept by means of preliminary design, simulation, and/or laboratory experimentation.

Phase II: A Phase II effort will include detailed design, fabrication, and evaluation of a working, but not necessarily optimized, breadboard or brassboard model. Phase II proposals will also include an assessment of commercial markets for the devices developed during Phase II.

Potential Commercial Market: A Phase II effort will include hardware prototype developed to a state where it can be demonstrated in an actual or simulated flight environment.

TOPIC: A92-174TITLE: Visible Sensors

CATEGORY: Basic Research

OBJECTIVE: Innovative approaches and designs to improve visible sensor performance for ASAT application.

DESCRIPTION: This program is intended to promote advances in visible sensor design and related technologies for Kinetic Energy Anti-Satellite Program application. A sensor and its associated systems will provide to the kill vehicle the means to update position by stellar alignment as well as to detect, acquire, and track target satellites against a variety of backgrounds. The current ASAT design employs a staring visible seeker. Technical challenges include off-axis light rejection, platform stability (jitter tolerance), seeker sensitivity, long term storage reliability, cooling requirements. New and innovative approaches to these requirements using advanced concepts are sought. In addition to novel sensing concepts, sensor-related device technology is also needed in areas such as advanced focal plane arrays, improved detector efficiency, improved optic baffle designs, platform damping, and image intensification methods.

Phase I: A Phase I effort will provide proof of concept by means of preliminary design, simulation, and/or laboratory experimentation.

Phase II: A Phase II effort will include detailed design, fabrication, and evaluation of a working, but not necessarily optimized, breadboard or brassboard model. Phase II proposals will also include an assessment of commercial markets for the devices to be developed during this phase of the project.

Potential Commercial Market: A Phase III effort will include a hardware prototype developed to a state where it can be demonstrated in an actual or simulated flight environment.

TOPIC: A92-175TITLE: Improved Real-Time Ionospheric Compensation for Kwajalein Missile Range (KMR) Radars

CATEGORY: Advanced Development

OBJECTIVE: Improve real time Ionospheric Compensation for the ARPA Long Range Tracking and Instrumentation Radar (ALTAIR) located at KMR.

DESCRIPTION: ALTAIR can accurately correct range and track measurements when it has UHF and VHF track on an object. Elevation corrections, which are based upon the UHF/VHF difference, are not as accurate because they do not correctly account for the height of the F region maximum in the ionosphere. When single frequency track is employed, an ionospheric model is used to make all corrections. This model was last updated in 1983 and does not include any data from the current solar cycle.

Phase I: Determine whether suitable models exist which could be used by ALTAIR for ionospheric compensation. Determine whether additional ionospheric measurements are required to construct a suitable mode. Determine potential for use of the model at sites other than ALTAIR.

Phase II: Obtain and install a high performance,e real time ionospheric correction model at ALTAIR. If necessary this work would be preceded by an ionospheric measurements program at ALTAIR. Phase II proposals should also include an assessment of commercial applications for the ionospheric compensation model.

TOPIC: A92-176TITLE: Real-Time Drag Determination for Kwajalein Missile Range (KMR) Tracking Development

CATEGORY: Advanced Development

OBJECTIVE: Determine the feasibility of augmenting existing tracking filters for the KMR radars to allow real time computation, correction and prediction of reentry (100km) drag experienced by objects under track.

DESCRIPTION: The complexity and uniqueness of some reentry objects observed by KMR cause drag profiles to significantly deviate from a prior predictions. If the deviation is excessive, track loss may result. A tracking filter that computes drag in real time through use of a predictor/corrector process is a potential method of solution. Use of the filter with KMR's narrow team radars (ALCOR, MMW, FPQ-19) is a particular interest.

Phase I: Develop algorithm and ascertain feasibility of implementation. Determine potential for application of the filter at other test ranges.

Phase II: Validate via simulation and deliver the algorithm recommended for implementation. Phase II proposals should also include an assessment of commercial applications for the tracking filter.

TRAINING AND DOCTRINE COMMAND (TRADOC)

TOPIC: A92-177TITLE: Concept-Based Requirements Decision Support System (CBRDSS)

CATEGORY: Basic Research

OBJECTIVE: Develop a sophisticated Artificial Intelligence (AI) based Decision support System (DSS) which provides advanced model management capabilities and heterogenous database integration facilities to support the preparation of the Program Objective Memorandum (POM) by TRADOC and other MACOMS.

DESCRIPTION: In an environment of tightly constrained resources automation is playing an increasing vital role in the modeling of competing investment strategies to determine which provides the optimum cost/benefit tradeoff while insuring the successful completion of the MACOM's mission. An integrated software package is required to support the analysis and decision process of senior Army executives in preparing the Program Objective Memorandum in which a MACOM establishes its short-term and 5-year mission objectives, requirements and resource priorities. Such a software system should include:

* a graphical user interface

* model management tools to support intelligent modeling of the cost vs benefits of investment opportunities, contingency ("what if?") analysis and automatic detection of reduced mission capability or inadequately supported programs or initiatives ("broken programs")

* AI-based capabilities which correctly model the priorities and preferences of the senior MACOM leadership and capabilities to translate mission objectives into mathematical models

* AI-based capabilities to model the decision process from premises through analysis to conclusion while insuring consistency in the reasoning process

* facilities to automatically retrieve and utilize data residing on remote heterogenous hosts without the requirement for specialized server software to be installed on these same hosts

Phase I: Conduct of investigations and technical analysis required to specify relevant AI and DSS technologies and to present a proposed software/hardware architecture required for a solution. Phase I will include the development of a prototype DSS which illustrates the relevance and contribution of the proposed technologies to the construction of a production DSS. The demonstration should use existing Army-owned PC's (various IBM compatibles or Apple Macintosh computers). Mini-computes available from existing requirements contracts and/or current Army owned mainframes.

Phase II: Extend the results of Phase I to a production system to be used by senior Army analysts and executives in preparing a MACOM POM submission to HQDA. In addition, user training and full documentation to include software maintenance manuals, user's guides and programmer's reference manuals will be required.